Tonkin+Taylor

Job No: 11015172.1400
1 November 2021

Auckland Council
Private Bag 92300
Auckland 1142

Attention: Mark Ross

Dear Mark

Keith Hay CC9 - BUN60382589, Response to Section 92 Request for Further Information

Further to your letter dated 19 August 2021 requesting further information pursuant to section 92 of the Resource Management Act 1991 (RMA), we write to provide a response to the matters outlined therein. The information requested is shown in *blue italics*, followed by our response. For ease of reference our numbering corresponds to the numbering set out in your letter.

Natural Hazards/Flooding

1. Please advise if manhole covers within the overland flow paths and flood plains are proposed to be sealed. This is necessary to assess whether or not the proposal increases the risk of adverse flooding effects, noting that sealed devices will provide appropriate levels of mitigation whereas unsealed manholes will increase flooding risks at outfall locations, causing surcharging and overflows.

The manholes are assets owned and designed by Watercare, an organisation that is responsible for planning, developing, operating and maintaining the Auckland region's wastewater network. Stormwater/floodwater infiltration into the wastewater system is an operational issue for Watercare as opposed to a consenting matter, and is addressed through the Asset Management Plan 2021 - 2041 and the Wastewater Asset Strategies. Notwithstanding this, the following can be confirmed:

- Lids of the manhole chambers will be closely fitted to minimise the potential for water to enter.
- The manhole covers are not vented and therefore will largely prevent infiltration from occurring.

On that basis, there will be no increase in flooding risks due to infiltration.

2. Please advise if the ground levels where trenching works are proposed to be undertaken will be reinstated to existing ground levels upon completion. This is necessary to confirm that there will be no loss of flood storage / divergence of flows as a result of works, and will substantiate the assessment in Section 5.6 of the submitted assessment of environmental effects (AEE) that there will be no exacerbation of existing natural hazards and demonstrate compliance with Standards E26.5.5.2.(18)(b) and (19) of the Auckland Unitary Plan (Operative in Part) (AUP(OP)).

The ground levels where trenching works may be undertaken will be reinstated to existing ground levels upon completion.

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3. Please provide details of the flood hazard management /protocols that will be implemented during construction where trenching works within overland flow paths and flood plains are required. This is necessary to ensure that flood risks will be suitably managed during the construction period.

The works do not involve the storage of large quantities of spoil material on site. In any case, the works will be undertaken in accordance with the approved Site-Specific Erosion and Sediment Control Plan[1] (SSESCP) for Keith Hay Park. The SSESCP includes specific measures to address significant storm events and ensure flood risk is suitably managed. These measures include the following:

- Regular monitoring of the weather to ensure measures are put in place in the event of heavy rainfall events being forecasted.
- Covering stockpiles.
- Securing loose material and equipment.
- Returning all fuels, oils and chemicals to secure storage.
- Relocating plant, equipment and material away from areas that may flood, if practicable.

The SSESCP for Keith Hay Park will be updated to specifically address CC9 works, including trenching activities should this construction methodology be required. However the trenching will be undertaken in stages. During heavy rainfall events, the stage that is open will effectively act as a depression or small storage area. Trenching activities will therefore have no impact on flood hazards.

Construction Management

4. Section 5.2 of the AEE states that the works will be in accordance with the applicable management plans, including Construction Management Plan (CMP), Doc No. GAVJV-PLN-0017, Version 2.3 Final, approved 6 May 2020. Please provide a copy of this CMP for review.

The Construction Management Plan (CMP) is attached in Appendix E. We note that this has already been subject to the scrutiny and approval of Auckland Council. This CMP will be updated to incorporate the proposed CC9 works.

Traffic

5. The Hillsborough Kindergarten car park off Richardson Road currently provides around 14 to 16 parking spaces accessed via a two-way vehicle crossing. A public right of way running northwards from Richardson Road also commences in this car park, running between Hillsborough Kindergarten and Hay Park School, towards Mount Roskill Cricket Club. Whilst the Traffic Assessment Report refers to potential trenched construction over the southernmost section of the new wastewater connection, this is still to be confirmed. However, on the basis of anticipated effects associated with trenching methodology, the following additional information is requested:

a. Confirmation as to how many parking spaces within the Kindergarten Car Park are to be occupied by construction activities.

For health and safety reasons, the Hillsborough Kindergarten carpark will be closed while construction activities occupy the carpark (i.e. during construction of the southern extent of the CC9 alignment).

Watercare proposes to programme this construction over the school holiday period (refer response to Question 21 below). Should works need to extend into the term time, then Watercare will work closely with the kindergarten (and schools) to mitigate the effects on these facilities including ensuring alternative access and parking arrangements are in place.

[1] Site-Specific Erosion and Sedimental Control Plan (Site 3 – Keith Hay Park) (SSESCP) (Doc No. GAJV-00063, Version 1.1, approved 25 May 2020).

The CC9 works will be undertaken by the same Contractor[2] and generally in accordance with the existing CI designation and resource consent conditions as relevant to the CC9 works. Amongst other things, these conditions require that the Construction Traffic Management Plan (CTMP) includes a description of: *"Measures to maintain existing vehicle access to property where practicable, or to provide alternative access arrangements"* (Des 5.2 / RC 1.23 d)). While works will be programmed to avoid school term times, should the works need to extend outside of the holiday period and alternative access and parking arrangement be required, then these will be set out in the CI CTMP for Keith Hay Park (attached as Appendix G) which will be updated to address the CC9 works.

We also note that Watercare's ability to use the carpark is contingent on landowner approval. Requirements regarding alternative access and parking, should this be required, will be addressed directly with the Kindergarten (leasee) and Auckland Council (landowner). Other than the CTMP requirements outlined above, these matters do not need to be duplicated in the consent process.

b. An assessment of the car park vehicle crossing and access for use by large heavy vehicles associated with the works, including appropriate requirements of chapter E27 of the AUP(OP) and provision of vehicle tracking.

An assessment of vehicle crossing and access against the relevant requirements of Chapter E27 of the Auckland Unitary Plan (AUP) is set out in Appendix B. This includes vehicle tracking requirements.

Using the Auckland Council GIS viewer surveys, the existing formed width of the vehicle access to Hillsborough Kindergarten was measured to be 6.4 m wide. Vehicle tracking has been produced (as shown in Figures 1015172.1400-F01 to F03 in Appendix B) to ensure that this can accommodate construction vehicles. The construction vehicle used is assumed to be an 8.3 m dump truck. Figures 1015172.1400-F01 to F03 in Appendix B show the dump truck entering, exiting and manoeuvring on the site. This shows that the existing access to Hillsborough Kindergarten can accommodate the construction vehicles.

c. Given the relatively small size of this car park, please confirm if it will it be necessary for construction related vehicles to reverse manoeuvre onto the street? If reversing is required, please provide an assessment of the likely adverse effects, including the frequency of such manoeuvres and any necessary mitigation measures.

An assessment of vehicle crossing and access against the relevant requirements of Chapter E27 of the Auckland Unitary Plan (AUP) is set out in Appendix B. Given that the existing carpark is approximately 17.5 m wide, construction related vehicles are expected to be able to turn within the carpark area rather than reverse manoeuvre onto the street.

In the event that reverse manoeuvring is required, then as required by the existing CI designation and resource consent conditions the CTMP will include a description of: *"Measures to manage the proposed access to the site should the access be unable to cater for two-way traffic passing at the same time, and in particular to minimise reverse movements and blocking of the road;"* (Des 5.2 / RC 1.23 i)).

As stated above, the existing CTMP for the Central Interceptor works at Keith Hay Park, which has been reviewed and approved by Auckland Council, will be updated to address the CC9 works.

We also note that any effects on the road network would be subject to the approval of Auckland Transport through the Corridor Access Request (CAR) process.

d. Confirmation as to whether or not the public right of way will remain open for access in the event of trenched works being undertaken along its route. While section 3.1 of the AEE refers to a section of concrete walkway through Keith Hay Park being closed for the works duration, it is not clear as to whether this includes the section through the Kindergarten and School. If it is to be closed, will an alternative access be provided? If not, please assess adverse effects associated with the reduced levels of pedestrian connectivity.

[2] Ghella Abergeldie Joint Venture (GA).

As set out in the AEE, the existing concrete walkway within Keith Hay Park from the Eden Roskill Cricket Club carpark to the Cameron Leisure Pool carpark will need to be closed for the works' duration, however a suitably surfaced temporary shared path will be provided during the construction phase. This is subject to discussion and confirmation through the landowner approval process currently underway with Auckland Council – Parks, and reflects the approach to the current CI-related works at Keith Hay Park.

For the walkway between the school and kindergarten, while the southern extent of the works are being constructed it is expected that this walkway will need to be closed. However there is an existing access approximately 180 m to the west, along the western boundary of Waikowhai Intermediate, which will not be affected. Access is also available to the east along Noton Road and Rogan Street. Therefore, while the access between the school and kindergarten will likely need to be closed while the southern extent of CC9 is under construction, this is limited to a construction duration of approximately 2 to 3 months and alternative access is available nearby.

We also note that both schools provide access onto Keith Hay Park (Waikowhai Intermediate) or the end of Noton Road (Hay Park School) and Richardson Road for students, teachers and parents accessing the school (noting the works are programmed to occur outside of school term times).

In summary, while the accessway between Hay Park School and Hillsborough Kindergarten is likely to be closed while the works towards the southern end of CC9 take place, the effects are temporary and limited, with alternative options readily available.

6. The Mount Roskill Cricket Club / Noton Road car park is accessed via a double vehicle crossing at the cul-de-sac end of Noton Road, which narrows to a single file access into the car park area. The Traffic Assessment Report refers identifies this site as an access point for the potential trenched installation between the Eden Roskill Cricket Club and Richardson Road. The following additional information is requested to confirm the acceptability of the car park and access off Noton Road for construction activity:

a. Confirmation as to how many parking spaces within the Cricket Club Car Park are to be occupied by construction activities.

For the purpose of this application, for health and safety reasons it is expected that the car park spaces within the Cricket Club will not be available during construction of the southern section of CC9. This will be confirmed in the CTMP which is required to include a description of: *"Measures to maintain existing vehicle access to property where practicable, or to provide alternative access arrangements"* (Des 5.2 / RC 1.23 d)). Therefore, alternative access arrangements, should these be required, will be set out in the CTMP as per the existing CI designation and resource consent conditions.

As above in relation to the kindergarten carpark, we note that regardless of the outcome of this consenting process Watercare's ability to use the carpark is contingent on landowner approval. Requirements regarding alternative access and parking, should this be required, will also be addressed directly with the landowner through this process.

b. Assessment of the car park vehicle crossing and access for use by large heavy vehicles associated with the works, including appropriate requirements of chapter E27 of the AUP(OP) and provision of vehicle tracking.

An assessment of vehicle crossing and access against the relevant requirements of Chapter E27 of the Auckland Unitary Plan (AUP) is set out in Appendix B. This includes vehicle tracking requirements.

Using the Auckland Council GIS viewer surveys, the existing formed width of the vehicle access to the Eden Roskill Cricket Club was measured to be 3m wide. Vehicle tracking has been produced (as

shown in Figures 1015172.1400-F04 to F05 in Appendix B) to ensure that these facilities can accommodate the construction vehicles. The construction vehicle used is assumed to be an 8.3 m dump truck. Figures 1015172.1400-F04 in Appendix B shows the dump truck entering and exiting the site. This shows that the existing access to Eden Roskill Cricket Club is acceptable to accommodate the construction vehicles.

7. The Keith Hay Park / Arundel Street car park is accessed via a double vehicle crossing at the cul-de-sac end of Arundel Street. Watercare works are currently underway along the eastern boundary of the car park, associated with the Central Interceptor. The following additional information is requested to confirm the acceptability of the Keith Hay Park / Arundel Street car park and access off Arundel Street for construction activity:

a. Confirmation of the location of new construction activities within the car park area and how many parking spaces are expected to be occupied, noting that this car park is intended to function as the main construction lay-down area for the works.

As described in the AEE, the exact location of new construction activities within the Cameron Leisure Pool carpark will be determined by the Contractor and will vary depending on site constraints along the proposed alignment. However, the construction lay-down area is expected to comprise an area of approximately 1,000 m^2 and will be agreed through discussions with the landowner. Details of the specific location of construction activities within the car park area will be set out in the updated CI CTMP for Keith Hay Park. However, the total carpark area is around 7,000 – 8,000 m^2 which provides ample space to accommodate the lay-down area and still retain a substantial amount of parking within the carpark.

b. If appropriate, provision of vehicle tracking for large / heavy vehicles associated with the works, based on manoeuvring requirements associated with the new activity within the car park area.

Provision for vehicle tracking including in the carpark area is already addressed in the CI CTMP (Appendix G). The traffic management controls will be very similar to what will be utilised for the Branch 9B diversion works.

Groundwater

We have addressed the groundwater-related questions individually below. However, it is important to note that the works will be undertaken in accordance with the relevant CI resource consent groundwater conditions, together with the GSMCP for Keith Hay Park which has been reviewed and approved by Auckland Council on 3 December 2020. The GSMCP will be updated (via an addendum) to set out any CC9-specific requirements prior to the CC9 works commencing.

8. The settlement assessment in Appendix G of the AEE for the southern section of the pipe from MH01 to MH06 has been undertaken based on an open excavation. However, given the nature of the ground conditions (significant thicknesses of peat and soft organic clay) and the shallow groundwater level (approximately 1m below ground level), please provide a settlement assessment that includes temporary retaining of the southern section of the pipe from MH01 to MH06 and the temporary retaining of the proposed shafts for manholes and the temporary retaining launch and reception shafts / pits along the entire the length of the pipeline at the locations as shown on SK01 to SK03 in the submitted erosion and sediment control plan.

A settlement assessment which addresses mechanical settlement together with consolidation settlement is contained in Appendix A. This includes an updated assessment which addresses the section of pipeline which will potentially be constructed via open trenching methodologies, together with the manholes and launch and reception shafts along the full length of the pipeline.

9. Please provide profiles at the critical cross-sections showing the total (combined) settlement (i.e., the consolidation settlement due to groundwater drawdown plus the mechanical settlement due to retaining wall deflection) beneath the neighbouring buildings / structures (including driveways) and services. The profiles should be annotated with the calculated maximum differential settlement (slope gradient) across neighbouring buildings / structures (including driveways) and services.

Please refer to the Settlement Report included in Appendix A. Section 4 of this report sets out ground movement profiles at several representative depths for the trenchless and trenched sections as well as the manholes/launch and retrieval pits. The mechanical settlement estimates have then been combined with ground consolidation from dewatering to produce total predicted settlement adjacent to the construction works.

The combined settlement assessment demonstrates that there is negligible potential effect on surrounding buildings, with only the changing room shed at the Keith Hay Park carpark potentially within the zone of influence (10 mm settlement contour), and even then, still subject to negligible effects. For this reason, a series of settlement cross sections is not considered necessary, however a settlement cross-section for the changing room building is provided in the Settlement Report.

In summary, the assessment set out in Appendix A, including the figures in Section 4 and the 10 mm settlement contour plan, adequately demonstrate that the potential effects of settlement are less than minor. Therefore, no parties are considered to be adversely affected in relation to groundwater and settlement effects.

10. Please provide an assessment of the tolerance / sensitivity of the neighbouring buildings to the predicted differential settlement that could result from the dewatering and retaining wall deflections, with respect to their age, construction and foundation types, from the structural design engineer for the project. A Stage 1 Assessment - Burland Classification of Damage for the neighbouring buildings / structures is also required. If the Stage 1 assessment indicates "Slight Damage or greater", then a Stage 2 assessment is required.

Please refer to the Settlement Report in Appendix A.

11. Please identify all potentially affected public services / utilities and provide the predicted total and differential settlement as a result of the combined effect of groundwater drawdown and retaining wall deflection at each service. In addition, please provide details of any correspondence with the asset owner, together with proposed agreed mitigation measures for each service.

Please refer to Appendix A. Potentially affected public services and utilities are either Watercare-owned assets, or are Auckland Council – Healthy Waters Assets. The written approval of Healthy Waters is contained in Appendix H. Therefore, Healthy Waters is not an affected party in relation to this application in accordance with Section 95E of the RMA 1991.

12. On the basis of the settlement predictions, please provide a draft Groundwater Settlement Monitoring and Contingency Plan (GSMCP). The draft GSMCP should include, but not be limited to:

a plan showing the locations and types of monitoring devices including building settlement marks on the neighbouring buildings / structures; ground settlement marks; and retaining wall deflection marks.

Alert and alarm trigger levels and monitoring frequency are also required for total and differential settlement of the ground surface, buildings and retaining walls. If groundwater level monitoring is proposed in standpipe piezometers, then appropriate Alert Level 1 and Alert Level 2 should be provided for each piezometer.

Pre-and-post dewatering detailed condition surveys are required for existing walls, together with appropriate settlement monitoring and the identification of specific neighbouring buildings / structures that require pre-and-post dewatering detailed condition surveys, together with those

public services (if any), which require pre-and -post dewatering CCTV condition survey, together with a description of the proposed construction methodology / sequence and contingency options.

Refer to Section 6 of the Settlement Report in Appendix A which sets out monitoring and survey requirements specific to CC9. Consistent with existing CI consent requirements[3], these measures will be confirmed and updated as required at the detailed design stage once the position and dimensions of excavations are confirmed together with the alignment and construction methodology.

A detailed groundwater and settlement monitoring and contingency plan (GSMCP) is to be produced during the detailed design stage which will include suitable mitigation and response measures. These measures will be incorporated into the current GSMCP for the wider CI works at Keith Hay Park which has been reviewed and approved by Auckland Council on 3 December 2020. This will therefore form the basis for the CC9 works, and will be updated (via an addendum) to set out any CC9-specific requirements, including those identified in the Settlement Report, prior to the CC9 works commencing.

Noise and Vibration

13. Please clarify whether the noise level calculations (mitigated) are based on implementation of all specific mitigation measures listed in Section 7.3 of the submitted construction noise and vibration assessment (CNVA) or just the noise screens?

The predicted noise levels in Table 6.2 of the CNVA (predicted noise levels at sensitive receivers) include mitigation where it is likely to be practicable. This includes screening for trenching works but not for sheet piling and truck deliveries. Table 6.2 has been reproduced in Appendix D with a minor amendment to the formatting to clarify whether noise level calculations include the specific mitigation measures or not (note the assessment itself has not changed).

While further reduction of sound levels may be possible with the measures included in Section 7.3 of the CNVA, such as fitting silencers, screening, acoustic enclosures for fixed plant such as generators, this will be addressed through the CNVMP and ASCNMP and has not been included in Table 6.2. The implementation of other mitigation measures such as restricting timing of activities is discussed in Section 7.1.2 of the CNVA (Activity assessment).

The CI CNVMP and ASCNMP for Keith Hay Park set out extensive mitigation measures, including utilising noise barriers and enclosures (where practicable) and orienting mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade. Similar measures will be applied to the proposed CC9 works as set out in an update to the existing approved CNVMP and ASCNMP to reflect CC9-specific requirements.

14. Please provide estimated durations for the noise exceedances at all receivers.

Launch pits

Sheet piling is expected to take place over up to 30 non-consecutive days within the one month site establishment period at each of the launch pits (refer response to Question 17 below for location of pits). Within that 30-day period, sheet piling will be undertaken on an intermittent basis rather than continuously. This is also a conservative assessment on the basis that it assumes a large launch pit[4].

Trenching

In terms of the open trenching methodology, this is restricted to the southern approximately 300 m section of pipeline and is anticipated to be undertaken over a 2-3 month period (up to 4 months

[3] i.e. Condition 4.6 of the existing CI consent which requires that Watercare undertakes a risk assessment to identify existing buildings and structures at-risk of damage due to settlement caused by shaft sinking or tunnelling activities.
[4] A similar approach was taken to the Branch 9B sewer whereby a larger launch pit was assumed, but a smaller launch pit is now proposed (e.g. 6 m by 4.5 m) which significantly reduces installation timeframes.

maximum). It is more likely that trench shields will be used for any open trenching rather than sheet piling, however this will be confirmed by the Contractor and for the purpose of this assessment a more conservative approach has been taken.

Based on recent CI experience, sheet piling a 10m section of trench is expected to take between 2 to 3 days to complete. Sheet piling would be installed progressively as the trench is proposed to be constructed in stages, and the duration of noise at any one location will therefore be limited[5]. From proposed MH07 through the southern section of pipeline to proposed MH09 dwellings are located at a greater distance from the noise, and the cricket clubrooms and school buildings also provide some screening of noise for dwellings further to the east (i.e. at the western end of Noton Road and along Rogan Street).

As noted previously, trenching through the school grounds would be programmed to occur outside of the school term as far as practicable to avoid noise effects on the schools and kindergarten. In terms of the properties on Richardson Road, noise from sheet piling will only occur when works are underway at the very southern end of the alignment. Ambient noise levels at the Richardson Road properties will also be affected by traffic along Richardson Road which is a main arterial route and therefore construction noise is likely to be masked in this location to some extent.

CNVMP and ASCNMP

Adverse effects of noise from sheet piling (where proposed) would be managed in accordance with the CI CNVMP and ASCNMP for Keith Hay Park, a key element of which is effective communication with nearby properties. This will also be central to the approach to managing the effects of sheet piling required to construct CC9. Specific mitigation methodologies, including noise barriers where appropriate, will be confirmed through the CC9 update to the CI CNVMP.

15. It is noted the predicted noise levels in table 6.2 of the CNVA will be well over the night-time noise limit of 45 dB LAeq and Sunday noise limit of 55 dB LAeq at many receivers. Please confirm if these noise levels can be further reduced? If not, please assess the adverse effects resulting from these noise levels.

AND

20. As noise exceedances at night may occur, please proposed an assessment on night-time noise effects.

Consistent with the approach to CI, a key mitigation methodology will be timing of works. In this respect the hours of construction will generally be 7:30am to 6pm Monday to Friday and 8am to 6pm Saturday. Noisier aspects of works such as sheet piling and tree removal will be particularly subject to these restrictions, with these activities only undertaken during the daytime.

Where deliveries and general works extend outside normal working hours, this would mainly extend into the shoulder evening period (i.e. rather than at night). The AUP rules recognise this evening 'shoulder' period by reducing noise limits by 5 dB to 65 dB LAeq between 6 pm and 8 pm on weekdays, dropping to 45 dB LAeq at 8 pm on weekdays. The majority of works outside normal working hours will fall within this shoulder period and limited exceedances of the AUP rules are anticipated.

The CNVA assessed the noise effects of trenching activities on the basis that Watercare proposed to undertake trenching works 24 hours a day 7 days a week (or alternative extended hours) to shorten the construction period and confine construction activities to outside of school term[1]. Subsequent discussions have confirmed that for health and safety reasons, trenching activities will largely be confined to day time hours, and occasionally extending into the evening shoulder period during the

[5] It is approximately 53m between MH06 (in close proximity to dwellings) and MH07 located behind the cricket clubrooms.

daylight savings period. Should trenching activities need to extend outside of these times (i.e. where timing of activities relative to term start dates means it is beneficial to extend hours), then considering the setback from sensitive receivers, it is anticipated that this would be undertaken in accordance with the AUP construction noise limits (i.e. any such works would be required to meet the more stringent night time limit of 45 dB LAeq at sensitive receivers). Measures to ensure this would be set out in an activity-specific construction noise management plan as required by CI conditions DES3.5 and RC1.15 set out below.

For works outside of normal hours (noting this will not include sheet piling – refer above), appropriate measures will be implemented to ensure that the relevant construction noise, vibration and traffic management standards are met as far as practicable. These measures are set out in the certified Construction Noise and Vibration Management Plan (CNVMP) already approved for the wider CI works (which will be updated to incorporate the CC9-related construction works). When occasional work is required between 8 pm and 6:30 am which would potentially result in exceedances of the night-time construction noise limit of 45 dB LAeq, this would be addressed via an activity-specific construction noise management plan as required by CI conditions DES3.5 and RC1.15 set out below.

DES3.5(a) **RC1.15(a)**	Describe the activity (including duration), plant and machinery that is expected not to comply with the noise limits in conditions DES3.2 and RC1.12.
DES3.5(b) **RC1.15(b)**	Described the mitigation measures proposed to reduce the noise levels as far as practicable, including any options that have been discounted due to cost or any other reason.
DES3.5(c) **RC1.15(c)**	Provide predicted noise levels for all receivers where the noise levels will not be compliance with the limits in conditions DES3.2 and RC1.12, including the effect of mitigation specified in DES3.4(d) and RC1.14(d).
DES3.5(d) **RC1.15(d)**	Provide a set of noise limits that are Activity – Specific.
DES3.5(e) **RC1.15(e)**	Describe the noise monitoring that will be undertaken to determine compliance with the Activity – Specific noise limits.
DES3.5(f) **RC1.15(f)**	Describe any additional noise mitigation measures that may be implemented to maintain compliance with Activity – Specific noise limits.

16. Three alignment options are proposed within AEE for the southern portion of the sewer line but only one option has been assessed in the CNVA. Please advise if the option assessed in the noise report is the final one? If not, please provide the relevant noise assessment for other options.

The final alignment and construction methodology will be decided by the contractor at the detailed design stage. In summary:

- Option 1 comprises an alignment through the Hay Park School playground and Hillsborough Kindergarten carpark to connect to three manholes (MH08, MH09, MH10) at Richardson Road.
- Option 3 is basically the same as Option 1 (i.e. through the Hay Park School playground and kindergarten carpark) except that MH08 is located approximately 2 m further to the east of the playground.
- Option 2 comprises an alignment through the existing walkway between the Hillsborough Kindergarten and Hay Park School grounds to connect to the manholes at Richardson Road.

While this is approximately 30 m to the west of Option 1 at its far point (i.e. at proposed MH08 at the Hay Park School playground), this is further from sensitive receivers located to the east and in any case, due to site constraints this option is very likely to be trenchless.

In summary, there is a very marginal difference in alignments between Options 1 and 3, and Option 2 is located further from sensitive receivers and is likely to be constructed via a trenchless methodology anyway. We therefore consider the option assessed in the CNVA is representative of the noise and vibration effects of all three possible alignment options for the southern extent of the pipeline and do not consider that a noise assessment of the other options is required.

17. The AEE indicates launch pits may be required for the trenchless method at every second manhole along the proposed sewer line, meaning sheet piling may also occur. Residents facing the works will receive high sheet piling noise, but the noise assessment report does not include sheet piling noise for these receivers. Please address this.

Launch pits will be required at every second manhole location along the trenchless section of the alignment. While the final alignment and construction methodology will be determined by the contractor, as set out in Appendix C these will potentially be located at MH01, MH03 and either MH05 or MH06:

- MH01 is located in the Cameron Pool's carpark to the west of (behind) the CI shaft site and over 50 to 60+ m from the nearest dwellings at 47A Arundel Street and 19 Gregory Place.
  - The predicted noise level at these receivers is within the construction daytime limit of 75 dB LAeq but marginally exceeds the reduced limit of 70dB LAeq for overall construction duration of greater than 20 weeks (noting the linear nature of the works means that works at MH01 or at any particular location on the alignment is significantly less than 20 weeks).
  - Both properties have been assessed based on a 50 m setback, however 19 Gregory Place is located at a distance of 60+ m and therefore noise limits are expected to be met at this property. Potential mitigation including screening will be confirmed at the detailed design stage.
- MH03 is located approximately 20+ m from the nearest sensitive receivers at 52 and 54 Arundel Street.
- MH05 is located approximately 20+ m from the nearest sensitive receiver at 1/12 Rustic Avenue. The alternative launch pit site at MH06 is located approximately 20 m from 8 and 8A Raven Avenue.
  - The predicted noise level at the receivers identified above in relation to MH03, MH05 or MH06 exceeds the construction noise limit. Potential mitigation including screening will be confirmed at the detailed design stage.

If the southern section of pipeline is installed by trenchless methodologies, then the potential launch pit configuration would be MH01, MH03 and MH05 as above with additional launch pits required at MH07 and MH09 as follows:

- MH07 is located in the carpark of the Eden Roskill Cricket Club. There are no dwellings in close proximity, with the club rooms located between the launch pit and the closest dwellings at the end of Raven Avenue located some 45 to 50 m away.
  - Due to screening provided by the clubrooms, the predicted noise level at these receivers comfortably meets the daytime construction limit of 70dB LAeq.
- MH09 is located on the border of Hay Park School and the Hillsborough Kindergarten carpark approximately 35 m and 40 m respectively from the closest dwellings at 672A and 672 Richardson Road.

- The predicted noise level at these receivers is within the construction daytime limit of 75 dB LAeq but exceeds the reduced limit of 70dB LAeq for an overall construction duration of greater than 20 weeks (noting that works at the MH09 location is significantly less than 20 weeks). Potential mitigation including screening will be confirmed at the detailed design stage.

Noise sensitive receivers, including the above receivers, are identified in Table 4.1 of the CNVA. Noise level data at different distances from the noise source, including sheet piling, is set out in Table 6.1 and predicted noise for sensitive receivers is set out in Table 6.2. This later table has been updated to include noise from sheet piling operations associated with the launch pits above, as set out in Appendix D attached.

18. Please provide a copy of the referenced Activity Specific Construction Noise and Vibration Management Plan for sheet piling and wood chipping. This plan may be in draft form such that it could be amended as necessary as part of a condition certification process.

The Activity Specific Construction Noise Management Plan – Keith Hay Park Sheet Piling and Wood Chipping is attached in Appendix F. We note that this has already been subject to the scrutiny and approval of Auckland Council.

Watercare proposes to update this plan to specifically address the CC9 works and provide to Council for further approval prior to construction commencing.

19. As the tunnelling operation will be 24/7, the vibration effect at night time needs to be considered and assessed, as the AUP(OP) night time vibration limit is significantly lower than the daytime limit. Please address this.

As set out in Section 3.8 of the AEE, micro tunnelling/HDD will generally occur during normal working hours, 7 am to 6 pm, Monday to Friday and 8 am to 6pm Saturday. However, in particular circumstances, Watercare may need to undertake micro tunnelling/HDD 24 hours a day 7 days a week (or alternative extended hours) to meet construction demands, provided that construction work can be managed to meet construction noise and vibration (along with construction traffic requirements).

In terms of vibration effects, the proposed works are expected to give rise to only low levels of vibration - primarily from sheet piling which will *not* take place outside normal daytime hours. This activity is expected to be compliant with the daytime limit of 2 mm/s at a distance of 20 m or less. All sensitive receivers are set back at least 20 m from the works.

As noted above, micro tunnelling/HDD will generally occur during normal working hours. However should this occur outside normal working hours, then the activity is expected to meet the AUP night-time vibration limit of 0.3 mm/s.

20. As noise exceedances at night may occur, please proposed an assessment on night-time noise effects. Refer response to questions 15 and 20 above.

21. One of the proposed mitigation measures with respect to the adjacent schools and kindergarten to carry out noisy works during the school holidays. Please confirm the times when these facilities will close during the school holidays and the acceptance of a condition specifying this as a mitigation measure?

While Watercare will make every endeavour to ensure that works are undertaken during the school holiday period, and expects this is also likely to reflect landowner requirements, Watercare cannot accept a condition restricting works in the vicinity of the schools and kindergarten to the school holiday period only. This would create issues in the event that the programme for construction was prolonged or delayed for some reason (e.g. due to Covid-19 lockdown restrictions).

As noted in the AEE, trenching is anticipated to be undertaken over a 2–3-month period. In the event that works need to be undertaken during school and kindergarten terms, temporary traffic management measures will be used in liaison with affected stakeholders and will be set out in the CTMP. This is likely to include a restriction on heavy vehicle movements during the relevant start (drop-off) and finish (pick-up) times as anticipated by conditions DES 8.3 / RC1.10(c).

Notwithstanding the above, Watercare proposes the following condition to manage works undertaken during school and kindergarten terms:

> *Condition X*
>
> *The consent holder shall ensure that works within or immediately adjacent to Hay Park School, Waikowhai Intermediate School and Hillsborough Kindergarten are programmed to occur outside of the school term as far as practicable.*
>
> *In the event that works are required to be undertaken during school and kindergarten terms, additional temporary traffic management measures will be established in the vicinity of the schools and kindergarten during peak drop-off and pick-up times. These measures will be detailed in the update to the CI CTMP and any associated site specific management strategies to be developed by the contractor for Council approval prior to the works commencing.*
>
> *Advice note: School term is as determined by the Ministry of Education (www.education.govt.nz/school/school-terms-and-holiday-dates) and subject to the specific term start and end dates as advised by Hay Park School, Waikowhai Intermediate School and Hillsborough Kindergarten.*

Planning

22. In section 7.1 of the submitted AEE, it is stated that Iwi have been engaged through Watercare's Mana Whenua Kaitiaki Forum. Can you please provide details as to what Iwi groups this includes (including confirmation that it includes, or is delegated responsibility for, all Iwi groups with mana whenua interest in the area) and the feedback that has been provided to date by this forum on the proposed development.

Watercare's engagement with mana whenua is outlined at https://www.watercare.co.nz/About-us/Who-we-are/Mana-whenua with the text included below:

> Mana whenua
>
> Our ties with local iwi form a valued partnership that continues to evolve
>
> Mana whenua are the iwi (Māori tribal groups) recognised by the Crown as having links to Tāmaki Makaurau (Auckland). Their interests are represented by 19 tribal authorities, with whom we have a longstanding cooperative relationship.
>
> Kaitiaki values
>
> We recognise the importance of the values held by kaitiaki (guardians or protectors). These include their environmental and spiritual ties to ancestral lands, water, sites, waahi tapu (sacred areas) and other taonga (treasures), and the wellbeing of the entire iwi.
>
> Consulting on projects
>
> Our engagement with mana whenua includes valuable input when considering the cultural, environmental, social and economic impact of projects.
>
> In 2012 we established the Mana Whenua Kaitiaki Forum to encourage discussion and guidance, and to share views on the management of water and wastewater. The forum's focus has widened to all matters affecting the strategic interests of mana whenua across the Auckland region.

The Kaitiaki Schedule is regularly sent to the 19 tribal authorities. It sets out our planned work programme, most of which requires resource consent. Representatives are invited to express interest in projects. Whether they choose to join the project team or just make comments, there is an opportunity for iwi input throughout the process of developing infrastructure.

The Kaitiaki Managers Group, a sub-group of the forum, also meets to discuss matters of regional interest arising from larger projects, and strategic processes that could affect their interests.

Benefits of consultation

Our ties with mana whenua go well beyond our Treaty of Waitangi obligations, forming a respectful and valued partnership that continues to evolve.

We also acknowledge the importance of Mātauranga Māori (Māori knowledge systems) and the contribution of a unique world view, providing a long-term vision for protecting natural resources.

During planning and decision-making, these principles can offer new ways of thinking, and opportunities to achieve more mutually agreeable outcomes.

The project was included on the Kaitiaki Schedule in February 2021. Te Ākitai Waiohua and Ngāti Whātua Ōrākei expressed their interest in the project in February 2021. Ngāti Whanaunga expressed their interest in the project in August 2021.

23. Following on from question 22, it is noted within the same section of the AEE that Te Ākitai Waiohua and Ngāti Whātua Ōrākei have expressed an interest in the application. Please detail what further consultation has been undertaken with these Iwi groups and how any identified issues have been, or will be, resolved.

Communication with interested partners is as follows:

Te Ākitai Waiohua

- Application provided on 5 July.
- Section 92 letter provided on 23 August.
- Engaged to complete assessment on 24 August.
- On 31 August, contacted to confirm Section 92 response timeframe of 15 October.

Ngāti Whātua Ōrākei

- Application provided on 5 July.
- Section 92 letter provided on 23 August.

Ngāti Whanaunga

- Application and Section 92 letter provided on 12 October.

No issues have been raised to date.

1 Conclusion

We trust that there is now sufficient information available for you to continue processing the application. Please do not hesitate to contact Karen Baverstock on 09 3592735 or KBaverstock@tonkintaylor.co.nz if you require further clarification on any aspects of this letter.

Tonkin & Taylor Ltd

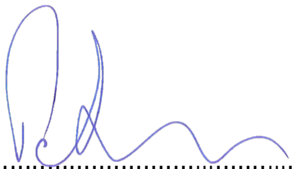
Environmental and Engineering Consultants

Report prepared by:

.....

Karen Baverstock
Technical Director - Planning

Authorised for Tonkin & Taylor Ltd by:



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Peter Roan
Project Director

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Appendix A: Settlement Report

Tonkin+Taylor

Job No: 1015172.1400
1 November 2021

Watercare

Attention: Xenia Meier and Shalini Sanjeshni

Dear Xenia and Shalini

CC9 Keith Hay Park
S92 Responses - Assessment of Settlement Effects

1 Introduction

Watercare Services Ltd (Watercare) is proposing to undertake construction of a sewer connection (CC9) at Keith Hay Park, Mt Roskill. The proposed works involve the installation of an approximately 810 m long sewer pipeline beneath Keith Hay Park, from Watercare's Central Interceptor (CI) Keith Hay shaft construction site to a termination manhole at Richardson Road. The diversion is expected to be constructed using a combination of either open trenching and trenchless methods, or entirely via trenchless methods.

This memorandum has been prepared in response to a Section 92 Request (S92)[1] from Auckland Council. This memo provides:

- Details of the estimated surface settlements from the sewer connection construction and operation.
- The potential effects of that settlement on adjacent assets.
- Proposals for monitoring and mitigation of those effects.

It should be noted that this memo addresses the ground movements associated with the excavation of the works (mechanical settlement), as well as the potential effects caused by the total cumulative settlement (mechanical settlement and consolidation settlement). The consolidation settlement component of this assessment has been assessed separately, in the memo titled *CC9 Keith Hay Park – Groundwater and settlement overview* included in Appendix B to this document.

2 Description of works

The proposed works involve the installation of a sewer beneath Keith Hay Park in Mt Roskill. The CC9 sewer extends from the Keith Hay Park Central Interceptor (CI) shaft construction site located at the Cameron Leisure Pool carpark off Arundel Street, beneath Keith Hay Park and beneath Hay Park School, Hillsborough Kindergarten and Waikowhai Intermediate School to a termination manhole at Richardson Road (refer to Appendix A).

The construction methodology is expected to be primarily trenchless, likely pipe-jacked or possibly

[1] Keith Hay CC9 - BUN60382589, Section 92 Request for Further Information

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via horizontal directional drilling (HDD) methods, from the CI Keith Hay construction site through to the Eden Roskill Cricket Club carpark (at MH06) at a depth to invert of between approximately 4 m to 8 m bgl.

The remaining section of the CC9 route will be installed via a trenchless construction methodology as outlined above, or by open trenching or a combination of both. In the case of open trenching, this would occur from around the Eden Roskill Cricket Club (MH06) approximately 300 m southwards to Richardson Road at a maximum depth to invert of up to 5 m bgl. Three alignment options for this section of pipeline are being considered and are detailed further in the AEE (refer to alignment in Appendix A).

The route and construction methodology has yet to be finalised and will be decided on by the contractor during the detailed design stage. For the purpose of this preliminary assessment, the alignment and proposed construction methodologies has been reviewed for each option, and the worst case has been assessed. Assumptions relating to excavation supports are discussed in Section 4.

3 Existing environment

3.1 Geology and groundwater

A summary of the geology and groundwater conditions of the site are discussed in detail in the groundwater assessment report included in Appendix B.

3.2 Existing buildings

The structures immediately adjacent to the CC9 works are typically low-rise communal non-residential buildings.

Four buildings within the existing environment have been identified which are in the immediate vicinity of the CC9 works. The details of these buildings are summarised in Table 3.1. The location of these buildings in relation to the works are shown on the instrumentation plan presented in Appendix A.

Table 3.1: Buildings located near the CC9 works

ID	Address	Building use
1	53 Arundel Street	Changing room building at Keith Hay Park
2	668 Richardson Road	Hillsborough Kindergarten
3	670 Richardson Road	Hay Park School building
4	13 Noton Road	Eden Roskill Cricket Club building

4 Predicted settlement

4.1 Overview

Construction of the CC9 works has the potential to cause ground movements that could adversely impact nearby buildings and utilities.

The three sources of potential construction-related ground movement are:

- Excavation of the trenches, manholes, and launch pits (mechanical settlement).
- Excavation of the sewer tunnel (trenchless) using HDD or pipejacking (mechanical settlement).
- Consolidation of compressible soil due to groundwater drawdown (consolidation settlement).

Mechanical settlement due to surface excavations (caused by deflection of the excavation support systems) and trenchless excavations are expected to occur rapidly, within days to weeks following excavation and construction. Groundwater drawdown and any resultant consolidation settlement can develop over an extended period (years), depending on the surrounding geological and groundwater conditions, and the duration over which drawdown occurs.

A brief description of each source of potential ground movement is presented below. The ground movements arising from the individual construction activities have been assessed independently, but where the influence of these mechanisms overlap, the results have been combined, by superposition, to produce vertical ground movement (settlement) contours.

4.2 Mechanical settlement

4.2.1 Trenchless excavation

For all proposed alignments, the construction methodology is expected to be a trenchless excavation from the CI Keith Hay construction site to the Eden Roskill Cricket Club. A trenchless excavation is also proposed for alignment option 2 from Eden Roskill Cricket Club to Richardson Road. The trenchless excavations are expected to be carried out using either HDD or pipe jacking methods. The depth of the trenchless excavation will likely vary between 4 m and 8 m bgl, with the deepest portion of the trenchless excavation near the Keith Hay construction site.

The vertical ground movements arising from trenchless section of the pipe was estimated using the empirical 'Gaussian' curve methodology outlined in Peck (1969)[2]. The controlling input parameters assumptions include a volume loss (VL) of 7.5% and a trough width coefficient value (k) of 0.7, following guidance for soft soils in Sinclair et al (1988)[3].

Ground movement profiles for five representative pipe installation depths have been assessed for the trenchless section. These ground movement profiles are presented in Figure 4.1.

[2] Peck. R.B. (1969). Deep Excavations and Tunnelling in Soft Ground, Proc. of the 7th Int. Conf. Soil Mech. Foundation Eng, Stage of the Art Volume, 1969, pp. 225-290

[3] Sinclair, T.J., Hulme, T.W. and Andrews, D.C., 1988, August. Settlements over bored tunnels: fantasy and fact!. In *Australia-New Zealand Conference on Geomechanics, 5th, 1988, Sydney* (No. 88/11).

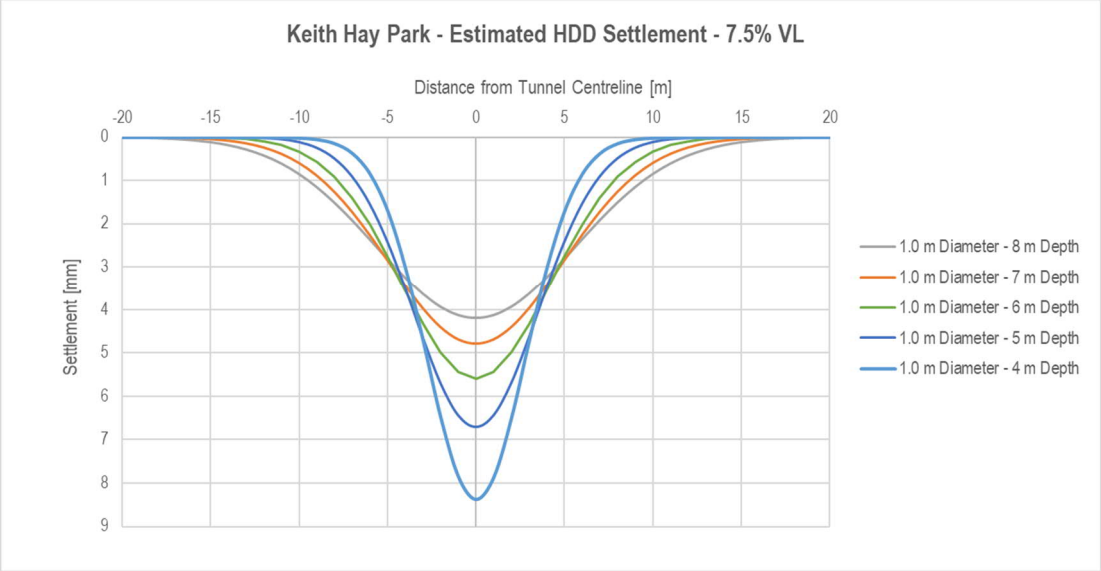

Figure 4.1: Mechanical settlement for a range of pipeline installation depths due to trenchless excavations.

4.2.2 Trench excavation

For options 1 and 3, the construction methodology of the alignment, from the Eden Roskill Cricket Club (MH06) to Richardson Road (MH10), will likely be trenched excavations. In this case, the trench would likely be excavated using a 16-tonne excavator and is expected to be supported using trench shields or similar, to a maximum depth of 4.5 m bgl.

Mechanical settlement due to the excavation of the trench has been assessed using the empirical method outlined in CIRIA C517[4] which provides guidance on estimating surface settlements for low stiffness walls in soft soils.

Ground movement profiles for two representative pipeline installation depths have been assessed for the trenched section. These ground movement profiles are presented in Figure 4.2.

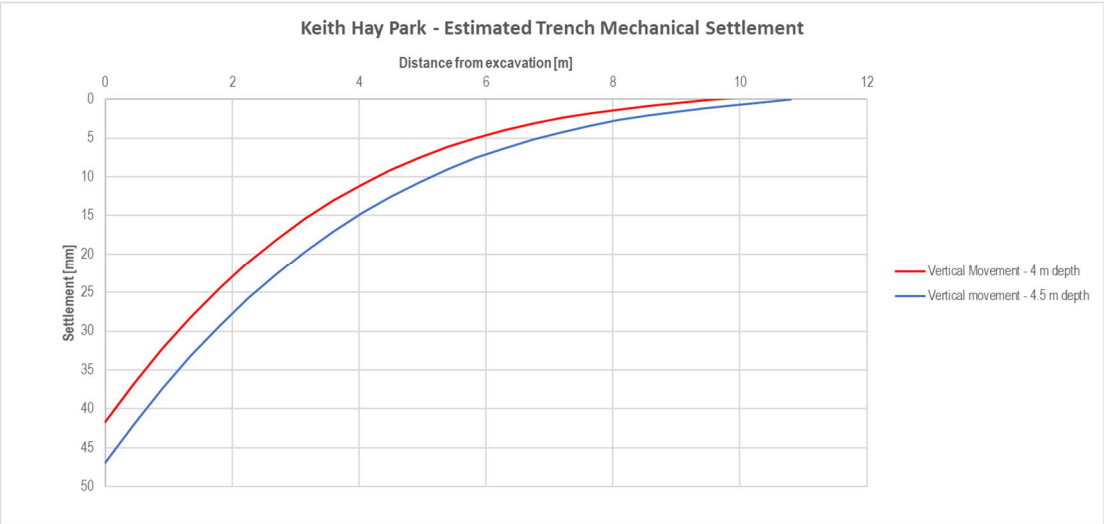

Figure 4.2: Mechanical settlement at different depths due to trench excavations

[4] CIRIA C517, 1999. Temporary propping of deep excavations – guidance on design. London, 24 pp Figure 2.5.

4.2.3 Manhole and launch/retrieval pit excavations

Several excavations are required for all alignment options to form the manholes, and launch pits for the trenchless excavation. While construction details have not been confirmed during this stage of the project, these will likely be constructed using either sheet piles with shoring or concrete piles.

The excavation envelopes, in plan, will vary in size depending on their purpose but are expected to be 4.0 m x 4.0 m for the manhole excavations, and between 4.5 m x 6.0 m and 6.0 m x 6.0 m for the launch pits. These excavations vary in depth between 4.5 m and 8.5 m bgl, with the deepest excavations on the northern end of the alignment at MH01, near the CI Keith Hay construction site.

Mechanical settlements due to the excavation of the manholes/pits were assessed using the empirical method outlined in CIRIA C760[5]. Ground movement profiles for five representative excavation depths have been assessed. These ground movement profiles are presented in Figure 4.3.

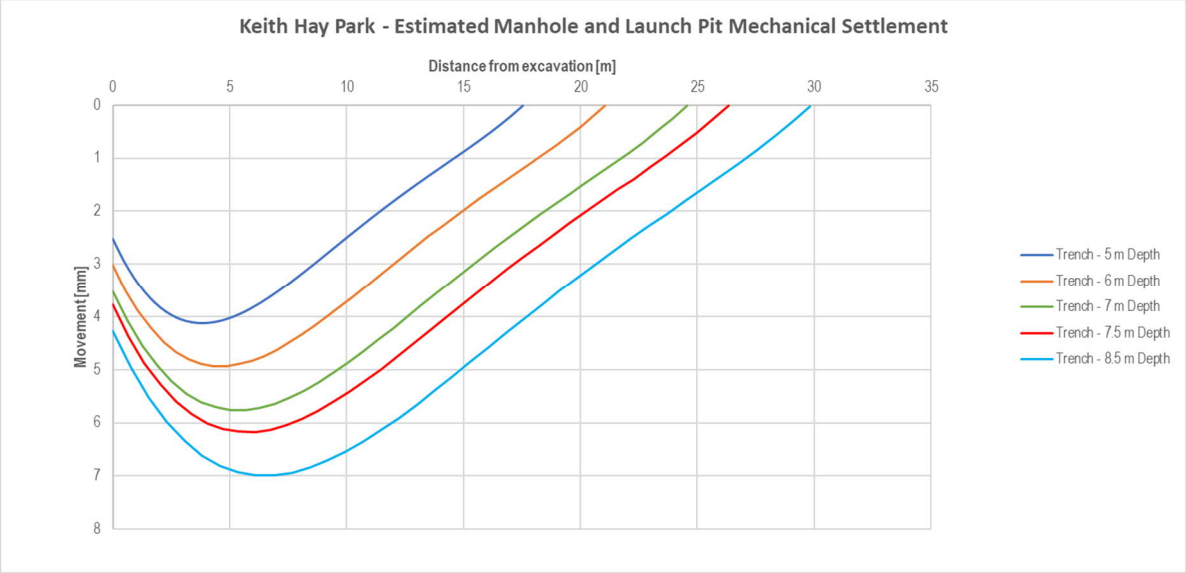

Figure 4.3: Mechanical settlement at different depths due to the manhole/launch pit excavations

4.3 Consolidation settlement

A separate assessment of consolidation settlement due to the construction of the CC9 works has been undertaken by T+T and is reported separately. This assessment is presented in Appendix B.

Where the influence of the predicted consolidation settlements overlap with the mechanical settlements presented in this report, the results have been combined, by superposition, to produce vertical ground movement (settlement) contours.

4.4 Combination of settlement predictions and assessment

4.4.1 Methodology

The various estimates of settlement have been combined, adopting the principle of superposition, to determine the total predicted settlement in the areas adjacent to the construction works. These movements were summed to create composite settlement profiles, which formed the basis of the assessment of effects on surrounding buildings.

[5] CIRIA C760, 2018. Guidance on Embedded Retaining Wall Design. London, 455 pp Figure 6.15.

4.4.2 Results

The extent of the predicted cumulative 10 mm settlement contour generally does not intersect any buildings adjacent to the CC9 works. The exception is the changing room shed at 53 Arundel Street, which is located in the Keith Hay Park carpark north-west of the excavation at MH01. This is shown in the instrumentation plan in Appendix A.

5 Assessment of settlement effects

5.1 Effects on buildings

5.1.1 Overview

For assessing the impact of settlement on existing buildings and services, the criteria set out in Item 6 (a)(vi) of Chapter E7.8.1 (6) of the Auckland Unitary Plan[6] has been adopted - with a limiting ground settlement value of 10 mm and differential settlement of 1/500 for all existing buildings adjacent to the works.

Having assessed the potential extent and magnitude of vertical ground movement in the zone of influence around the proposed works, a staged approach assessment of potential damage to existing structures has been adopted in line with international practice. The assessment of effects on buildings is based on the method presented in Burland (1995) [7].

The assessment follows a three-stage approach, where buildings are progressively screened for further and more rigorous assessment based on the outcome of the previous assessment stage. Those buildings that are predicted to be subject to settlement greater than 10 mm and a maximum differential settlement greater than 1/500 (normalised ratio of vertical movement over distance), are assessed further by considering each buildings tolerance based on its construction form and underlying soil parameters. Buildings are removed from further assessment when the predicted effects in any one stage are within defined serviceability limits.

5.1.2 Results

The results of the building damage assessment indicates that the changing room shed at 53 Arundel Street has a damage classification of “negligible” (using the Burland categorisation of building damage). This damage classification corresponds to a risk of “aesthetic damage” only.

The estimated ground movement and subsequent assessment results for this building is summarised in Table 5.1.

[6] Auckland Council, 2016. Auckland Unitary Plan. *Auckland New Zealand; Auckland Council.*
[7] Burland, J. B., 1995. Assessment of risk of damage to buildings due to tunnelling and excavations. In 1st Int. Conf. on Earthquake Geotech. Engrg., IS-Tokyo'95.

Table 5.1: Assessment results – settlement effects on nearby buildings

Input Parameters	
Address	53 Arundel Street (changing room shed)
Building height [m]	3.5
E/G	2.6
Poisson Ratio (v)	0.3
Estimated Effects	
Maximum estimated settlement [mm]	14
Maximum differential settlement	1/1550
Tensile strain [%]	0.045
Building damage classification	Negligible

5.2 Effects on utilities

While many types of utilities are able to accommodate high levels of differential settlement, certain types of utilities are susceptible to damage. The methodology to assess the effects on utilities is based on guidance from O'Rourke and Trautman (1982)[8] – which recommends a maximum allowable differential settlement for different utility construction types. A summary of utility types and their expected allowable differential settlement is included in Table 5.2.

Table 5.2: Utility deformation maximum slopes

Utility type	Maximum allowable differential settlement
Brick unlined	1:245
Welded steel pipe	1:122
Cast-in-situ concrete	1:173
PVC & HDPE	1:67
Reinforced concrete pipe	1:229
Ductile iron pipe	1:229
Vitrified clay pipe	1:229
Cast iron pipe	1:150 to 1:500 (varies by diameter)

For the purposes of this initial screening assessment, a single envelope differential settlement criterion of 1/250 was adopted to identify services which may potentially be subject to adverse differential settlement. Most utility services should be able to tolerate this level of differential settlement, with the possible exception of particularly fragile services such as old, cast iron gas mains.

[8] O'Rourke, T. D., & Trautmann, C.H. (1982). Buried pipeline response to tunnelling ground movements.

The maximum differential settlements were determined from the settlement contours across the CC9 alignment. Nine existing utility assets run perpendicular to the CC9 alignment (refer to site plans Appendix A) and will likely be subject to differential settlement in excess of the criterion identified above. These include existing watermains, stormwater and wastewater assets. These utilities are generally located between 1 m and 2 m bgl. These existing utilities are Watercare or Auckland Council (Healthy Waters) owned assets. Healthy Waters has provided their written approval for the project on 15 October 2021.

Based on this preliminary assessment, it is recommended that the existing utilities which run perpendicular to the alignment (area of greatest differential settlement) should be investigated further during detailed design to determine their risk of damage and/or impaired performance.

The Contractor should also ensure that utilities exposed during the trenched installation are supported. For the trenchless alignment, a risk-based analysis should be undertaken for all utilities within the zone of influence identified in this report, before construction is started. Utilities considered high risk (such as critical services) should be realigned to avoid the CC9 trenchless alignment. Utilities of lesser risk may remain in place during the construction works, however a contingency plan should be in place if monitoring indicates remediation or protective works will be required before such damage occurs.

6 Settlement monitoring plan

6.1 Overview

It is recommended that during construction, ground and building movements adjacent to the proposed works are monitored to verify the assumptions outlined in this report.

This section provides a preliminary overview of the monitoring scheme to be implemented. A detailed groundwater and settlement monitoring and contingency plan (GSMCP) is to be produced during the detailed design stage which will include suitable mitigation and response measures. These measures will be incorporated into the current GSMCP for the wider CI works at Keith Hay Park which has been reviewed and approved by Auckland Council on 3 December 2020. This will therefore form the basis for the CC9 works, and will be updated (via an addendum) to set out any CC9-specific requirements, including those identified below, prior to the CC9 works commencing.

6.2 Building surveys

On the basis of this assessment, visual inspection of the adjacent ground and the buildings listed in Table 6.1 shall be carried out as followed:

- The Contractor will undertake a pre-construction building inspection prior to dewatering and/or excavation to identify any pre-existing damage at the properties surrounding the construction works as identified in Table 6.1 below.
- Visual inspection of the surrounding ground and external building facades of the buildings will be carried out during construction in the immediate vicinity of each of the buildings to monitor deterioration of any pre-existing damage. This will be carried out at least monthly from the commencement of any dewatering and excavation in the immediate vicinity of each of the buildings until completion, or (in the event of shorter duration activities) within 1 week of completion of the works.
- No earlier than 6-months after the completion of dewatering and/or excavation, and within 6-months of completion of construction, a post construction building façades inspection will be carried out (in the areas where inspections were carried out prior to construction). The survey report will include an assessment of the cause of any damage identified.

The above requirements should be confirmed and updated as required at the detailed design stage once the position and dimensions of excavations are confirmed together with the alignment and construction methodology[9].

6.3 Utility surveys

It is expected that all existing utilities crossing the CC9 alignment that are not Watercare-owned assets are Auckland Council Healthy Water owned assets. As the owner, it is understood that they have given written approval for the works. In any case, it is expected that the Contractor will produce a contingency plan to protect these assets during construction and potentially repair if damage does occur.

6.4 Settlement monitoring

On the basis of this assessment, the installation and survey of ground and building monitoring prisms are recommended at 8 m intervals along the perimeter walls for the buildings specified in Table 6.1. An instrumentation plan showing the location of these proposed instruments is included in Appendix A.

Settlement trigger levels for each building are presented in Table 6.1.

At each prism, the monitoring frequency shall be:

- Surveyed and recorded at least three times prior to commencement of excavation.
- Weekly during construction of the trench, manhole, and trenchless excavations.
- Monthly to the completion of the construction works.

Table 6.1: Recommended monitored buildings

ID	Building address		Description	Monitoring required		Settlement trigger level [mm]	
	No.	Street		Ground prisms	Building prisms	Alert	Alarm
1	53	Arundel Street	Changing room building at Keith Hay Park	Yes	Yes	11	14
2	668	Richardson Road	Hillsborough Kindergarten	Yes	No	8	10
3	670	Richardson Road	Hay Park School building	Yes	No	8	10
4	13	Noton Road	Eden Roskill Cricket Club building	Yes	No	8	10

The above requirements (including trigger levels) provide guidance on appropriate settlement monitoring and associated trigger levels. These should be confirmed and updated as required at the detailed design stage once the position and dimensions of excavations are confirmed together with the alignment and construction methodology (consistent with the existing CI consent requirements).

[9] Noting this approach is consistent with Condition 4.6 of the existing CI consent which requires that Watercare undertakes a risk assessment to identify existing buildings and structures at-risk of damage due to settlement caused by shaft sinking or tunnelling activities.

6.5 Groundwater monitoring

Groundwater monitoring is proposed to identify groundwater drawdown in the vicinity of the construction works. The monitoring network will comprise piezometers within the zone of influence, as presented in the instrumentation plan in Appendix A. An additional piezometer is proposed outside of the expected zone of influence to monitor baseline groundwater.

The Contractor will install and maintain all piezometers within the groundwater monitoring network until monitoring is no longer required. Piezometers must remain in place and if destroyed during construction, shall be replaced to maintain a continuous monitoring record.

At each piezometer, the monitoring frequency shall be:

- Weekly for a minimum of three months prior to commencement of excavation.
- Three times a week for all piezometers until completion of works.
- Weekly for six months following the completion of works, or until such time after construction has completed, that monitoring of settlement has stabilised.

The groundwater alert trigger level criteria for the proposed piezometers is specified as 90% of predicted drawdown response in all geological units.

As above, the groundwater monitoring requirements should be confirmed and updated as required at the detailed design stage once the position and dimensions of excavations are confirmed together with the alignment and construction methodology (consistent with the existing CI consent requirements).

7 Conclusion

This memo summarises predicted ground movement and subsequent effects resulting from the design and construction of the CC9 works at Keith Hay Park.

To assess whether a detailed assessment was required on the buildings adjacent to the works, a limiting settlement value of 10 mm and differential settlement of 1/500 was specified – ground movement of this level is generally considered negligible and unlikely to have any effects. Only one building at 53 Arundel Street (the changing shed in Keith Hay Park) falls within the extent of the 10 mm settlement contour. The assessment indicates that the predicted settlement is likely to have a negligible effect on this building.

The effects on adjacent utilities were assessed. It was concluded that several of the utility services which cross the CC9 alignment are at risk of damage due to high differential settlements near the trench excavations. While it is recommended that these utilities are investigated further during detailed design to determine their risk of damage and/or impaired performance, these utilities are owned by Watercare or otherwise by Auckland Council Healthy Waters which has provided written approval for the works.

During construction, it is recommended that the buildings discussed in Section 6 are monitored to confirm that the actual construction related effects are consistent, or lesser than, those assessed in this memo. When finalising the design of the excavation support and construction methodology, the appointed contractor should confirm that the assumptions outlined in this memorandum are appropriate for the construction methodology to be adopted. Where more adverse (or less) conditions or circumstances are identified, then the monitoring and control provisions presented in this report should be reviewed, and adjusted if required.

The information used and assumptions made in this memo are valid for the alignment and scope of the proposed works outlined here. Should any of these not be representative of the actual final works (position or dimensions of excavation changed, different construction methodologies followed than that assumed here), a re-assessment of the effects is required.

8 Applicability

This report has been prepared for the exclusive use of our client Watercare , with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:

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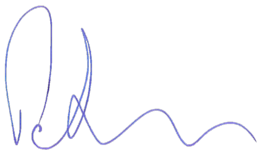
James Lawrie
Geotechnical Engineer

Report reviewed by:

.....

George Brink
Engineering Geologist

Authorised for Tonkin & Taylor Ltd by:



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Peter Roan

Project Director

JALA
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Appendix A: Plans

C:\Users\jala\Documents\QGIS\Projects\S92 - Keith Hay Park\Maps\Keith Hay Park - CI.qgz Layout: Instrumentation Plan Drawn by JALA

LEGEND

- 10 mm SETTLEMENT CONTOUR
- PROPOSED BUILDING PRISMS
- PROPOSED GROUND PRISMS
- PROPOSED PIEZOMETERS

BUILDINGS

- NEGLIGIBLE DAMAGE ASSESSEMENT
- OUTSIDE 10 mm CONTOUR

NOTES

1. THE 10 mm SETTLEMENT CONTOUR PRESENTED IN THIS PLAN IS FOR SCREENING PURPOSES ONLY TO SHOW THE LIKELY WORST CASE ZONE OF INFLUENCE FROM THE CC9 - KEITH HAY PARK WORKS. IT IS EXPECTED THAT FINAL SETTLEMENT CONTOURS ARE PRODUCED DURING DETAILED DESIGN ONCE THE ALIGNMENT AND CONSTRUCTION METHADOLOGY ARE FINALISIED TO CONFIRM EFFECTS FROM THE WORKS.
2. TRIGGER LEVELS FOR PROPOSED INSTRUMENTATION ARE PRESENTED IN THE ACCOMPANYING ASSESSMENT OF SETTLEMENT EFFECTS REPORT.

Tonkin+Taylor

Exceptional thinking together www.tonkintaylor.co.nz

NOTES:

AERIAL PHOTO SOURCED FROM LINZ. LICENSED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENSE (CC BY 4.0).

REV	DESCRIPTION	GIS	CHK	DATE
0	First version	JALA	GEBR	OCT. 21

LOCATION PLAN

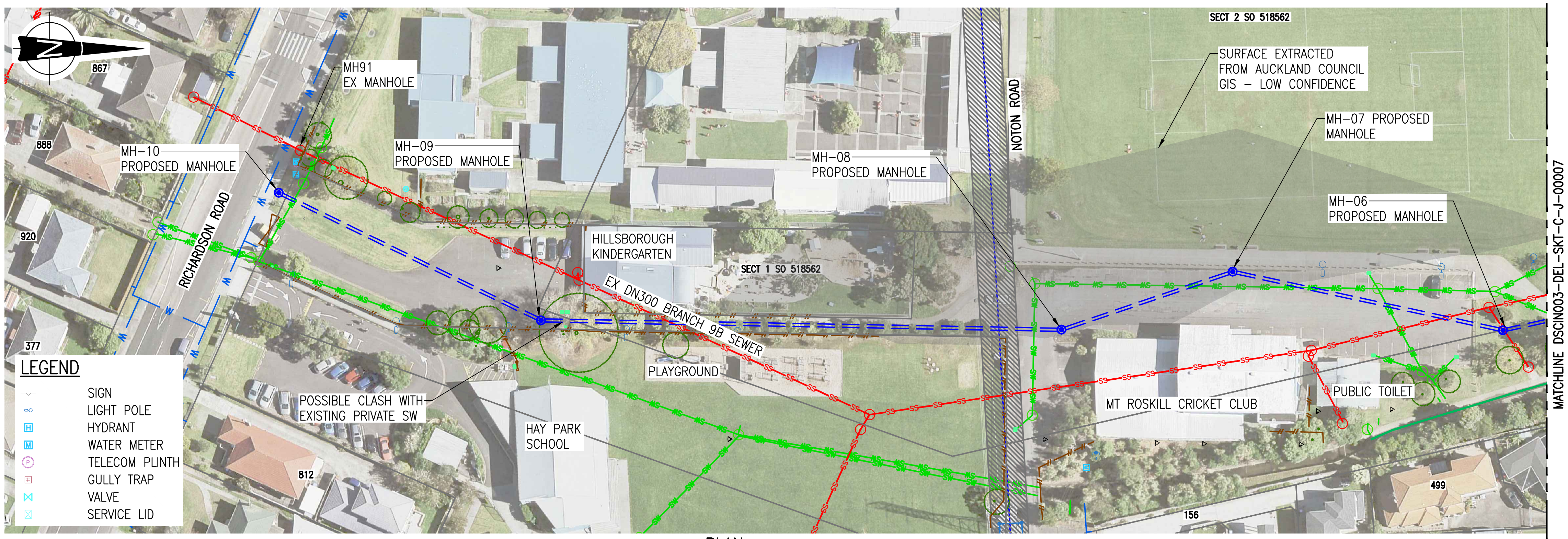
PROJECT No.	1015172.1400	
DESIGNED	JALA	OCT.21
DRAWN	JALA	OCT.21
CHECKED	GEBR	OCT.21
APPROVED		DATE

CLIENT **WATERCARE**

PROJECT **CSO CC9 KEITH HAY PARK**

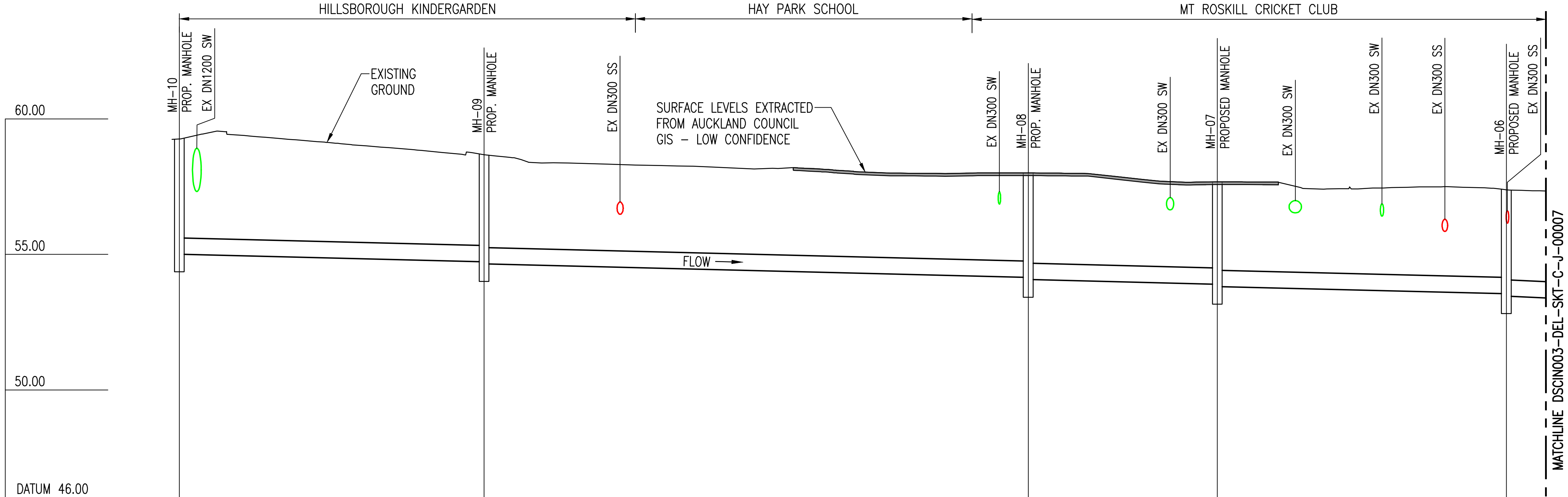
TITLE PROPOSED INSTRUMENTATION PLAN AND SETTLEMENT CONTOUR

SCALE (A3) 1:1,800 FIG No. FIGURE 1. REV 0



PLAN

SCALE 1:500 (A1)



PIPE DIAMETER AND GRADE	600 ID (1:200) PIPE				
EXISTING GROUND LEVELS (mRL)	59.25	58.67	58.00	57.67	57.38
PROPOSED INVERT LEVELS (mRL)	55.01	54.73 54.65	54.15 54.07	53.90 53.82	53.55 53.47
DEPTH TO INVERT (m)	4.24	3.94 4.02	3.85 3.93	3.77 3.85	3.83 3.91
CHAINAGE (m)	100.00	156.18	256.47	291.33	344.61

LONGITUDINAL SECTION

SCALE 1:100 V 1:500 H (A1)

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
2. LOCATION OF EXISTING SERVICES HAVE BEEN EXTRACTED FROM AUCKLAND COUNCIL GIS AND UTILITIES PLANS AND ARE INDICATIVE. CONTRACTOR IS RESPONSIBLE FOR ASSESSING DIAL B 4 U DIG INFORMATION PRIOR TO CONSTRUCTION. PHYSICAL LOCATION OF AFFECTED SERVICES WILL BE REQUIRED PRIOR TO CONSTRUCTION. ALL AFFECTED SERVICES SHALL BE PROTECTED DURING CONSTRUCTION.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR DESIGN OF PIPE STRUCTURE CLASS AND PRESSURE RATING TO BOTH LONG-TERM PERMANENT-CASE AND TEMPORARY LOADS.

LEGEND

- PROPOSED MAIN TUNNEL
- PROPOSED LINK SEWER
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- PROPOSED SEWERAGE
- PROPOSED STORMWATER
- PROPOSED POWER/CONTROL DUCT
- SW — EXISTING STORMWATER
- EXISTING STORMWATER STREAM
- SS — EXISTING NETWORK WASTEWATER
- SS — EXISTING TRANSMISSION WASTEWATER
- W — EXISTING WATERMAIN
- LV — LV POWER CABLE
- HV — HV POWER CABLE
- MV — MV POWER CABLE
- TRANSPOWER LINE
- DESIGNATION BOUNDARY
- PROPOSED ALL WEATHER TRAFFICABLE ACCESS
- PROPOSED AIR DUCT
- CADASTRAL BOUNDARY
- OPEN WATER CHANNEL
- FENCE
- SURVEY MARK
- PP — POWER POLE
- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

SCALE 1:100 (A1) 2 1 0 2 4 6 8 10m

SCALE 1:500 (A1) 10 8 6 4 2 0 10 20 30 40 50m

INFORMATION ISSUE

JACOBS AECOM McMILLEN JACOBS ASSOCIATES

Plot Date: Feb 03, 2021 – 11:55 Users\pfar\appdata\local\projectwise\watercare_ltd_projects\dms51944\DSCIN003-DEL-SKT-C-J-00006.dwg

ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

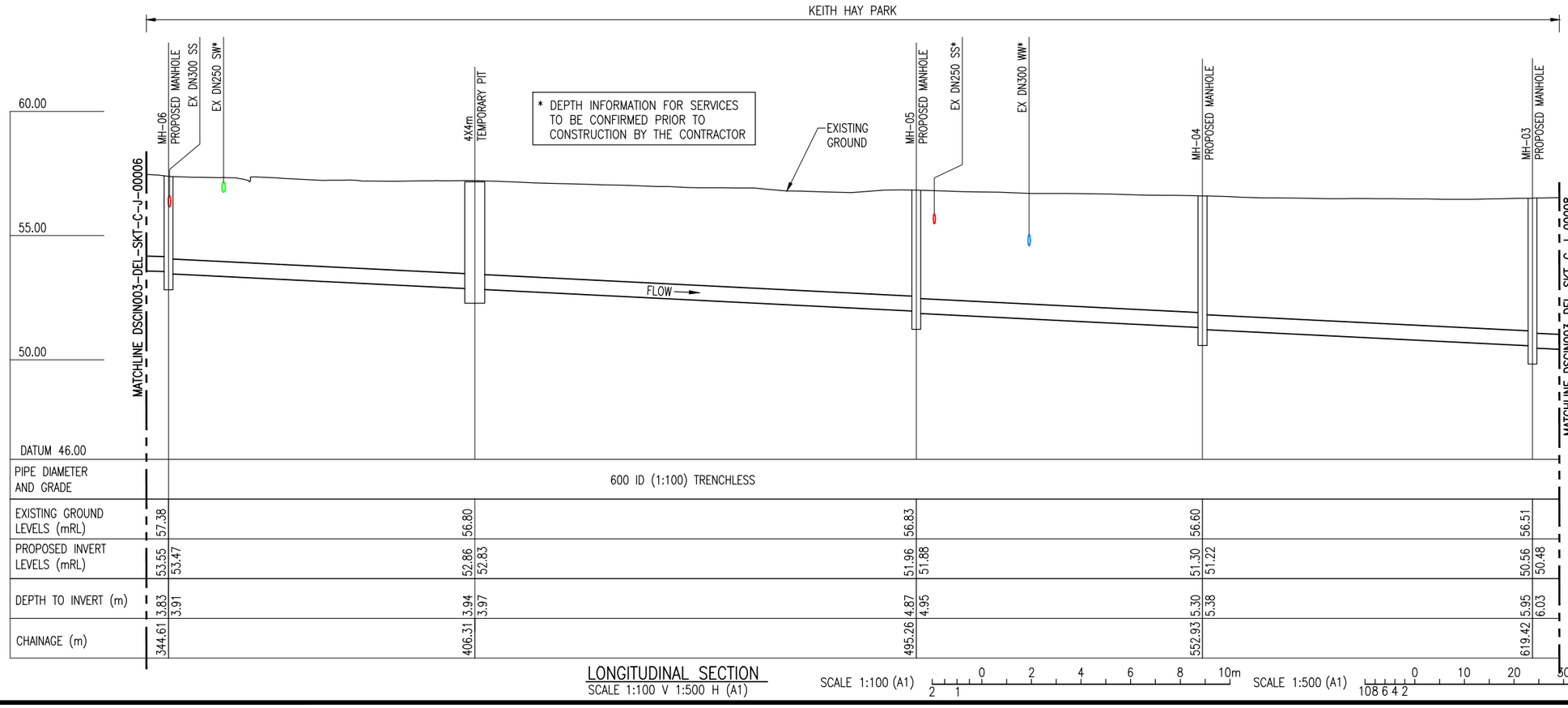
Watercare

KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES

PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 2 – SHEET 1 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00006.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00006
ISSUE	A

PLAN
SCALE 1:500 (A1)



LONGITUDINAL SECTION
SCALE 1:100 V 1:500 H (A1)

SCALE 1:100 (A1) 0 2 4 6 8 10m

SCALE 1:500 (A1) 0 10 20 30 40 50m

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
2. LOCATION OF EXISTING SERVICES HAVE BEEN EXTRACTED FROM AUCKLAND COUNCIL GIS AND UTILITIES PLANS AND ARE INDICATIVE. CONTRACTOR IS RESPONSIBLE FOR ASSESSING DIAL B 4 U DIG INFORMATION PRIOR TO CONSTRUCTION. PHYSICAL LOCATION OF AFFECTED SERVICES WILL BE REQUIRED PRIOR TO CONSTRUCTION. ALL AFFECTED SERVICES SHALL BE PROTECTED DURING CONSTRUCTION.
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LEGEND

- PROPOSED MAIN TUNNEL
- PROPOSED LINK SEWER
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- PROPOSED SEWERAGE
- PROPOSED STORMWATER
- PROPOSED POWER/CONTROL DUCT
- SW — EXISTING STORMWATER
- EXISTING STORMWATER STREAM
- SS — EXISTING NETWORK WASTEWATER
- SS SS SS — EXISTING TRANSMISSION WASTEWATER
- W — EXISTING WATERMAIN
- LV — LV POWER CABLE
- HV — HV POWER CABLE
- MV — MV POWER CABLE
- TRANSPOWER LINE
- DESIGNATION BOUNDARY
- PROPOSED ALL WEATHER TRAFFICABLE ACCESS
- PROPOSED AIR DUCT
- CADASTRAL BOUNDARY
- OPEN WATER CHANNEL
- FENCE
- SURVEY MARK
- PP POWER POLE
- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

INFORMATION ISSUE

JACOBS AECOM MAULLEN ASSOCIATES

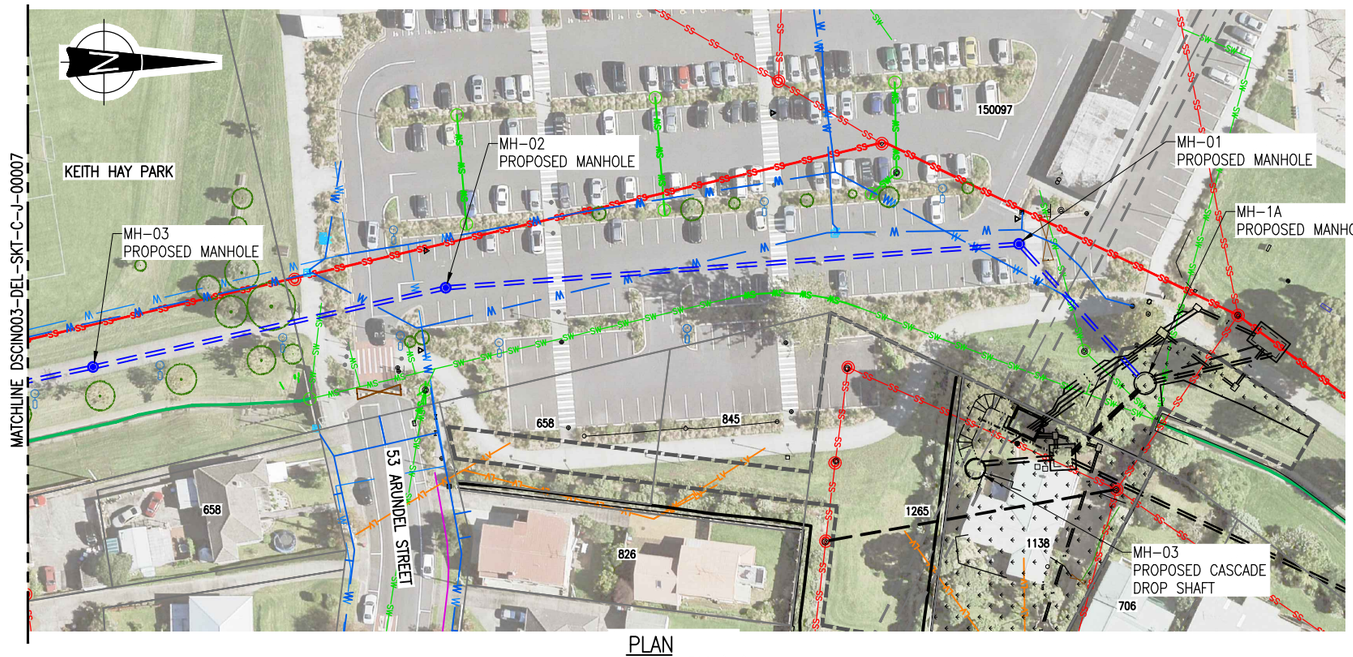
ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

Watercare

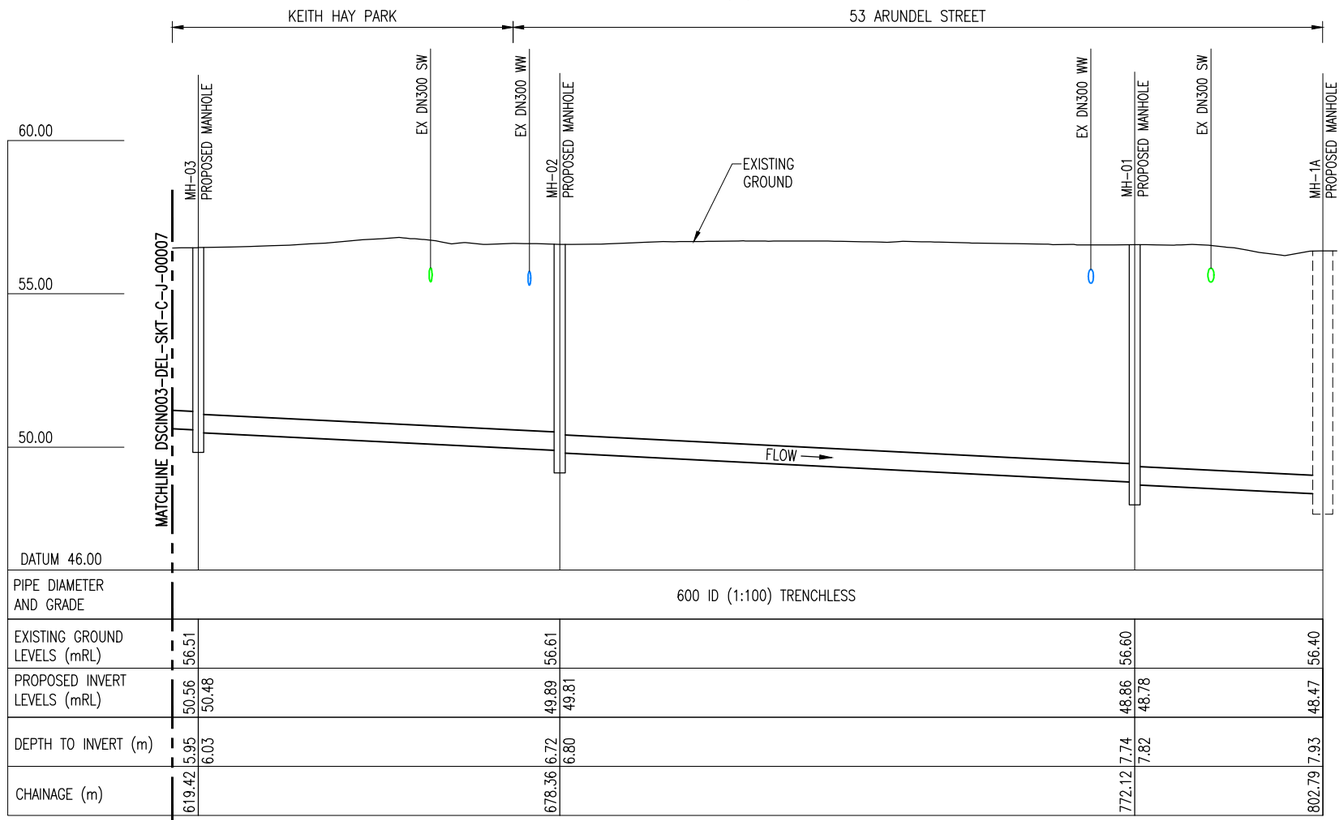
KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES
PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 2 – SHEET 2 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00007.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00007
ISSUE	A

Plot Date: Feb 03, 2021 – 11:38:46 – C:\Users\jfar\appdata\local\projectwise\watercare_ltd_projects\dms51944\DSCIN003-DEL-SKT-C-J-00007.dwg



PLAN
SCALE 1:500 (A1)



LONGITUDINAL SECTION
SCALE 1:100 V 1:500 H (A1)

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
2. LOCATION OF EXISTING SERVICES HAVE BEEN EXTRACTED FROM AUCKLAND COUNCIL GIS AND UTILITIES PLANS AND ARE INDICATIVE. CONTRACTOR IS RESPONSIBLE FOR ASSESSING DIAL B 4 U DIG INFORMATION PRIOR TO CONSTRUCTION. PHYSICAL LOCATION OF AFFECTED SERVICES WILL BE REQUIRED PRIOR TO CONSTRUCTION. ALL AFFECTED SERVICES SHALL BE PROTECTED DURING CONSTRUCTION.
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LEGEND

- PROPOSED MAIN TUNNEL
- PROPOSED LINK SEWER
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- PROPOSED SEWERAGE
- PROPOSED STORMWATER
- PROPOSED POWER/CONTROL DUCT
- SW — EXISTING STORMWATER
- EXISTING STORMWATER STREAM
- SS — EXISTING NETWORK WASTEWATER
- SS SS SS — EXISTING TRANSMISSION WASTEWATER
- W — EXISTING WATERMAIN
- LV — LV POWER CABLE
- HV — HV POWER CABLE
- MV — MV POWER CABLE
- TRANSPOWER LINE
- DESIGNATION BOUNDARY
- PROPOSED ALL WEATHER TRAFFICABLE ACCESS
- PROPOSED AIR DUCT
- CADASTRAL BOUNDARY
- OPEN WATER CHANNEL
- FENCE
- SURVEY MARK
- PP — POWER POLE
- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

LEGEND

- SIGN
- LIGHT POLE
- H — HYDRANT
- W — WATER METER
- P — TELECOM PLINTH
- GULLY TRAP
- VALVE
- SERVICE LID

SCALE 1:100 (A1) 0 2 4 6 8 10m
SCALE 1:500 (A1) 2 1 0 10 20 30 40 50m
10 8 6 4 2

INFORMATION ISSUE

JACOBS AECOM McMILLEN JACOBS ASSOCIATES

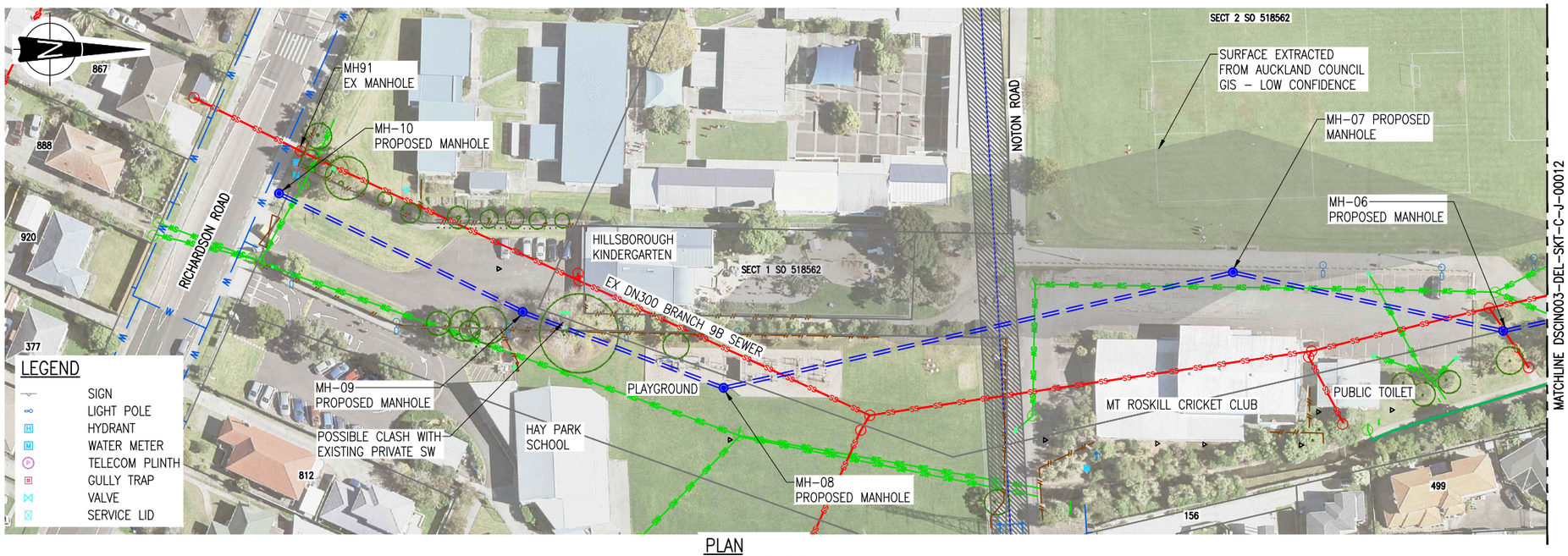
ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

Watercare

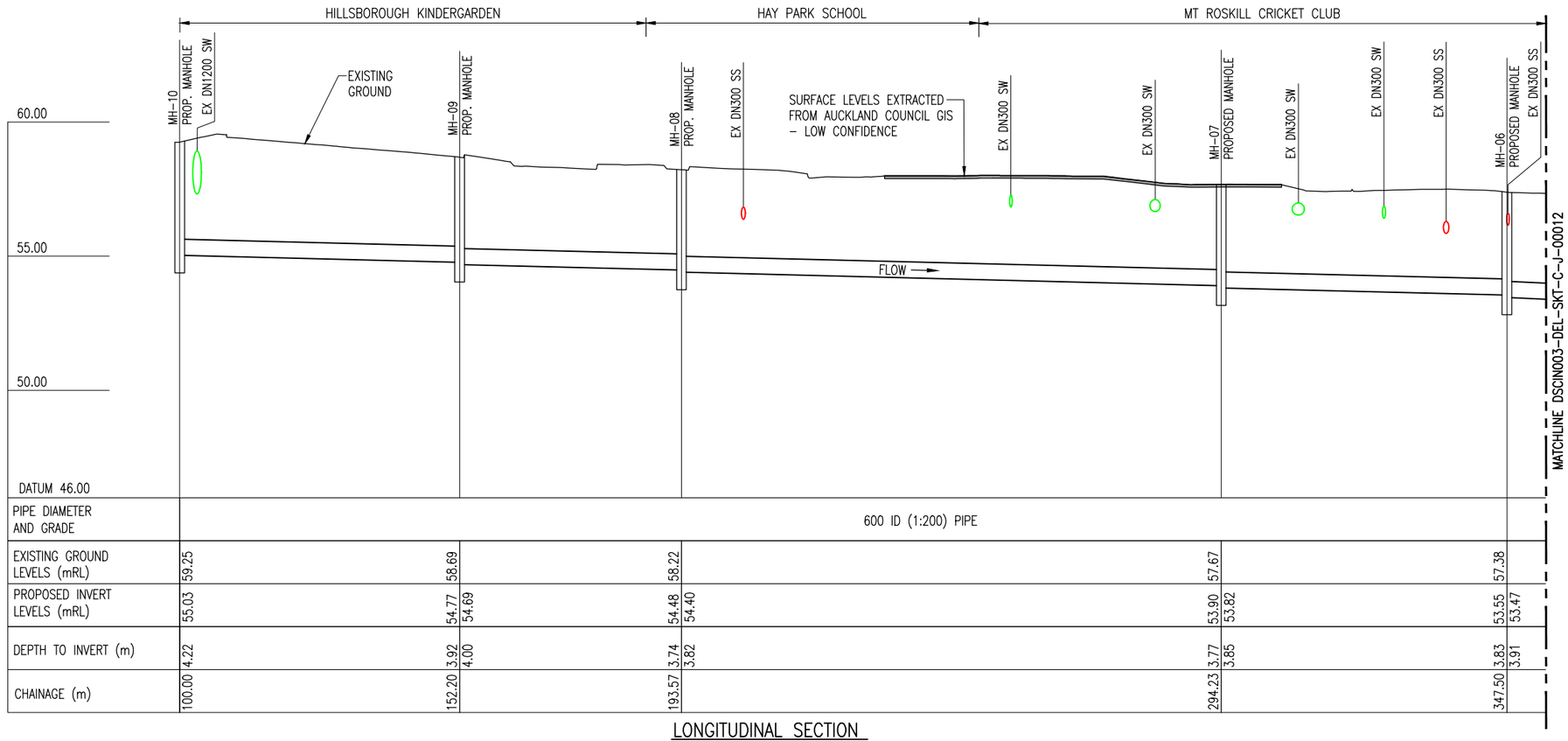
KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES
PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 2 – SHEET 3 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00008.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00008
ISSUE	A

Plot Date: Feb 03, 2021 - 11:37 C:\Users\pfar\appdata\local\projectwise\watercare_ltd_projects\dms51944\DSCIN003-DEL-SKT-C-J-00008.dwg



PLAN
SCALE 1:500 (A1)



PIPE DIAMETER AND GRADE	600 ID (1:200) PIPE	
EXISTING GROUND LEVELS (mRL)	59.25	58.69 / 58.22 / 57.67 / 57.38
PROPOSED INVERT LEVELS (mRL)	55.03	54.77 / 54.69 / 54.48 / 54.40 / 53.90 / 53.82 / 53.55 / 53.47
DEPTH TO INVERT (m)	4.22	3.92 / 4.00 / 3.74 / 3.82 / 3.77 / 3.85 / 3.83 / 3.91
CHAINAGE (m)	100.00	152.20 / 193.57 / 294.23 / 347.50

LONGITUDINAL SECTION
SCALE 1:100 V 1:500 H (A1)

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
2. LOCATION OF EXISTING SERVICES HAVE BEEN EXTRACTED FROM AUCKLAND COUNCIL GIS AND UTILITIES PLANS AND ARE INDICATIVE. CONTRACTOR IS RESPONSIBLE FOR ASSESSING DIAL B 4 U DIG INFORMATION PRIOR TO CONSTRUCTION. PHYSICAL LOCATION OF AFFECTED SERVICES WILL BE REQUIRED PRIOR TO CONSTRUCTION. ALL AFFECTED SERVICES SHALL BE PROTECTED DURING CONSTRUCTION.
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- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

SCALE 1:100 (A1) 0 2 4 6 8 10m
SCALE 1:500 (A1) 2 1 0 10 20 30 40 50m 10 8 6 4 2

INFORMATION ISSUE

JACOBS AECOM MJ MCMILLEN JACOBS ASSOCIATES

ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

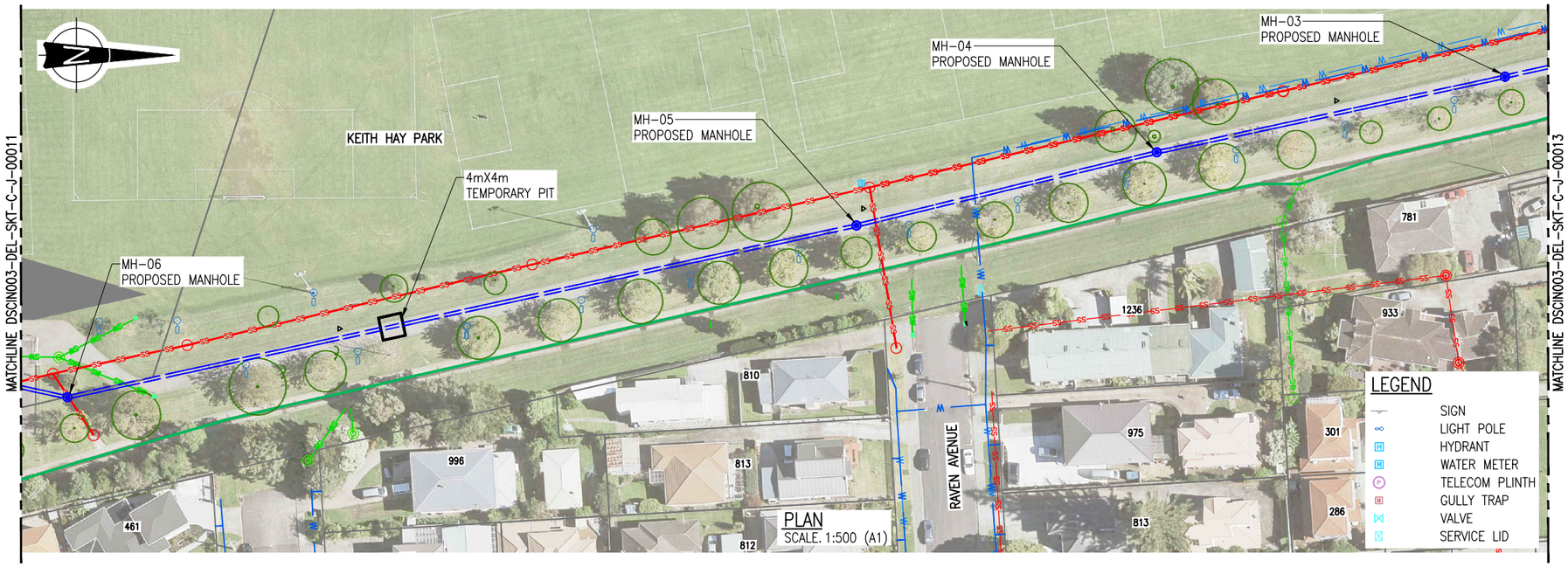
Watercare

KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09) 82 GRAVITY SEWER INCLUDING MANHOLES

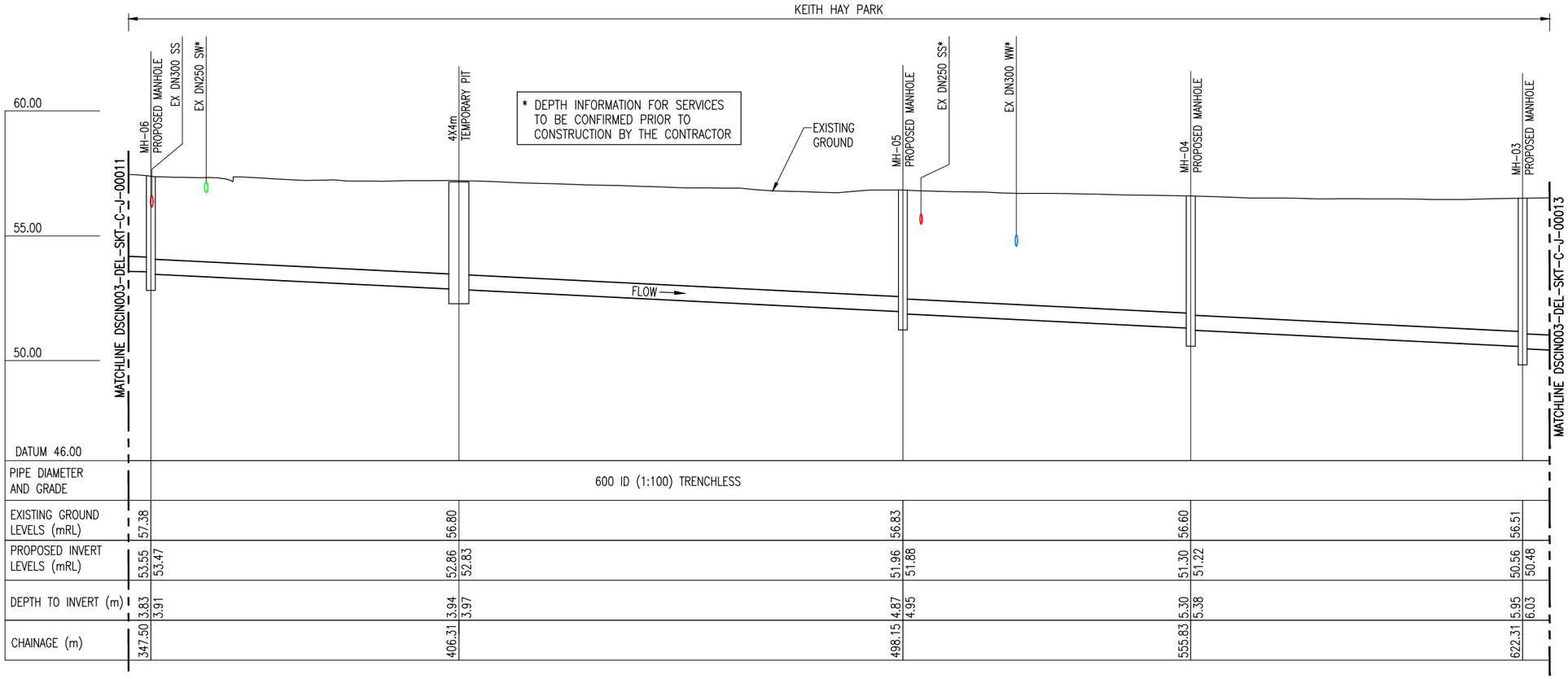
PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 3 – SHEET 1 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00011.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00011
ISSUE	A

Plot Date: Feb 03, 2021 - 11:54:09 C:\Users\pfar\appdata\local\projectwise\watercare_ltd_projects\dms51944\DSCIN003-DEL-SKT-C-J-00011.dwg



PLAN
SCALE. 1:500 (A1)



PIPE DIAMETER AND GRADE		600 ID (1:100) TRENCHLESS
EXISTING GROUND LEVELS (mRL)	57.38	56.80 / 56.83 / 56.60 / 56.51
PROPOSED INVERT LEVELS (mRL)	53.55 / 53.47	52.86 / 52.83 / 51.96 / 51.88 / 51.30 / 51.22 / 50.56 / 50.48
DEPTH TO INVERT (m)	3.83 / 3.91	3.94 / 3.97 / 4.87 / 4.95 / 5.30 / 5.38 / 5.95 / 6.03
CHAINAGE (m)	347.50	406.31 / 498.15 / 555.83 / 622.31

LONGITUDINAL SECTION
SCALE. 1:100 V 1:500 H (A1)

SCALE 1:100 (A1) 0 2 4 6 8 10m

SCALE 1:500 (A1) 0 10 20 30 40 50m

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
2. LOCATION OF EXISTING SERVICES HAVE BEEN EXTRACTED FROM AUCKLAND COUNCIL GIS AND UTILITIES PLANS AND ARE INDICATIVE. CONTRACTOR IS RESPONSIBLE FOR ASSESSING DIAL B 4 U DIG INFORMATION PRIOR TO CONSTRUCTION. PHYSICAL LOCATION OF AFFECTED SERVICES WILL BE REQUIRED PRIOR TO CONSTRUCTION. ALL AFFECTED SERVICES SHALL BE PROTECTED DURING CONSTRUCTION.
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LEGEND

- PROPOSED MAIN TUNNEL
- PROPOSED LINK SEWER
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- PROPOSED SEWERAGE
- PROPOSED STORMWATER
- PROPOSED POWER/CONTROL DUCT
- SW — EXISTING STORMWATER
- EXISTING STORMWATER STREAM
- SS — EXISTING NETWORK WASTEWATER
- SS — EXISTING TRANSMISSION WASTEWATER
- W — EXISTING WATERMAIN
- LV — LV POWER CABLE
- HV — HV POWER CABLE
- MV — MV POWER CABLE
- TRANSPOWER LINE
- DESIGNATION BOUNDARY
- PROPOSED ALL WEATHER TRAFFICABLE ACCESS
- PROPOSED AIR DUCT
- CADASTRAL BOUNDARY
- OPEN WATER CHANNEL
- FENCE
- SURVEY MARK
- PP — POWER POLE
- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

INFORMATION ISSUE

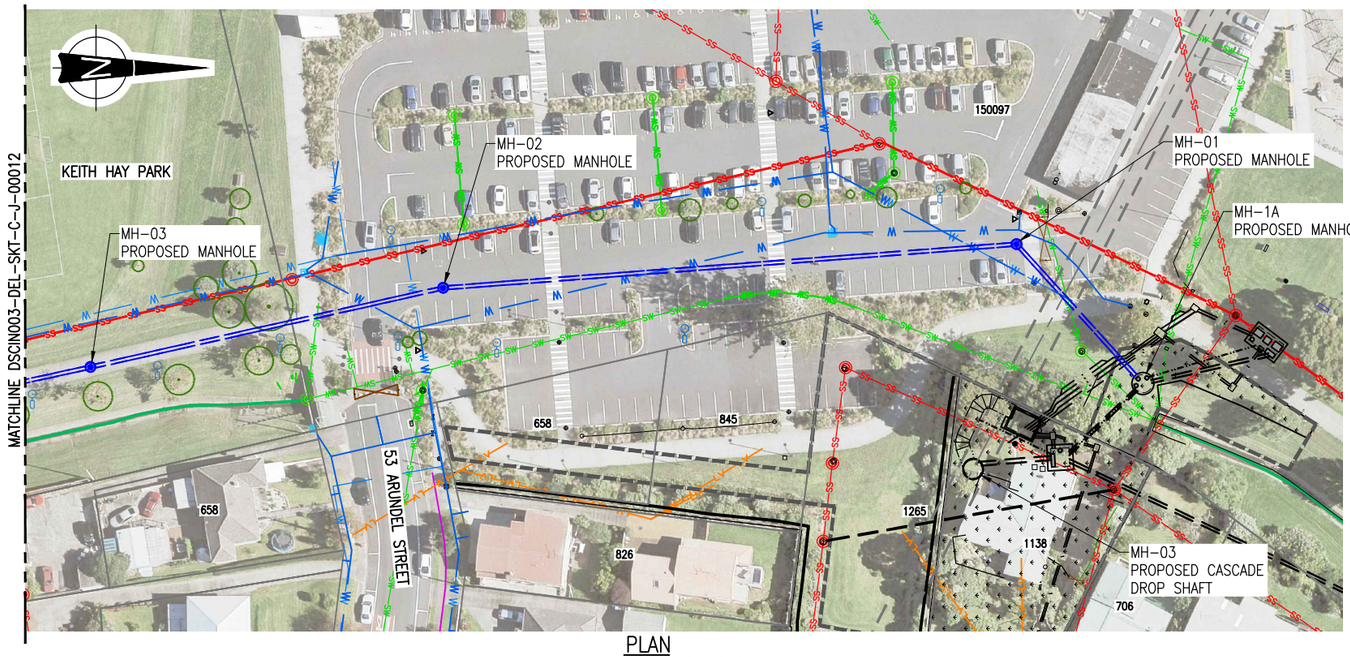
JACOBS AECOM McMILLEN JACOBS ASSOCIATES

ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

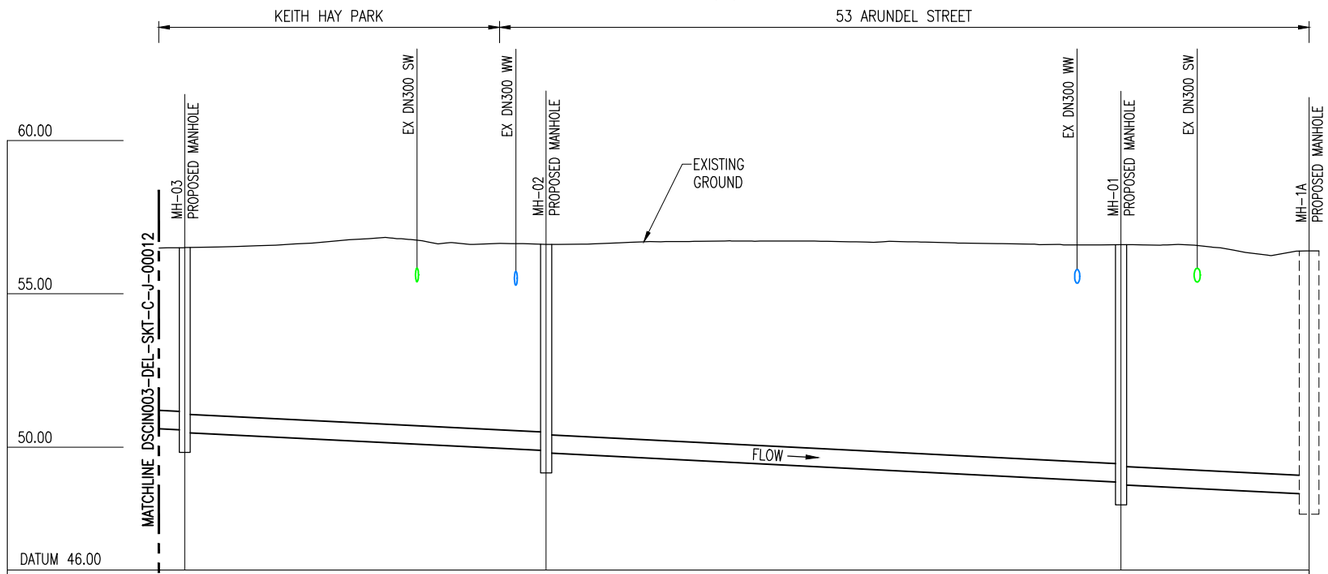
KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES
PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 3 – SHEET 2 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00012.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00012
ISSUE	A

Plot Date: Feb 03, 2021 - 11:51am C:\Users\pfan\appdata\local\projectwise\watercare_ltd_projects\dms519414\DSCIN003-DEL-SKT-C-J-00012.dwg



PLAN
SCALE. 1:500 (A1)



PIPE DIAMETER AND GRADE	600 ID (1:100) TRENCHLESS																						
EXISTING GROUND LEVELS (mRL)	56.51														56.61								
PROPOSED INVERT LEVELS (mRL)	50.56	50.48													49.89	49.81							
DEPTH TO INVERT (m)	5.95	6.03													6.72	6.80							
CHAINAGE (m)	622.31														681.25								

PIPE DIAMETER AND GRADE																							
EXISTING GROUND LEVELS (mRL)																							
PROPOSED INVERT LEVELS (mRL)																							
DEPTH TO INVERT (m)																							
CHAINAGE (m)																							

LONGITUDINAL SECTION
SCALE. 1:100 V 1:500 H (A1)

NOTES:

1. CO-ORDINATES ARE IN NZTM AND LEVELS ARE TO AUCKLAND L&S 1946 DATUM.
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LEGEND

- PROPOSED MAIN TUNNEL
- PROPOSED LINK SEWER
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- PROPOSED SEWERAGE
- PROPOSED STORMWATER
- PROPOSED POWER/CONTROL DUCT
- SW — EXISTING STORMWATER
- EXISTING STORMWATER STREAM
- SS — EXISTING NETWORK WASTEWATER
- SS SS SS — EXISTING TRANSMISSION WASTEWATER
- W — EXISTING WATERMAIN
- LV — LV POWER CABLE
- HV — HV POWER CABLE
- MV — MV POWER CABLE
- TRANSPOWER LINE
- DESIGNATION BOUNDARY
- PROPOSED ALL WEATHER TRAFFICABLE ACCESS
- PROPOSED AIR DUCT
- CADASTRAL BOUNDARY
- OPEN WATER CHANNEL
- FENCE
- SURVEY MARK
- PP — POWER POLE
- BOLLARD
- GATE
- CESSPIT SINGLE
- MANHOLE
- STORMWATER PIPE INVERT
- TREE TRUNK & APPROXIMATE DRIP LINE

LEGEND

- SIGN
- LIGHT POLE
- HYDRANT
- WATER METER
- TELECOM PLINTH
- GULLY TRAP
- VALVE
- SERVICE LID

SCALE 1:100 (A1) 0 2 4 6 8 10m
SCALE 1:500 (A1) 2 1 0 10 20 30 40 50m
10 8 6 4 2

INFORMATION ISSUE

JACOBS AECOM McMILLEN JACOBS ASSOCIATES

ISSUE	DATE	AMENDMENT
A	03.02.21	IFI – CC9 CONSENT OPTION ISSUE

Watercare

KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES
PLAN AND LONGITUDINAL SECTION – CONSENT OPTION 3 – SHEET 3 OF 3

CAD FILE	DSCIN003-DEL-SKT-C-J-00013.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	AS SHOWN
SKETCH No.	DSCIN003-DEL-SKT-C-J-00013
ISSUE	A

Plot Date: Feb 03, 2021 - 11:57am C:\Users\plan\appdata\local\projectwise\watercare_ltd_projects\dms51944\DSCIN003-DEL-SKT-C-J-00013.dwg

NOTES:

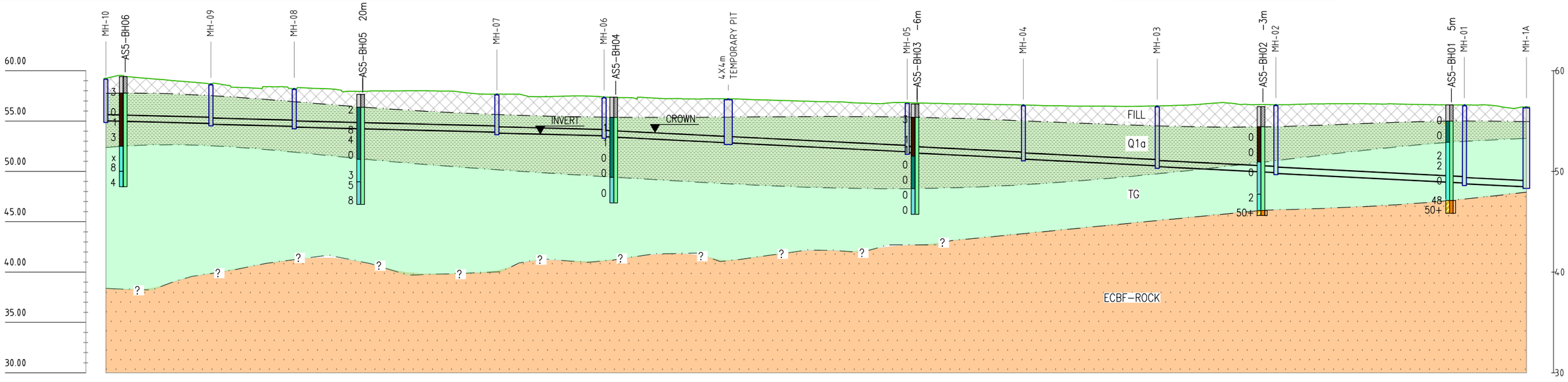
1. EXISTING GROUND SURFACE MODELLED FROM AUCKLAND COUNCIL GIS DATA AND LANDSURVEY DATA PROVIDED BY BECA.
2. BACKGROUND AERIAL PHOTOGRAPHY & CADASTRAL DATA FROM AUCKLAND COUNCIL GIS DATA. 21/08/2015
3. VERTICAL HEIGHT DATUM AUCKLAND 1946.
4. COORDINATE SYSTEM NZTM.
5. ALL DIMENSIONS IN METRES AND ELEVATIONS IN mRL UNLESS OTHERWISE NOTED.
6. THE GEOTECHNICAL INFORMATION SHOWN IS FOR GUIDANCE ONLY.
7. UPPER ECBF BOUNDARY UNKNOWN SOUTH OF AS5-BH02.

LEGEND

AS5-BH03 -6m — Borehole ID and offset from section. (Negative numbers are into the page.)

	BH LEFT	PLAN AND SECTION	BH RIGHT
No core			Made Ground (FILL)
Fill and topsoil			Recent Alluvium (Q1a)
Basalt		TAURANGA GROUP	
Other volcanics			Undifferentiated Tauranga Group (TG)
Clay and clay dominated mixtures			Kaawa Formation (KAAWA)
Organic clay and organic clay dominated mixtures		AUCKLAND VOLCANIC FIELD (PLEISTOCENE)	
Peat			Basalt (AVL)
Silt and silt dominated mixtures			Tuff / Ash / Scoria (AVT)
Organic silt and organic silt dominated mixtures		WAITEMATA GROUP (MIOCENE)	
Sand and sand dominated mixtures (clean)			Residually to Highly Weathered - Cohesive Soils (RS)
Sand and sand dominated mixtures (with fines)			Residually to Highly Weathered - Granular Soils (RS)
Organic sand and organic sand dominated mixtures			Parnell Volcaniclastic Conglomerate (PVC)
Sandstone			Moderately Weathered to Unweathered ECBF (ECBF-ROCK)
Mudstone			
Interbedded mudstone and sandstone			
Conglomerate			
Coal			

STANDPIPE PIEZOMETER RESPONSE ZONE · VW PIEZOMETER TIP DEPTH · FORMATION · CPT TIP RESISTANCE · SPT N · LITHOLOGY · FORMATION · ROCK STRENGTH · INTERPRETED PIEZOMETRIC SURFACE AT TUNNEL HORIZON



CHAINAGE (m)	100	200	300	400	500	600	700	800
GROUND LEVEL (mRL)	59.25	58.22	57.67	55.28	56.23	57.55	57.55	56.40
CROWN LEVEL (mRL)	55.68	49.08	49.43	49.80	50.18	50.47	50.47	49.12
INVERT LEVEL (mRL)	55.03	48.43	48.78	49.15	49.53	49.82	49.82	48.47

ISSUED FOR INFORMATION

JACOBS · AECOM · McMILLEN JACOBS ASSOCIATES

C:\Users\pfar\appdata\local\projectwise\watercare_ltd_projects\dms519441\DSCIN003-DEL-SKT-GT-J-30001.DWG

Plot Date: Mar 18, 2021 - 1:39pm

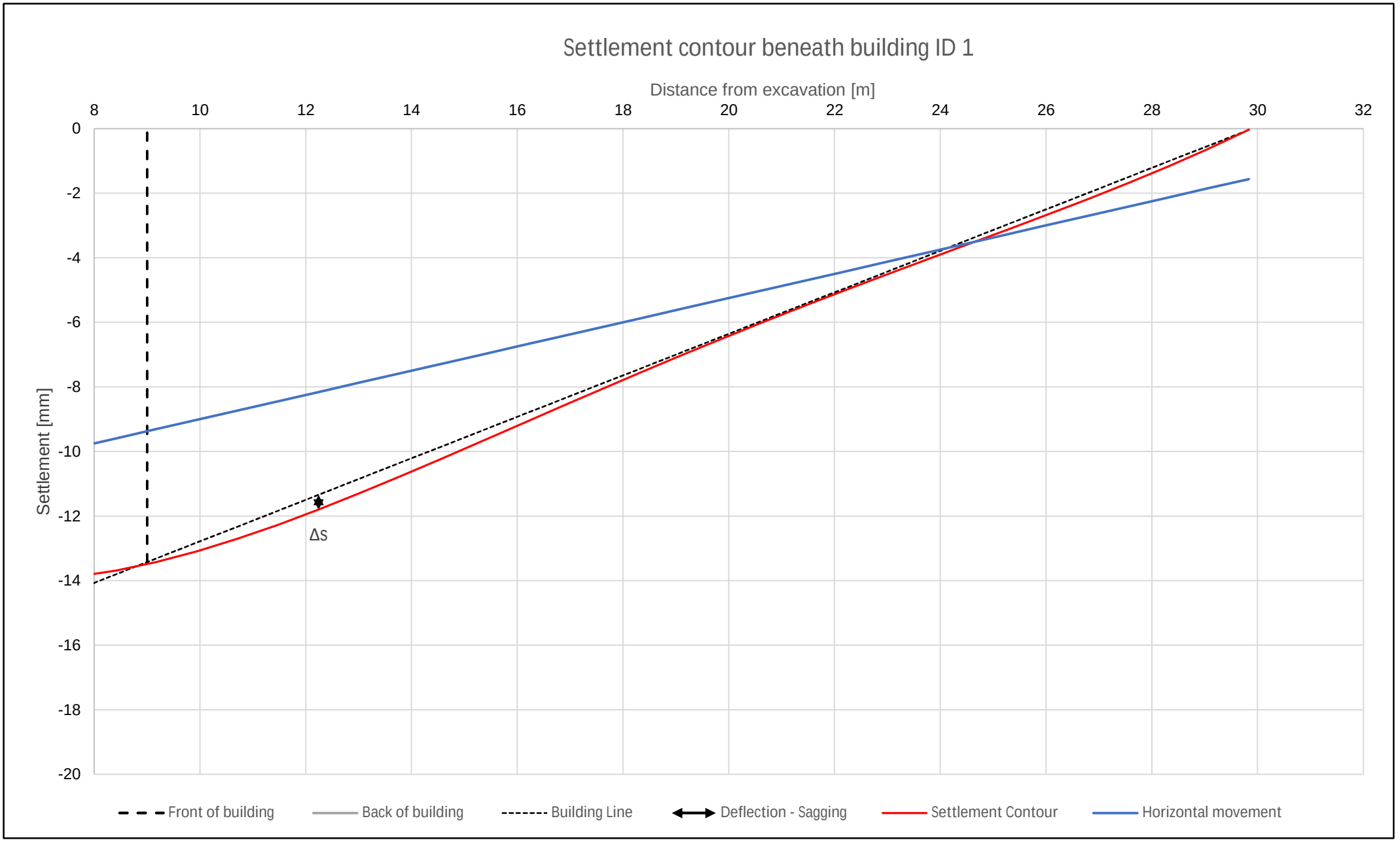
ISSUE	DATE	AMENDMENT
A	18.03.21	ISSUED FOR INFORMATION

KEITH HAY PARK – BRANCH 9 MT. ROSKILL (DSB09)
82 GRAVITY SEWER INCLUDING MANHOLES
SHAFT GEOLOGY – CC9 – PLAN AND SECTION

CAD FILE	DSCIN003-DEL-SKT-GT-J-30001.DWG
REF No.	CI-CIVIL
ORIGINAL SCALE A1	1:1000
SKETCH No.	DSCIN003-DEL-SKT-GT-J-30001
ISSUE	A

Appendix B: T+T Groundwater assessment report

Appendix C: Building assessment calculations


Settlement contour beneath building ID 1
Distance from excavation [m]
8
10
12
14
16
18
20
22
24
26
28
30
32
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
Settlement [mm]
ΔS
Front of building
Back of building
Building Line
Deflection - Sagging
Settlement Contour
Horizontal movement

Calculation for building response to excavation induced settlement

Method as per *Assessment of risk of damage to buildings due to tunneling and excavation (Burland, 1997)*

Building Address = 63 Arundel Street (changing room shed)
Building Name = N/A
Building Type = Unreinforced masonry (assumed)

Input parameters

$H := 3.5$ ***Height of building (excluding roof) [m]***

$G := 1$ ***Shear Modulus***

$E := 2.6$ ***Youngs Modulus***

$\upsilon := 0.3$ ***Poisons Ratio***

$\frac{E}{G} = 2.6$ ***Assume 2.6 for masonry structures, 12.5 for framed structures***

$d := 8.5$ ***Depth of excavation***

$x_1 := 9$ ***Distance from excavation centre line to edge of building***

$x_2 := 29.85$ ***Distance from excavation centre line to furtherst edge of building effected by settlement***

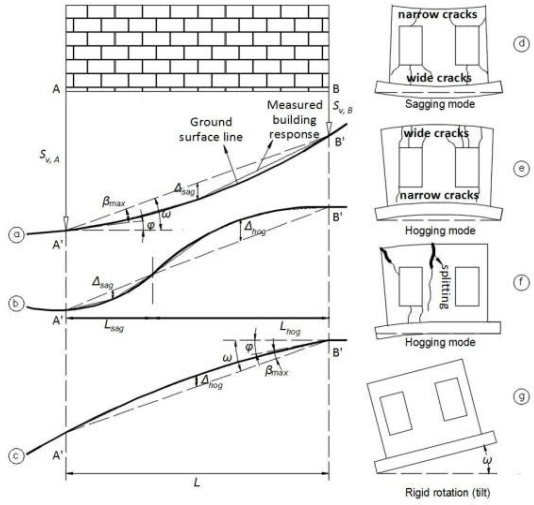
$L' := x_2 - x_1 = 20.85$ ***Length of building perpendicular to tunnel within settlement zone [m]***

$y_1 := 0.01342$ ***Settlement at edge of building [m]***

$y_2 := 0$ ***Settlement at furtherest edge of building affected by settlement [m]***

$h_1 := 0.00931$ ***Estimated horizontal displacement at edge of building***

$h_2 := 0$ ***Estimated horizontal displacement at furtherst effected edge of building***



Sagging Zone

$\Delta_s := 0.00046$ ***Input from excel (relative deflection of settlement contour in sagging zone)***

$L_s := 21.42$ ***Effective length of building in sagging zone (input from excel)***

$I_s := \frac{H^3}{12} = 3.573$ ***Second moment of area [m^3]***

$t_s := \frac{H}{2} = 1.75$ ***Neutral axis depth from edge of beam in tension (sagging zone)***

$$\varepsilon_{bs} := \begin{cases} 0 \text{ if } L_s = 0 \\ \frac{\Delta_s}{L_s} \cdot \left(\frac{L_s}{12 \cdot t_s} + \frac{3 \cdot I_s}{2 \cdot t_s \cdot L_s \cdot H} \cdot \frac{E}{G} \right)^{-1} \text{ otherwise} \end{cases} = 1.907 \times 10^{-5}$$

Fibre strain (sagging)

$$\varepsilon_{ds} := \begin{cases} 0 \text{ if } L_s = 0 \\ \frac{\Delta_s}{L_s} \cdot \left(1 + \frac{H \cdot L_s^{\,2}}{18 \cdot I_s} \cdot \frac{G}{E} \right)^{-1} \text{ otherwise} \end{cases} = 2.025 \times 10^{-6}$$

Diagonal strain (sagging)

$$\varepsilon_{hs} := \begin{cases} 0 \text{ if } L_s = 0 \\ \frac{(h_1 - h_2)}{L_s} \text{ otherwise} \end{cases} = 4.346 \times 10^{-4}$$

Horizontal strain (sagging)

$\varepsilon_{bstotal} := \varepsilon_{bs} + \varepsilon_{hs} = 4.537 \times 10^{-4}$ ***Total fibre strain (sagging)***

$\varepsilon_{dstotal} := \varepsilon_{hs} \cdot \frac{1 - \upsilon}{2} + \left[\varepsilon_{hs}^{\,2} \cdot \left(\frac{1 + \upsilon}{2} \right)^2 + \varepsilon_{ds}^{\,2} \right]^{0.5} = 4.346 \times 10^{-4}$ ***Total diagonal strain (sagging)***

Hogging Zone

$\Delta_h := 0$ ***Input from excel (relative deflection of settlement contour in hogging zone)***

$L_h := 0$ ***Effective length of building in hogging zone***

$I_h := \frac{H^3}{3} = 14.292$ ***Second moment of area [m³]***

$t_h := H = 3.5$ ***Neutral axis depth from edge of beam in tension (hogging zone)***

$$\varepsilon_{bh} := \begin{cases} 0 \text{ if } L_h = 0 \\ \frac{\Delta_h}{L_h} \cdot \left(\frac{L_h}{12 \cdot t_h} + \frac{3 \cdot I_h}{2 \cdot t_h \cdot L_h \cdot H} \cdot \frac{E}{G} \right)^{-1} \text{ otherwise} \end{cases} = 0$$

Fibre strain (Hogging)

$$\varepsilon_{dh} := \begin{cases} 0 \text{ if } L_h = 0 \\ \frac{\Delta_h}{L_h} \cdot \left(1 + \frac{H \cdot L_h^2}{18 \cdot I_h} \cdot \frac{G}{E} \right)^{-1} \text{ otherwise} \end{cases} = 0$$

Diagonal strain (hogging)

$$\varepsilon_{hh} := \begin{cases} 0 \text{ if } L_h = 0 \\ \frac{(h_1 - h_2)}{L_h} \text{ otherwise} \end{cases} = 0$$

Horizontal strain (hogging)

$\varepsilon_{bhtotal} := \varepsilon_{bh} + \varepsilon_{hh} = 0$ ***Total fibre strain (hogging)***

$\varepsilon_{dhtotal} := \varepsilon_{hh} \cdot \frac{1 - \upsilon}{2} + \left[\varepsilon_{hh}^2 \cdot \left(\frac{1 + \upsilon}{2} \right)^2 + \varepsilon_{dh}^2 \right]^{0.5} = 0$ ***Total diagonal strain (hogging)***

Summary

$\varepsilon_b := \max(\varepsilon_{bstotal}, \varepsilon_{bhtotal}) \cdot 100 = 0.045$ ***Critical building strain***

$\varepsilon_d := \max(\varepsilon_{dhtotal}, \varepsilon_{dstotal}) \cdot 100 = 0.043$

$\varepsilon_h := \max(\varepsilon_{hs}, \varepsilon_{hh}) \cdot 100 = 0.043$

$\varepsilon_{critical} := \max(\varepsilon_b, \varepsilon_d, \varepsilon_h) = 0.045$

$$\text{BuildingClassification} := \begin{cases} \text{"Negligible"} \quad \text{if } \varepsilon_{critical} \le 0.05 = \text{"Negligible"} \\ \text{"Very slight"} \quad \text{if } \varepsilon_{critical} \ge 0.05 \\ \text{"Slight"} \quad \text{if } \varepsilon_{critical} \ge 0.075 \\ \text{"Moderate"} \quad \text{otherwise} \end{cases}$$

$\text{Slope} := \left(\frac{y_1 - y_2}{L'} \right)^{-1} = 1.554 \times 10^3$ ***Max building slope***

Tonkin+Taylor

Memo

To:	Xenia Meier and Shalini Sanjeshni Watercare (CI)	Job No:	1015172.1400
From:	Troy McAlister, Tonkin & Taylor Ltd	Date:	24 June 2021 (updated 1 November 2021)
Subject:	CC9 Keith Hay Park - groundwater and dewatering settlement overview		

1 Introduction

Watercare Services Ltd (Watercare) proposes to construct a sewer connection (CC9) at Keith Hay Park, Mt Roskill. The proposed works involve the installation of a 810 m long sewer pipeline from the Central Interceptor (CI) shaft construction site at Keith Hay Park to Richardson Road to allow connection to the existing network.

The construction methodology for the northern extent of the pipeline route will be trenchless (likely micro-tunnelled or otherwise HDD) and the sewer will be installed at a depth to invert of up to approximately 8 m. The construction methodology for the southern section of the CC9 route from the Mt Roskill Cricket Club onwards to Richardson Road will be confirmed at the detailed design stage. While this section may also rely on trenchless methodologies, there is the potential that this section of pipeline will be installed via open cut trenching.

This memorandum sets out a review of potential groundwater drawdown effects along the CC9 alignment through Keith Hay Park to Richardson Road, based on an assessment which considers the credible scenario as well as a worst case scenario for the following three alignment options:

1 Option 1 – Trenchless MH01 to MH06, trenched MH06 to Richardson Road.
2 Option 2 – Trenchless MH01 to Richardson Road.
3 Option 3 - Trenchless MH01 to MH06, trenched MH06 to Richardson Road along a slightly alternate route.

This memorandum has been updated to include a review of potential groundwater drawdown effects at the shaft locations based on an assessment which also considers a credible scenario in terms of construction duration and associated drawdown, as well as a worst case scenario.

The scenarios for these options are defined by the duration of the project.

Settlement in relation to these scenarios has been reviewed in the context of the risk to adjacent infrastructure and buildings. This memorandum has been updated such that the potential effects on adjacent assets of both consolidation settlement and mechanical settlement are now addressed in the accompanying letter report from Tonkin & Taylor Ltd dated 1 November 2021.

2 Geology

Previous ground investigations include six boreholes located along the CC9 pipe alignment, as shown in Appendix A and Table 2.1. These boreholes identify a 9.5 to 11+ m cap of Tauranga Group sediments underlain by East Coast Bays Formation (ECBF). The Tauranga Group sediments, which were present in all boreholes drilled along the alignment, are composed of very soft to firm organic-

rich silt and peat deposits. These were found at depths ranging from 1.30 mbgl to 9.20 mbgl, with an average thickness of 5.8 m. A ground profile per drill hole is provided in Table 2.1.

Additional to the previous investigations, T+T completed a single borehole, BH01, to a depth of 9.0 m. This was undertaken to install a piezometer for groundwater monitoring. The geological profile identified from this borehole has also been used to inform the geological profile. The borehole identified organic clay, organic silt and peat from a depth of 2.1 to 7.5 mbgl. No ECBF material was identified within this borehole. The information obtained from the drilling of this hole is included in the ground profile in Table 2.1 and displayed on the borehole log in Appendix B.

Table 2.1: Borehole and geology summary

BH ID	Associated manhole ID (Drawings 2011805.046-.048)	Likely installation methodology	Tauranga Group sediments depth range (m)	Organic-rich silt and peat depth range – within Tauranga Group(m)	Weathered ECBF depth range (m)
AS5-BH01	MH-01	Trenchless	0.0-9.50	1.7-4.5	9.5-10.75+
AS5-BH02	MH-02	Trenchless	0.0-10.30	2.0-5.5	10.30-10.82+
AS5-BH03	MH-05	Trenchless	0.0-10.95	1.7-9.2	Not encountered
AS5-BH04	MH-06	Trenched	0.0-10.50	2.0-8.1	Not encountered
BH01 (T+T)	MH-07	Trenched	0.0-9.00	2.1-7.5	Not encountered
AS5-BH05	MH-08	Trenched	0.0-10.95	1.3-6.5	Not encountered
AS5-BH06	MH-11	Trenched	0.0-10.95	2.7-6.8	Not encountered

3 Groundwater

In previous ground investigations within 50m of the alignment options, one groundwater measurement was taken during the drilling of AS5-BH02. This measurement was taken during the drilling process (which used water as the drilling medium); therefore, this single groundwater level observation was not considered an accurate representation of the groundwater conditions of the area for the purposes of modelling.

To obtain an accurate groundwater level, BH01 was installed with a piezometer. The details of this piezometer are given on the borehole log in Appendix B. Groundwater has been continually monitored for two months from the 9th March 2021 using a Solinist Level logger. The maximum depth recorded was 1.07 mbgl and the minimum reading was 0.83 mbgl, giving an average water level of 0.93 mbgl. A water level of 0.90 mbgl has been adopted for this assessment report. The graphed groundwater data is available in Appendix C.

This groundwater level has been taken as a regional level aquifer, and not a perched level aquifer.

3.1 Permeability testing

Permeability testing in the form of a slug test was conducted on BH01 on the 9th March 2021. This testing was conducted on the organic units between 3.5 and 8.5 mbgl. The slug used for the test was a bailer filled with sand of approximate dimensions of 1 m in height and 0.04 m in width. The test comprised:

- Falling head test, which commenced when the slug was fully submerged into the well to displace water. Duration of 30 minutes, data recorded on a pressure transducer logger.
- Rising head test, which commenced immediately after the slug was removed from the well. Duration of 30 minutes, data recorded on a pressure transducer logger.

The falling head and rising head tests were analysed using the Hvorslev and Bouwer & Rice methods using AquiferTestPro software. The hydraulic conductivities obtained from the analysis are shown in Table 3.1. Based on this testing, the average permeability for organic units between 3.5 and 8.5 mbgl is 5.2 x 10^{-7} m/s.

Table 3.1: Slug test permeability results

Field Method - Analysis Method	Falling Head - m/s	Rising Head - m/s
Bouwer & Rice	4.4 x 10^{-7}	5.2 x 10^{-7}
Hvorslev	5.7 x 10^{-7}	5.6 x 10^{-7}
Average hydraulic conductivity	5.2 x 10^{-7}	

3.2 Groundwater drawdown

3.2.1 Trenchless section (northern end of alignment, MH01-MH06)

Based on the trenchless methodologies proposed for the alignment options, groundwater inflow/settlement is expected to occur throughout the construction. However, to ensure a conservative assessment, a series of potential scenarios for the trenchless construction methodology have been considered as follows:

1 Drawdown of the groundwater through general working and minor water flow though material with a high organic content (modelled for 20 days of continuous drawdown – assuming a machine progression of 10 m/day for a maximum distance of 200 m). This scenario assumes that groundwater inflow occurs at both the sides and face of the excavation, permeability is homogenous across the alignment, hydraulic head is homogenous across the alignment, and the cone of depression extends out from a point location at 10 m intervals.

2 Machine failure for a period of >100 days. This is very much a worst-case scenario and is considered unlikely. This scenario assumes that groundwater inflow occurs at both the sides and face of the excavation, permeability is homogenous across the alignment, hydraulic head is homogenous across the alignment, and the cone of depression extends out from a point location being the machine face.

Scenarios 1 and 2 are shown on Figure 3.1 below.

Under Scenario 1, drawdown of 2.4 m is estimated to occur. If complete drawdown is to develop during a worst case scenario (i.e. prolonged machine breakdown), there is likely to be 3.1 to 7.1 m of drawdown at the tunnel face depending on the depth to machine. In a worst-case scenario, drawdown is expected to reach approximately 10.2 m at MH01 and 4.5 m at MH06. However in a credible scenario the groundwater radius of influence is only expected to reach approximately 3.4 m.

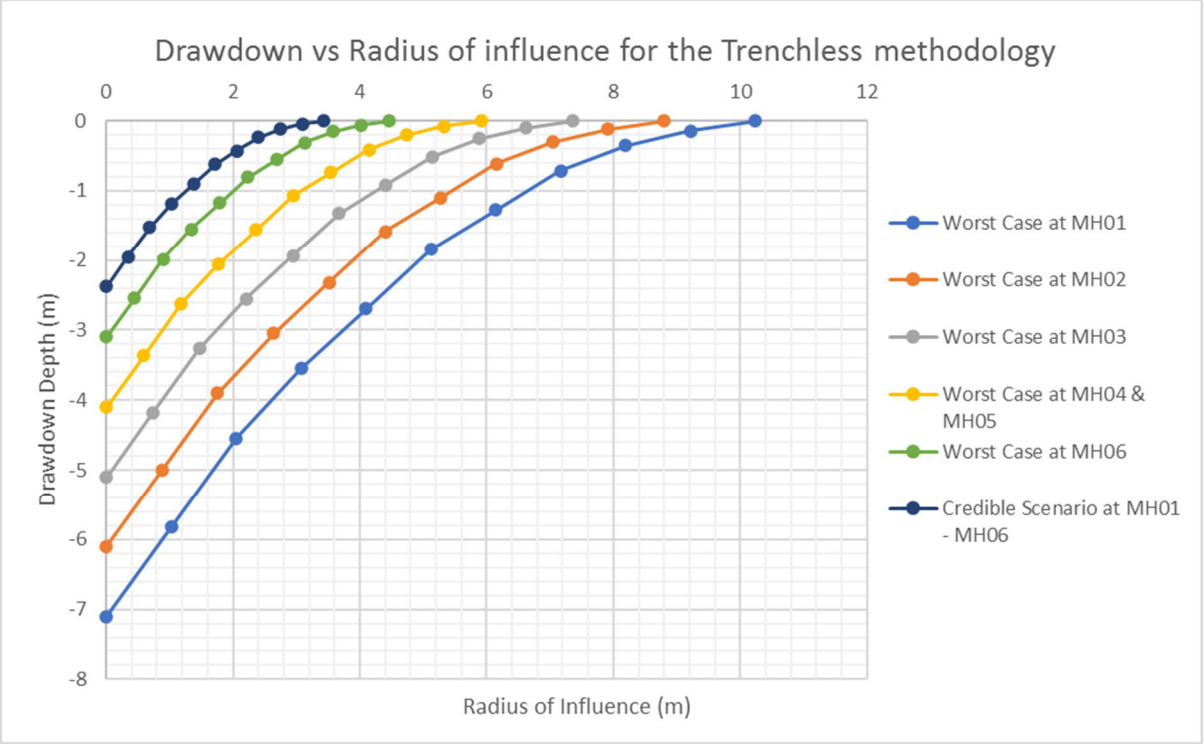


Figure 3.1: Groundwater drawdown for the trenchless methodology from MH01-MH06.

3.2.2 Trenched section (southern end of alignment, MH06-Richardson Rd)

For the proposed open trench construction methodology for alignment options 1 and 3, groundwater will flow freely and dewatering will be required for the installation of the pipe, for which the following scenarios have been assessed:

1 Limited construction time for any one section of the trench to be open (10 days open). This will limit the groundwater flow into the trench and the radius of influence. At any one time the trench wall area is assumed to be approximately 80 m^2, permeability is homogenous across the alignment and hydraulic head is homogenous across the alignment.

2 Prolonged construction period with full drawdown (which occurs at 32 days of an open trenched section). At any one time the trench wall area is assumed to be approximately 80 m^2, permeability is homogenous across the alignment and hydraulic head is homogenous across the alignment.

These scenarios are shown on Figure 3.2 below.

After 10 days of the trench being open, approximately 2.1 m of drawdown has been estimated to occur. On complete drawdown, which occurs from approximately 32 days, 3.1 m of drawdown has been estimated to occur.

In a worst-case scenario, the radius of influence is estimated to be 4.5 m from the trench edge. In a credible scenario, the radius of influence is estimated to be approximately 3.0 m from the trench edge.

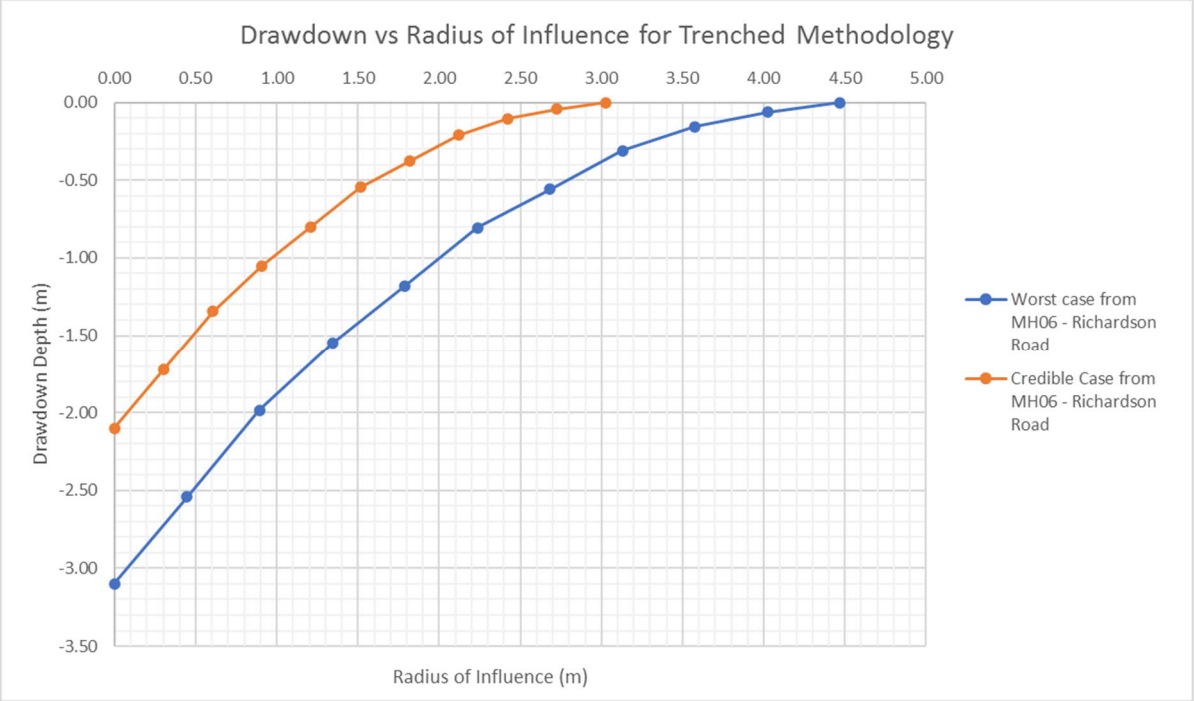


Figure 3.2: Groundwater drawdown for the trenched methodology.

3.2.3 Trenchless section (southern end of alignment, MH06-Richardson Rd)

Based on the trenchless methodologies proposed for alignment option 2 (i.e. generally following the walkway alignment between Hay Park School and the Hillsborough Kindergarten), groundwater inflow/settlement is expected to occur throughout the construction. However, to ensure a conservative assessment, a series of potential scenarios for the trenchless construction methodology have been considered as follows:

1 Minor drawdown of the groundwater through general working and minor water flow though material with a high organic content (modelled for 20 days of continuous drawdown – assuming a machine progression of 10 m/day for a maximum distance of 200 m). This scenario assumes that groundwater inflow occurs at both the sides and face of the excavation, permeability is homogenous across the alignment, hydraulic head is homogenous across the alignment, and the cone of depression extends out from a point location at 10 m intervals.

2 Machine failure for a period of >50 days. This is very much a worst-case scenario and is considered unlikely. This scenario assumes that groundwater inflow occurs at both the sides and face of the excavation, permeability is homogenous across the alignment, hydraulic head is homogenous across the alignment, and the cone of depression extends out from a point location being the machine face.

Scenarios 1 and 2 are shown on Figure 3.3 below.

Under Scenario 1, drawdown of 2.4 m is estimated to occur. If complete drawdown is to develop during a worst case scenario (i.e. prolonged machine breakdown >50 days), there is likely to be 3.1 m of drawdown at the tunnel face. In a worst case scenario groundwater drawdown is estimated to extend approximately 4.5 m from the tunnel excavation. In a credible scenario, groundwater drawdown is estimated to extend approximately 3.4 m from the tunnel excavation.

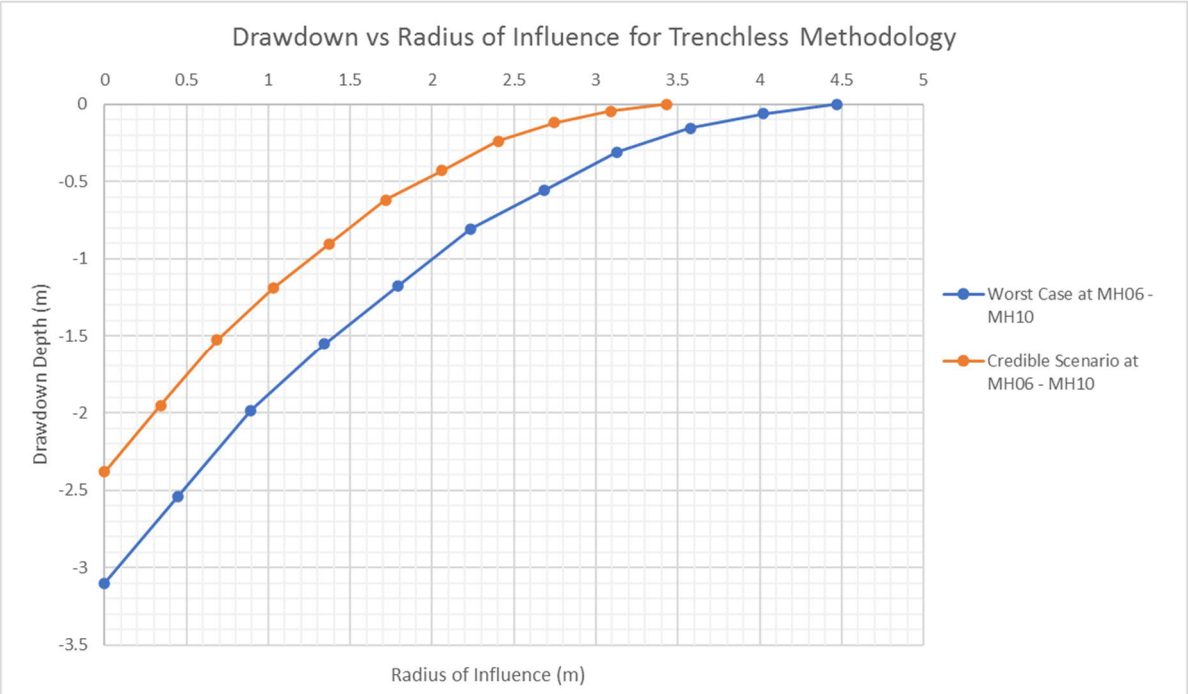


Figure 3.3: Groundwater drawdown for the trenchless methodology from MH06 to Richardson Rd.

3.2.4 Shaft excavations (MH01-MH10)

Based on the approximate shaft dimensions presented in Table 3.2 and assuming a methodology allowing groundwater inflows, two scenarios have been assessed for groundwater drawdown. To ensure a conservative assessment of the shaft groundwater drawdown, the scenarios are:

1 Limited construction time for any one shaft such that it is expected to be open for up to 40 days. This will limit the groundwater flow into the shaft and the radius of influence. Groundwater drawdown in relation to the shafts has been assessed for the largest wall of each particular shaft (Table 3.2 for dimensions), permeability is homogenous across the alignment and hydraulic head is homogenous across the alignment.

2 Prolonged construction period with full drawdown (which occurs at >100 days of an open shaft). Groundwater drawdown in relation to the shafts has been assessed for the largest wall of each particular shaft (Table 3.2 for dimensions), permeability is homogenous across the alignment and hydraulic head is homogenous across the alignment.

The drawdown for each shaft is shown on Figure 3.4 below.

Under Scenario 1, groundwater drawdown is estimated to vary between 1.8 m and 1.3 m, depending on the shaft location and dimensions. If complete drawdown is to develop during a worst-case scenario (i.e. prolonged open excavation >100 days), drawdown will reach the base of the shaft (between 7.1 m at MH01 and 3.1 m at MH10). The maximum distance groundwater drawdown will extend from any one shaft is approximately 10.2 m in the worst case scenario and 2.5 m in a credible scenario.

Table 3.2: Shaft dimensions

Shaft ID	Depth (m)	Shape	Width (m)
MH01	8	Square	6 x 6
MH02	7	Square	4.5 x 4.5
MH03	6	Rectangle	6 x 4.5
MH04	5	Square	4.5 x 4.5
MH05	5	Rectangle	6 x 4.5
MH06	4	Square	4.5 x 4.5
MH07	4	Square	6 x 6
MH08	4	Square	4.5 x 4.5
MH09	4	Rectangle	6 x 4.5
MH10	4	Square	4.5 x 4.5
Temporary Pit	4	Square	4 x 4

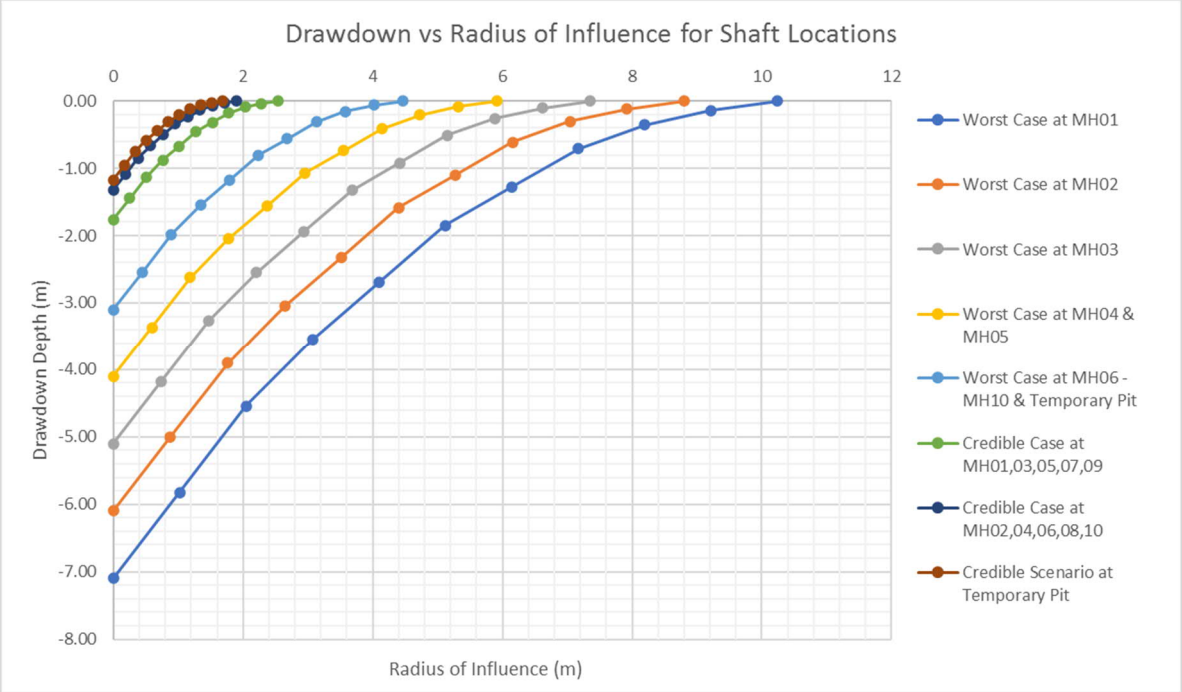


Figure 3.4: Groundwater drawdown at the shaft locations.

4 Consolidation settlement

Table 4.1 outlines the compression properties adopted for the estimates of settlement for both trenchless, trenched and shaft construction methodologies, based on Look:2007[1]. Utilising the values in Table 4.1, there are two scenarios adopted in deriving the settlement estimates:

- Worst case (complete groundwater drawdown).
- Credible case for the trenched, trenchless and shaft construction methodologies (10, 20 & 40 days of groundwater drawdown, respectively).

The settlement estimates for these scenarios are provided in Table 4.2.

Table 4.1: Settlement Assumptions[1]

Description of settlement	Unit	Value
Coefficient of Volume Compressibility (mv) for alluvial clay/silt	m^2/kN	0.0008
Coefficient of Volume Compressibility (mv) for organic silt and peat	m^2/kN	0.0015
Static groundwater level	m bgl	0.90
Settlement calculation (where s is settlement, h is thickness)		$s = m_v \times \Delta\sigma \times h$
Dewatering period	days	10 to >100
Depth to Invert (m)	m	8 Northern most end 4 Southern most end
Organic silt/Peat thickness dewatered	m	Up to 6.5m
Alluvial clay/silt thickness dewatered	m	Up to 1.5m

[1] Handbook of Geotechnical Investigation and Design Tables, Burk Look, 2007

Table 4.2: Settlement estimates along the CC9 alignment

Method	Trenchless										Trenched		Shafts															
Location ID	MH01		MH02		MH03		MH04 & MH05		MH06 – MH10		MH06 – Richardson Road		MH01		MH02		MH03		MH04		MH05		MH06, MH08 & MH10		MH07 & MH09		Temporary Pit	
Scenario	Worst Case (>100 days)	Credible (20 days)	Worst Case (>100 days)	Credible (20 days)	Worst Case (>100 days)	Credible (20 days)	Worst Case (>100 days)	Credible (20 days)	Worst Case (>50 days)	Credible (20 days)	Worst Case (32 days)	Credible (10 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)	Worst Case (>100 days)	Credible (40 days)
Maximum groundwater drawdown (m)	7.1	2.4	6.1	2.4	5.1	2.4	4.1	2.4	3.1	2.4	3.1	2.1	7.1	1.8	6.1	1.3	5.1	1.8	4.1	1.3	4.1	1.8	3.1	1.3	3.1	1.8	3.1	1.2
Settlement immediately above pipe alignment (mm)	370	40	230	40	170	40	110	40	70	40	70	30	370	30	230	20	170	30	110	20	110	30	70	20	70	30	70	10
Differential settlement (over full extent of groundwater drawdown)	1:30 at 10.2 m radius	1:85 at 3.4m radius	1:40 at 8.8m radius	1:85 at 3.4m radius	1:45 at 7.4m radius	1:85 at 3.4m radius	1:55 at 5.9m radius	1:85 at 3.4m radius	1:65 at 4.5m radius	1:85 at 3.4m radius	1:65 at 4.5m radius	1:100 at 3.0m radius	1:30 at 10.2 m radius	1:85 at 2.5m radius	1:40 at 8.8m radius	1:95 at 1.9m radius	1:45 at 7.4m radius	1:85 at 2.5m radius	1:55 at 5.9m radius	1:95 at 1.9m radius	1:55 at 5.9m radius	1:85 at 2.5m radius	1:65 at 4.5m radius	1:95 at 1.9m radius	1:65 at 4.5m radius	1:85 at 2.5m radius	1:65 at 4.5m radius	1:170 at 1.7m radius

5 Assumptions

For groundwater drawdown effects of the trenchless methodology we have assumed:

- Groundwater inflow occurs across the entire tunnel alignment. For drawdown calculations, 10 m sections of pipe excavation have been assessed and assumed a pipe diameter of approximately 1.0 m.
- Permeability is homogenous across the alignment.
- Hydraulic head is homogenous across the alignment.
- The cone of depression extends out from a point location.

For groundwater drawdown effects of the trenched methodology we have assumed:

- At any one time the trench wall area is approximately 80 m^2.
- Permeability is homogenous across the alignment.
- Hydraulic head is homogenous across the alignment.

For groundwater drawdown effects of the shaft locations:

- Groundwater inflow has been assessed for particular depth and dimensions described in Table 3.2. In cases where dimensions are rectangular, the longer edge has been assessed.
- Permeability is homogenous across the alignment.
- Hydraulic head is homogenous across the alignment.

Recognising the many assumptions considered in the groundwater effect calculation, the report gives best estimates of settlement outcomes. It is likely that the stated figures will differ from those that will eventuate, which could be lesser or greater.

6 Summary

Groundwater and dewatering settlement has been assessed for the CC9 sewer connection at Keith Hay Park. From this assessment the following summary of groundwater drawdown and dewatering settlement has been concluded.

Trenchless methodologies:

- Maximum dewatering settlement at the pipe invert, under a worst case scenario (complete and continual drawdown) is expected to be 370mm at MH01 and reduce to 70mm by MH06. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 10.2 m at MH01 and reduce to 4.5 m by MH06.
- Maximum dewatering settlement at the pipe invert, under a credible scenario is expected to be 40mm. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 3.4 m.

Trenched methodologies:

- Maximum dewatering settlement at the trench edge, under a worst case scenario (complete and continual drawdown) is expected to be 70mm. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 4.5 m.
- Maximum dewatering settlement at the trench edge, under a credible scenario is expected to be 30mm. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 3.0 m.

Shaft construction:

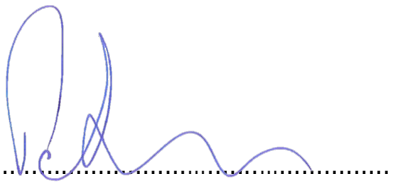
- Maximum dewatering settlement at the shaft edge, under a worst case scenario (complete and continual drawdown) is expected to be 370mm at MH01 and reduce to 70mm by MH06. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 10.2 m at MH01 and reduce to 4.5 m by MH06.
- Maximum dewatering settlement at the trench edge, under a credible scenario is expected to be 30mm. The maximum radius of influence of settlement and groundwater drawdown is expected to be approximately 2.5 m.

7 Applicability

This report has been prepared for the exclusive use of our client, Watercare Service Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be submitted to Auckland Council in support of an application for resource consent for the works described herein and that council will rely on this report for the purposes of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
.....	.....
Troy McAlister	Peter Roan
Engineering Geologist	Project Director

1-Nov-21
\\ttgroup.local\files\aklprojects\1015172\1015172.1400 cso cc9 keith hay park\issueddocuments\section 92 response\01.11.21 1015172.1400 cc9 settlement and groundwater final.docx

Appendix A: Ground investigation locations

LEGEND:

- AS5–BH01 — MACHINE BOREHOLE LOCATIONS
- FUTURE CSO COLLECTOR SEWER AND MANHOLE
- SS SS SS — EXISTING TRANSMISSION WASTEWATER
- SS — EXISTING WASTEWATER
- Tonkin & Taylor Machine Borehole Location

SCALE 1:200

0 4 8 12 16 20m

4 3 2 1

FOR INFORMATION
CONTRACTOR'S DESIGN

Ghella 5 Generations of Tunnelers | ABERGELDIE

ISSUE	DATE	AMENDMENT
A	25.11.20	FOR INFORMATION

Watercare

KEITH HAY PARK – BRANCH 9B CARR RD (DSB9B)
00 SITE GENERAL
GEOTECHNICAL INVESTIGATIONS – TEMP

CAD FILE DSCIN003–DEL–SKT–C–G–00086.DWG
REF No.
ORIGINAL SCALE A1 1:400
SKETCH No. DSCIN003–DEL–SKT–C–G–00086
ISSUE A

Plot Date: Dec 09, 2020 - 12:48pm X:\CAD\6661 DRAWINGS\DSCIN003 (Keith Hay Park)\SKETCHES\DSCIN003-DEL-SKT-C-G-00086.dwg

Appendix B: Tonkin & Taylor machine borehole

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BH01

SHEET: 1 OF 1

PROJECT: Keith Hay Park CC9 Consenting

JOB No.: 1015172.1400

LOCATION: Keith Hay Park

CO-ORDINATES: 5912320.00 mN, 1755342.00 mE (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 57.80m

R.L. COLLAR: 57.80m

DATUM: NZVD2016

SURVEY: GIS\Web map viewer

DRILLED BY: Lei and Craig

LOGGED BY: ANZH

CHECKED: TRMC

START DATE: 25/02/2021

FINISH DATE: 25/02/2021

CONTRACTOR: McMillan Drilling

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)
	Vacuum excavation.							
	GRAVEL, minor silt; grey brown. Dense, moist, gap graded; gravel, fine to coarse, subangular, unweathered.			HVAC	0		57	1
Tauranga Group	Organic CLAY, some silt; dark brownish black. Soft, wet, high plasticity; Organics: fibrous wood.						56	2
	1.90m: Rootlets.							
	PEAT, trace silt; dark brownish black. Fibrous, moist, non-plastic. Organics: fibrous wood.			HQTT	100			
	Organic SILT, some clay; dark brownish black. Soft, moist, low plasticity; Organics: fibrous wood.						55	3
	Organic CLAY, trace silt; brown. Soft, moist, high plasticity; Organics: fibrous wood.							
	PEAT, trace silt; dark brownish black. Fibrous, moist, non-plastic. Grey inclusions. Organics: fibrous wood.					8/0 kPa		
	Core loss; soft core fell from barrel.			HQTT	33		54	4
	PEAT; dark brownish black. Fibrous, moist, non-plastic. Organics: fibrous wood.							
	PEAT, some clay; dark brownish black. Soft, wet, low plasticity. Organics: fibrous wood.			HQTT	100		53	5
	Organic CLAY, some silt; brown. Soft, moist, low plasticity; Organics: fibrous wood.			HQTT	100	8/0 kPa	52	6
	PEAT; black. Fibrous, moist, non-plastic. Organics: fibrous wood.					47/0 kPa	51	7
	Core loss; soft core fell from barrel.							
	Organic SILT, some clay; dark brownish black. Soft, wet, low plasticity; Organics: fibrous wood.			HQTT	73		50	8
	CLAY, trace peat (fibrous) and silt; brownish grey. Soft to firm, moist, high plasticity; Organics: fibrous wood.						49	9
	9m: Target depth					28/12 kPa	48	

ROCK DEFECTS

Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations
	2000 600 200 60 20		

Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
25 50 75	25/02/2021		Box 1, 0.0-5.5m; Box 2, 5.5-8.7m	

COMMENTS:

Hole Depth 9m

Scale 1:50

Rev.: A

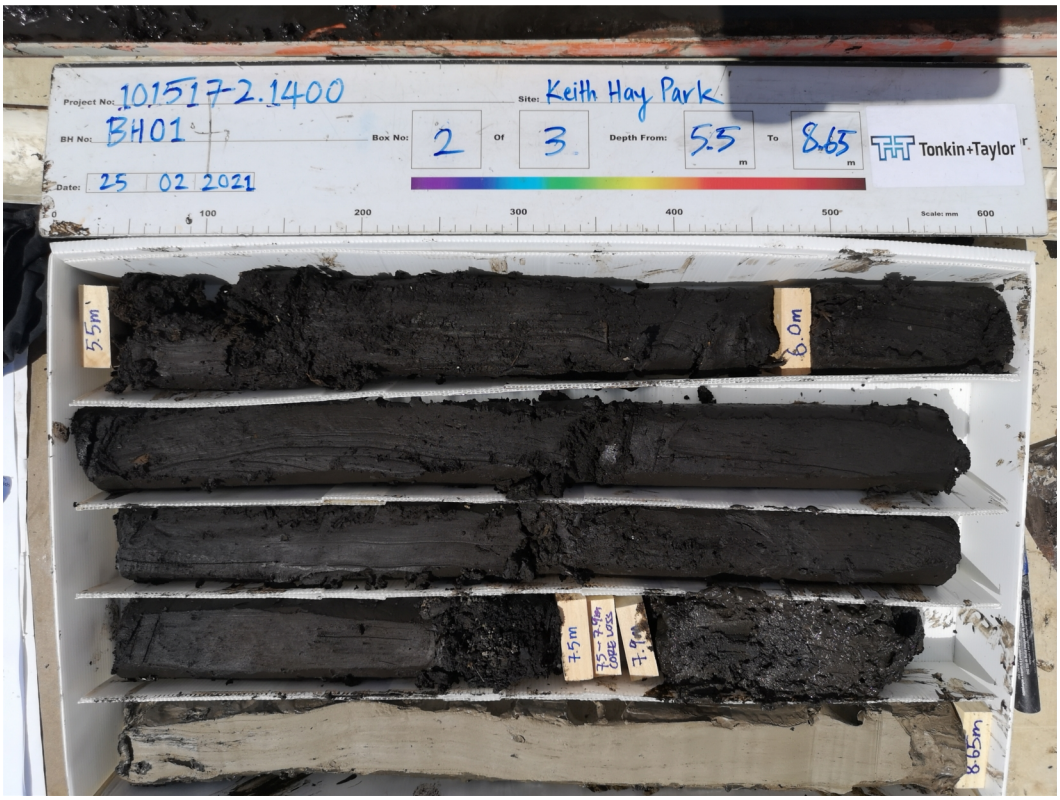
CORE PHOTOS

BOREHOLE No.: **BH01**

Hole Location: Keith Hay Park

PROJECT: Keith Hay Park CC9 Consenting		LOCATION:	JOB No.: 1015172.1400
CO-ORDINATES: (NZTM2000)	5912320.00 mN 1755342.00 mE	DRILL TYPE: Massenza MM3 HQ DRILL METHOD: RC	HOLE STARTED: 25/02/2021 HOLE FINISHED: 25/02/2021 DRILLED BY: McMillan Drilling
R.L.:	57.80m		LOGGED BY: ANZH CHECKED: TRMC
DATUM:	NZVD2016		

0.00-5.50m



5.50-8.65m

CORE PHOTOS

BOREHOLE No.: **BH01**

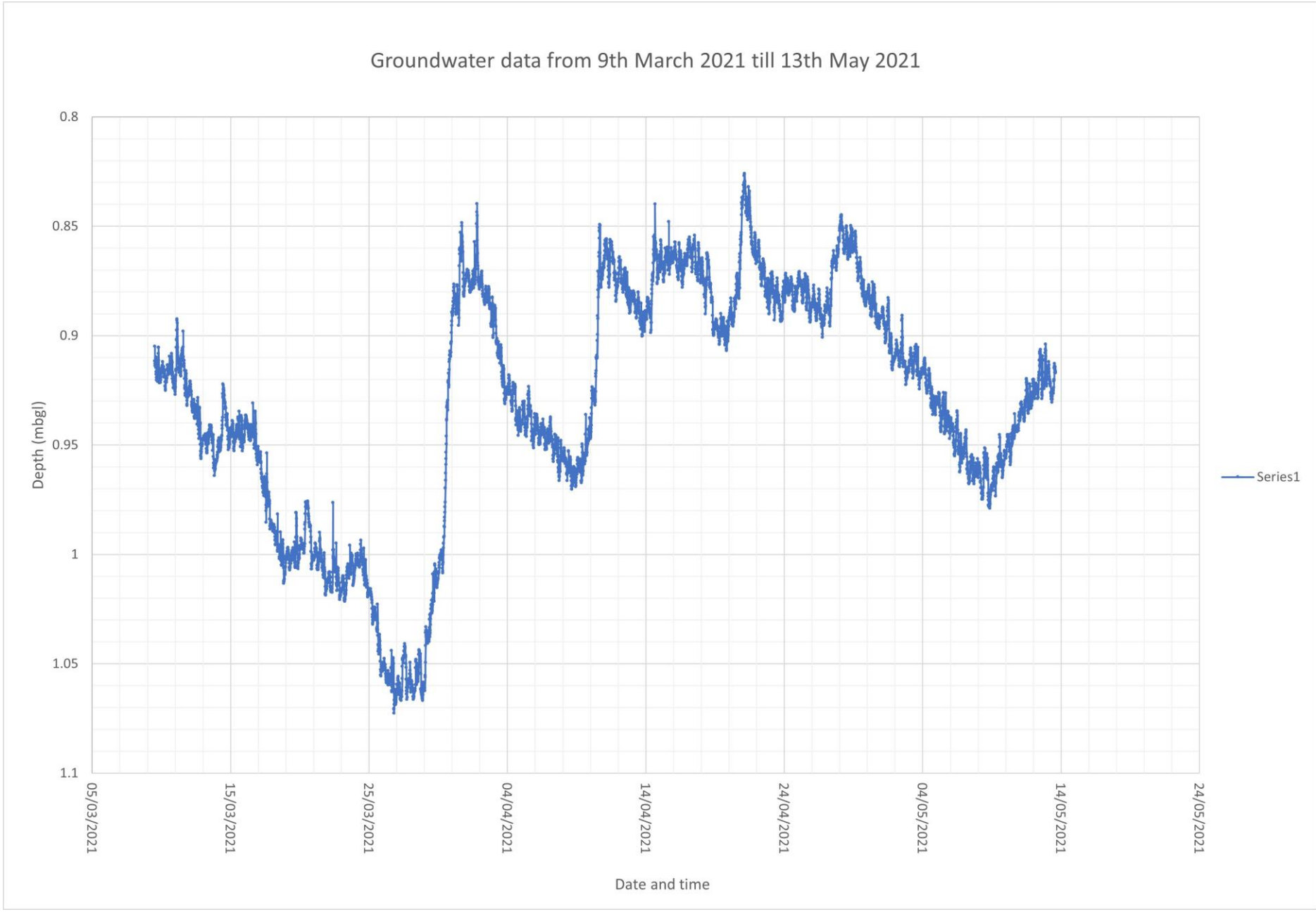
Hole Location: Keith Hay Park

PROJECT: Keith Hay Park CC9 Consenting		LOCATION:	JOB No.: 1015172.1400
CO-ORDINATES: (NZTM2000)	5912320.00 mN 1755342.00 mE	DRILL TYPE: Massenza MM3 HQ DRILL METHOD: RC	HOLE STARTED: 25/02/2021 HOLE FINISHED: 25/02/2021 DRILLED BY: McMillan Drilling
R.L.:	57.80m		LOGGED BY: ANZH CHECKED: TRMC
DATUM:	NZVD2016		

8.65-9.00m

Appendix C: Groundwater levels

- Groundwater graph


Groundwater data from 9th March 2021 till 13th May 2021
0.8
0.85
0.9
0.95
1
1.05
1.1
Depth (mbgl)
05/03/2021
15/03/2021
25/03/2021
04/04/2021
14/04/2021
24/04/2021
04/05/2021
14/05/2021
24/05/2021
Date and time
Series1

Appendix B: AUP Chapter E27 Assessment and Vehicle Tracking

Review of Applicable AUP Transport Standards

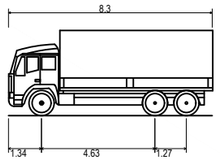
<table>
<tr><th>Standard</th><th>Commentary</th></tr>
<tr><td>E27.6.3.3 (1) Every parking space must have driveways and aisles for entry and exit of vehicles to and from the road, and for vehicle manoeuvring within the site. Access and manoeuvring areas must accommodate the 85 percentile car tracking curves in Figure E27.6.3.3.1</td><td>Existing driveways will be utilised for construction traffic and a vehicle tracking exercise has been undertaken to ensure vehicle manoeuvring within the site can be accommodated.</td></tr>
<tr><td>E27.6.3.4 (1) Sufficient space must be provided on the site so vehicles do not need to reverse off the site or onto or off the road from any site where any of the following apply:
(a) four or more parking spaces are served by a single access;
(b) there is more than 30m between the parking space and the road boundary of the site; or
(c) access would be from an arterial road or otherwise within a Vehicle Access Restriction covered in Standard E27.6.4.1.</td><td>Hillsborough Kindergarten is accessed via Richardson Rd which is identified as an arterial road according to Waka Kotahi's One Network Road Classification. Vehicle tracking has been undertaken to ensure vehicle manoeuvring within the site can be accommodated as to ensure vehicle do not need to reverse off the site or onto the road.</td></tr>
<tr><td>E27.6.4.2 (2) The width of a vehicle crossing(s) must meet the minimum width and not exceed the maximum width as specified in Table E27.6.4.3.2.
Table E27.6.4.3.2 Vehicle crossing and vehicle access widths
<table>
<tr><th colspan="2">Location of site frontage</th><th>Number of parking spaces served</th><th>Minimum width of crossing at site boundary</th><th>Maximum width of crossing at site boundary</th><th>Minimum formed access width</th></tr>
<tr><td>(T149)</td><td rowspan="3">Residential zone</td><td>Serves 1 or 2 parking spaces</td><td>2.75m</td><td>3.0m</td><td>2.5m provided it is contained within a corridor clear of buildings or parts of a building with a minimum width of 3m</td></tr>
<tr><td>(T150)</td><td>Serves 3 to 9 parking spaces</td><td>3.0m (one way)</td><td>3.5m (one way)</td><td>3.0m provided it is contained within a corridor clear of buildings or parts of a building with a minimum width of 3.5m</td></tr>
<tr><td>(T151)</td><td>Serves 10 or more parking spaces</td><td>5.5m (two-way)</td><td>6.0m (two-way)</td><td>5.5m (providing for two-way movements)
The formed width is permitted to be narrowed to 2.75m if there are clear sight lines along the entire access and passing bays at 50m intervals are provided.
1.0m pedestrian access for rear sites which may be located within the formed driveway</td></tr>
<tr><td>(T152)</td><td>Centres, Mixed Use and all other</td><td>Serves nine or less parking</td><td>3.0m (one way)</td><td>3.5m (one way)</td><td>3.0m provided it is contained within a corridor clear of buildings or parts of a building with</td></tr>
</table></td><td>Using the Auckland Council GIS viewer surveys, the existing formed width of the vehicle access to Hillsborough Kindergarten was measured to be 6.4m wide. The existing formed width of the vehicle access to the Eden Roskill Cricket Club was measured to be 3m wide. Construction traffic can be accommodated within these accesses.</td></tr>
</table>

	zones not listed below	spaces			a minimum width of 3.5m
(T153)		Serves 10 or more parking spaces or three	5.5m (two-way)	6.0m (two-way)	5.5m (providing for two-way movements) 1.5m pedestrian access for rear sites
(T154)	General Business, Business Park or Industrial zones	Serves nine or less parking spaces	3.7m (one way)	4.0m (one-way)	3.0m provided it is contained within a corridor clear of buildings or parts of a building with a minimum width of 3.5m
(T155)		Serves 10 or more parking spaces	6.0m (two-way)	7m (two-way)*	6.0m (providing for two-way movements)
(T156)	Rural zones		3.0m	6.0m*	No minimum specified

* Provided that a maximum width of 9.0m is permitted where the crossing needs to accommodate the tracking path of large heavy vehicles

E27.6.4.3 (1) Every on-site parking and loading space must have vehicle access from a road, with the vehicle access complying with the following standards for width: (a) passing bays are provided in accordance with Table E27.6.4.3.1; and (b) meeting the minimum formed access width specified in Table E27.6.4.3.2. E27.6.4.3 (2) Access must be designed so that vehicles using or waiting to use fuel dispensers, ticket vending machines, remote ordering facilities and devices, entrance control mechanisms, or other drive-through facilities do not queue into the adjoining road reserve or obstruct entry to or exit from the site.	As outlined in the Sewer Connection (CC9) Keith Hay Park - Construction Traffic Effects Assessment it is anticipated that the construction of CC9 will generate the following trips per day and per hour during the peak construction season: · 14 standard vehicle movements per day (4 vehicle movements during peak hour). · 25 heavy vehicle movements per day (average of 2 - 3 heavy vehicles movements per hour over the course of an 11 hour day). With a maximum of 2 – 3 heavy vehicle movements per hour (roughly one vehicle every 20-30 min) vehicle queuing is not anticipated.

\\ttgroup.local\files\AKLProjects\1015172\1015172.1400 CSO CC9 Keith Hay Park\WorkingMaterial\Planning\s92\Vehicle Tracking\1015172.1400-F01_F05.dwg 2021-Sep-30 3:41:26 PM Plotted By: IAN RAY



AT - Truck - 8.3m Truck

Overall Length	8.300m
Overall Width	2.500m
Overall Body Height	3.471m
Min Body Ground Clearance	0.373m
Track Width	2.500m
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	40.20°

BACKDRAFTING REQUIRED	CHECK PRINT	
READY TO ISSUE	INITIAL	DATE
CAD SELF CHECK		
DESIGN CHECK		
DRAFTING CHECK		
BACKDRAFTER - EDITS MADE		
BACKCHECKER - EDITS CONFIRMED		

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DESIGNED	MAAH	Sep.21
DRAWN	IARA	Sep.21
CHECKED		
APPROVED		DATE

CLIENT **WATERCARE SERVICES LTD**

PROJECT **KEITH HAY CC9**

TITLE CONSTRUCTION VEHICLES TURNING INTO HILLSBOROUGH KINDERGARTEN

UNDER REVISION 1

SCALE (A3) 1:250 FIG No. 1015172.1400-F01 REV 1

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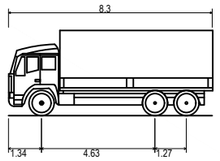

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Overall Length	8.300m
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☐ READY TO ISSUE		
CAD SELF CHECK		
DESIGN CHECK		
DRAFTING CHECK		
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PROJECT **KEITH HAY CC9**

TITLE CONSTRUCTION VEHICLES TURNING OUT OF HILLSBOROUGH KINDERGARTEN

UNDER REVISION 1

SCALE (A3) 1:250 FIG No. 1015172.1400-F02 REV 1

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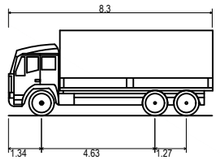

AT - Truck - 8.3m Truck

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Overall Body Height	3.471m
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Track Width	2.500m
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	40.20°

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BACKCHECKER - EDITS CONFIRMED		

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PROJECT **KEITH HAY CC9**

TITLE CONSTRUCTION VEHICLE TURNING WITHIN HILLSBOROUGH KINDERGARTEN CARPARK

UNDER REVISION 1

SCALE (A3) 1:250 FIG No. 1015172.1400-F03 REV 1

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AT - Truck - 8.3m Truck

Overall Length	8.300m
Overall Width	2.500m
Overall Body Height	3.471m
Min Body Ground Clearance	0.373m
Track Width	2.500m
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	40.20°

A3 SCALE 1:250

0 5 10 15 (m)

ORIGINAL IN COLOUR

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READY TO ISSUE

	INITIAL	DATE
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CLIENT **WATERCARE SERVICES LTD**

PROJECT **KEITH HAY CC9**

TITLE CONSTRUCTION VEHICLE ENTERING AND EXITING EDEN ROSKILL CRICKET CLUB

UNDER REVISION 1

SCALE (A3) 1:250 FIG No. 1015172.1400-F04 REV 1

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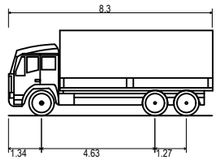

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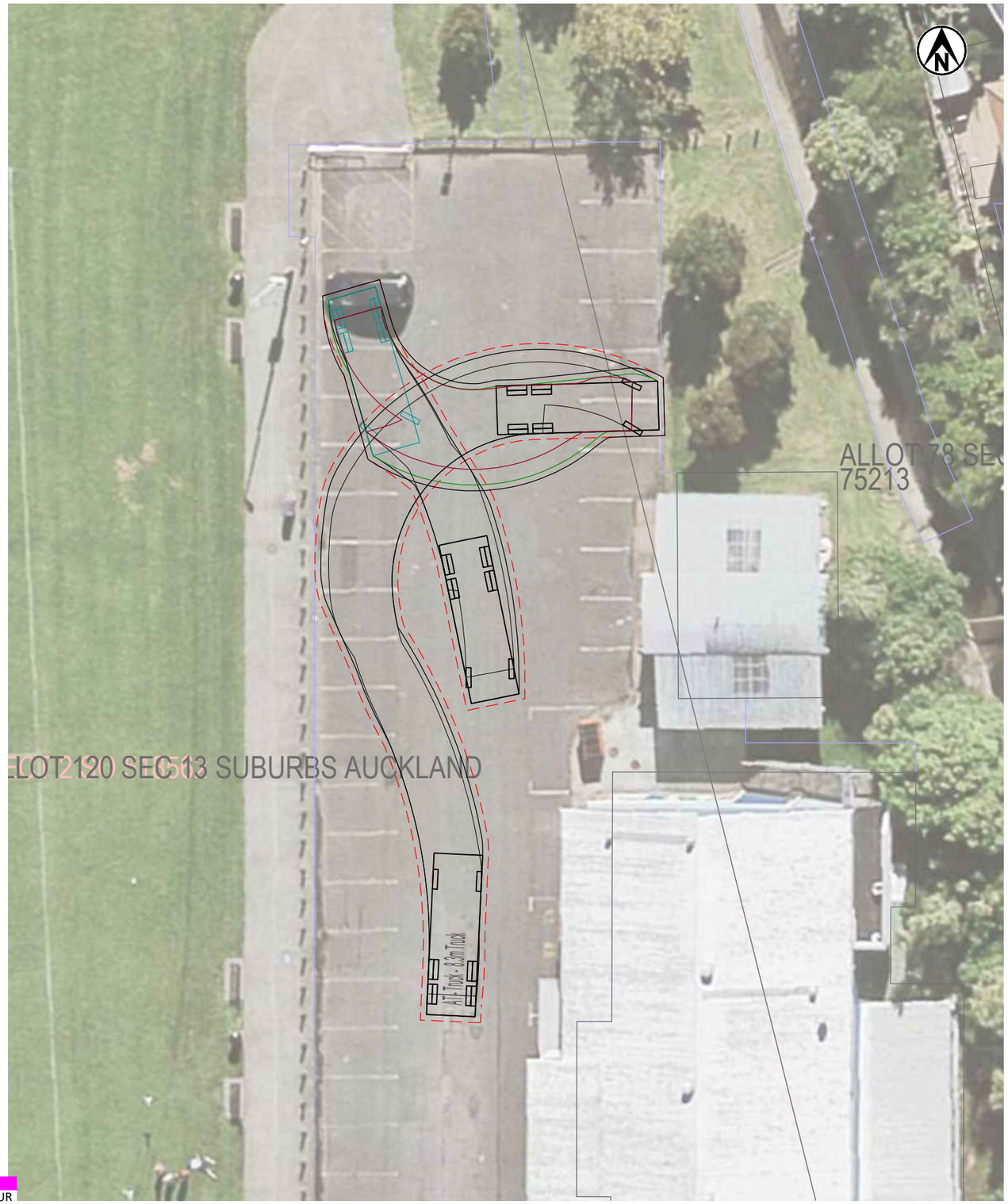
Overall Body Height	3.471m
Min Body Ground Clearance	0.373m
Track Width	2.500m
Lock-to-lock time	6.00s
Max Steering Angle (Virtual)	40.20°



A3 SCALE 1:250

0 5 10 15 (m)

ORIGINAL IN COLOUR

		INITIAL	DATE
☐	BACKDRAFTING REQUIRED	CHECK PRINT	
☐	READY TO ISSUE		
	CAD SELF CHECK		
	DESIGN CHECK		
	DRAFTING CHECK		
	BACKDRAFTER - EDITS MADE		
	BACKCHECKER - EDITS CONFIRMED		

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CHECKED		
APPROVED		DATE

CLIENT **WATERCARE SERVICES LTD**

PROJECT **KEITH HAY CC9**

TITLE CONSTRUCTION VEHICLE TURNING WITHIN EDEN ROSKILL CRICKET CLUB

UNDER REVISION 1

SCALE (A3) 1:250 FIG No. 1015172.1400-F05 REV 1

Appendix C: Indicative construction sequence

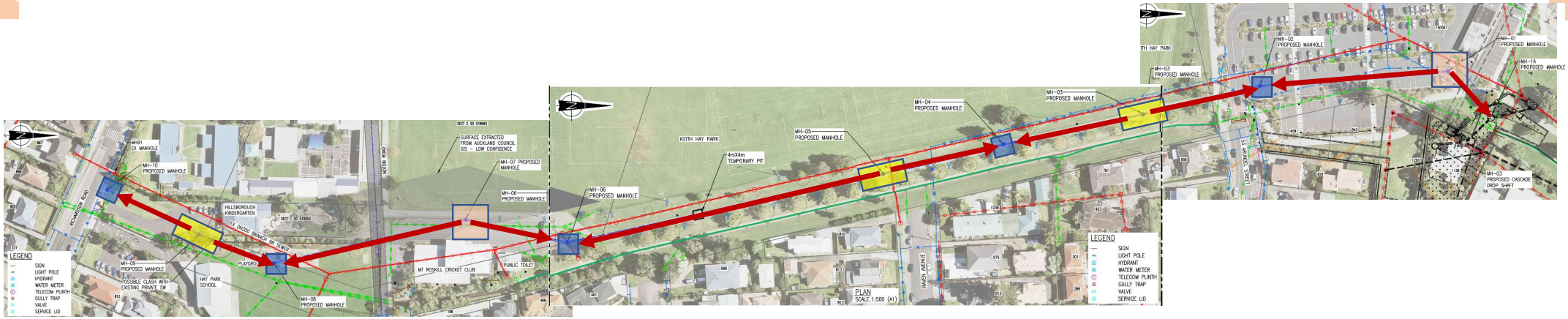
CC 09 – Over all

600mm ID pipe (700 mm OD jacking pipe or bigger) Micro tunneling sequence

Richardson Road

KHP Main site

	MH10	MH09	MH08	MH07	MH06	MH05	MH04	MH03	MH02	MH01	MH1A
Drive length c/c	52m	41m	100m	53m	150m	57m	67m	58m	94m	31m	



706m

Note : Assumed all MHs are 1950mm ID

- **Min 4.5m x4.5m** shaft required for **1950mm** ID MH
- **Min 6m x6m** shaft required for 3000mm ID MH
- Maximum single drive for 700mm OD pipe is 200m

5 nos of launching shafts and 5 nos of reception shaft

LEGEND

- 6mx6m for Launch shaft with major direction changes
- 6mx4.5m for Launch shaft and for 1950mm ID MH
- 4.5mx4.5m for reception shaft and for 1950mm ID MH

CC 09 – Over all

600mm ID pipe (700 mm OD jacking pipe or bigger) Micro tunneling sequence options

Richardson Road

MH10	MH09	MH08	MH07	MH06	MH05	MH04	MH03	MH02	MH01	MH1A
Drive length c/c	52m	41m	100m	53m	150m	57m	67m	58m	94m	31m

KHP Main site

Micro tunneling sequence – option 1

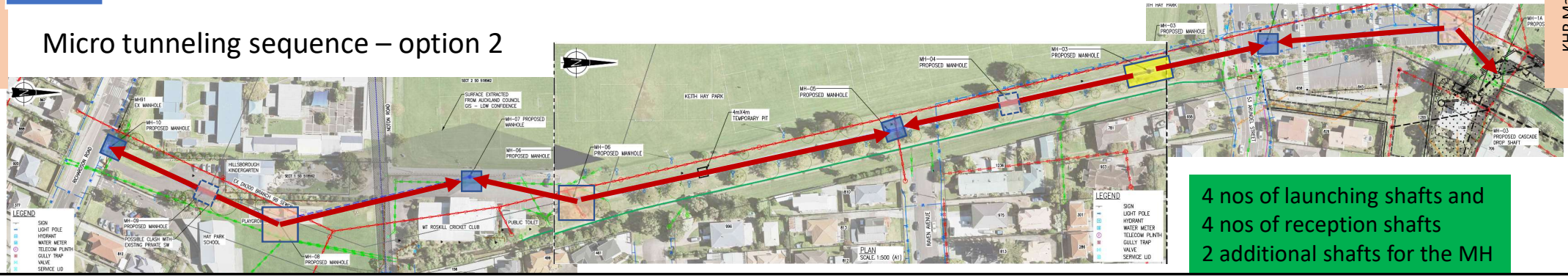
5 nos of launching shafts and
5 nos of reception shafts

Richardson Road

MH10	MH09	MH08	MH07	MH06	MH05	MH04	MH03	MH02	MH01	MH1A
Drive length c/c	93m	100m	53m	150m	124m	58m	94m	31m		

KHP Main site

Micro tunneling sequence – option 2



4 nos of launching shafts and
4 nos of reception shafts
2 additional shafts for the MH

Appendix D: CNVA Table 6.2 addendum

Table 6.2: Predicted noise levels at sensitive receivers

(From CNVA with minor changes to formatting of predicted noise level columns to demonstrate whether mitigation included in assessment).

Receiver	Approx. min distance to works m	Activity	Predicted noise level dB LAeq		Night working required?	Mitigation/limitations
			Without mitigation	With mitigation[1]		
639-647, 672, 672A Richardson Road	20	Sheet piling (trenching)	81	-	No	Restrict to daytime.
		Trenching	71	61	May extend during summer daylight savings (including night time work)	Screening, timing of works
		General	68	58	May extend during summer daylight savings (including night time work)	Screen generator
		Truck deliveries	71	-	Some deliveries outside normal hours	Discreet events, relatively short duration and low traffic vols. Masked by relatively high background traffic noise levels.
Waikowhai Intermediate School, Hillsborough Kindergarten[2]	10-15	Sheet piling (trenching)	87	-	N/A – not sensitive at night	Only when unoccupied
		Trenching	77	67		Screening, timing of works
		General	74	64		Screen generator
		Truck deliveries	77	-		Discreet events, relatively short duration and low traffic vols
Hay Park School, Eden Roskill Cricket Club	5-10	Sheet piling (trenching)	93	-	N/A – not sensitive at night	Only when unoccupied
		Trenching	83	73		Ideally only when unoccupied
		General	80	70		Ideally only when unoccupied

[1] Column left blank unless mitigation included in assessment.
[2] And potentially two properties at south western end of Raven Avenue (8 and 8A Raven Avenue) if trenching commences from MH06 rather than MH05.

Receiver	Approx. min distance to works m	Activity	Predicted noise level dB LAeq		Night working required?	Mitigation/limitations
			Without mitigation	With mitigation[1]		
		Truck deliveries	83	-		Discreet events, relatively short duration and low traffic vols
Properties facing park	20	Tunnelling	69	59	24/7 at times	Screening, timing of works
		General	68	58	May extend during summer daylight savings	Screening, timing of works
		Truck deliveries	71	-	Some deliveries outside normal hours	Discreet events, relatively short duration and low traffic vols
Properties near Cameron Leisure Pools carpark	30	Tunnelling	65	55	24/7 at times	Screening, timing of works
		General	64	54	May extend during summer daylight savings	Screening, timing of works
		Truck deliveries	67	-	Some deliveries outside normal hours	Discreet events, relatively short duration and low traffic vols

Addendum to Table 6.2: Predicted noise levels at sensitive receivers

Receiver	Approx. min distance to works m	Activity	Predicted noise level dB LAeq		Night working required?	Mitigation/limitations
			Without mitigation	With mitigation[3]		
Sheet piling for launch pits (daytime)						
47A Arundel Street, 19 Gregory Place	50	Sheet piling at MH01	72	-	No	Restrict to daytime. Consider screening at detailed design stage (based on activity-specific assessment).
52, 54 Arundel Street	20	Sheet piling at MH03	81	-	No	Restrict to daytime. Consider screening at detailed design stage (based on activity-specific assessment).
1/12 Rustic Avenue OR 8, 8A Raven Avenue	20	Sheet piling at MH05 OR MH06	81	-	No	Restrict to daytime. Consider screening at detailed design stage (based on activity-specific assessment).
End of Raven Avenue	45	Sheet piling at MH07	73	63	No	Restrict to daytime (including evening shoulder period). Screened by club rooms.
672A, 672 Richardson Road	45	Sheet piling at MH09	73	-	No	Restrict to daytime. Masked by relatively high traffic noise levels. Consider screening at detailed design stage (based on activity-specific assessment).
Tunnelling activities (generally only during daytime but may extend in particular circumstances)						
Properties facing park	20	Tunnelling	69	59	Generally occur during normal working hours. However in particular circumstances may need to occur 24/7.	Screening, timing of works.

[3] Column left blank unless mitigation included in assessment.

Receiver	Approx. min distance to works m	Activity	Predicted noise level dB LAeq		Night working required?	Mitigation/limitations
			Without mitigation	With mitigation[3]		
		General	68	58	May extend during summer daylight savings – typically evening rather than night-time	Screening, timing of works.
		Truck deliveries	61	-	Some (limited) deliveries outside normal hours. Likely to be in evening shoulder period.	Discreet events, relatively short duration and low traffic vols. Assumed 10% driving, 90% idling within 15-minute period
Properties near Cameron Leisure Pools carpark	30	Tunnelling	65	55	24/7 at times	Screening, timing of works.
		General	64	54	May extend during summer daylight savings – typically evening rather than night-time	Screening, timing of works.
		Truck deliveries	57	-	Some (limited) deliveries outside normal hours – typically evening rather than night-time	Discreet events, relatively short duration and low traffic vols. Assumed 10% driving, 90% idling within 15-minute period

Appendix E: CI Construction Management Plan

Appendix F: Activity-Specific Construction Noise Management Plan – Keith Hay Park Sheet Piling (and CNVMP)

This document is an exact copy of the Council approved plan (with approval documentation inserted) and has been issued For Information only.

Drawings embedded in this document are from the tender package and are not to be used for construction.

Activity Specific Construction Noise Management Plan – Keith Hay Park Sheet Piling

Keith Hay Park Shaft Site, 49 Arundel Street, 20 and 22 Gregory Place, Mt Roskill

Central Interceptor

Doc No: GAJV-PLN-00079

Version: [0.3 Final]

Watercare
An Auckland Council Organisation

Ghella 5 Generations of Tunnelers
ABERGELDIE COMPLEX INFRASTRUCTURE

Lesley Hopkins

From: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Sent: Wednesday, 18 March 2020 8:11 AM
To: Lesley Hopkins
Cc: Paul Venter; XMeier (Xenia); Sandra Edwards; Tommy Ma
Subject: RE: Central Interceptor - Noise endorsement for 47A Arundel Street (attached)

Thanks Lesley,

Great news, I can confirm the ASCNMPs (tree removal, sheet piling and shaft drilling) are now approved.

Ngā mihi | Kind Regards

Randy Leung | Senior Compliance Monitoring Officer | Licensing & Regulatory Compliance
Auckland Council | T: +64 (09) 353 9101 | M: 027 272 0302
Location: Level 1 | 35 Graham Street | CBD Auckland
Postal: Private Bag 92300 | Wellesley Street | Auckland | 1036
mailto: randy.leung@aucklandcouncil.govt.nz |

From: Lesley Hopkins <lhopkins@ga-jv.com>
Sent: Tuesday, 17 March 2020 12:57 PM
To: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Cc: Paul Venter <paul.venter@aucklandcouncil.govt.nz>; XMeier (Xenia) <Xenia.Meier@water.co.nz>; Sandra Edwards <sedwards@ga-jv.com>; Tommy Ma <tma@ga-jv.com>
Subject: Central Interceptor - Noise endorsement for 47A Arundel Street (attached)

Hi Randy

Fantastic development, we have received the written endorsement from 47A Arundel Street for the Keith Hay Park Activity Specific Construction Noise Management Plans. See attached.

Please could you confirm approval of the three plans you currently have for the site on the basis of us now having all the written endorsements. We would like to make a start on the activities asap.

We would still like to have a broader discussion with Council about the noise endorsement process as we discussed with Paul last week. Xenia will be in touch separately to discuss timing for this.

Cheers

Lesley

Lesley Hopkins
Key Relationships Manager – Central Interceptor
M +64 27 2414 351
T +64 9 301 3769

Ghella Abergeldie JV
Level 1, 360 Dominion Road, Mt Eden
Auckland 1024, New Zealand

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Appendices

Revision History

Review and Approval

FUNCTION	POSITION	NAME	SIGNATURE	
Prepared by	Acoustic Consultant, Marshall Day Acoustics	Shaun King		7/11/2019
Reviewed by	Key Relationship Manager, Ghella Abergeldie JV	Lesley Hopkins		12/11/2019
Approved by	Shafts and Micro-Tunnels Construction Manager, Ghella Abergeldie JV	Mark Whelan		18/02/2020

Each page of this document bears a document number and revision date. When revisions to the document are issued, the following table will be updated to show the most recent revision level. The revised document will be forwarded to the holders of controlled copies. Recipients are responsible for destroying or marking "superseded" on the previous revision.

Revision Status

VERSION	DATE	STATUS	AMENDMENT DESCRIPTION
0.1	25/10/2019	Initial draft	Draft for internal review
0.2	12/11/2019	Draft	Draft for Watercare review
0.3	18/02/2020	Final	For submission with Auckland Council

Where review and revision is deemed warranted, i.e. such as comments received from the Client, or where necessary to reflect changes in contractual or Project requirements, or as a result of an incident then these revisions shall be reviewed by the respective Project Manager and approved by the Construction Manager.

Distribution (Controlled Copies)

COPY #	ISSUED TO	COMPANY / POSITION	DATE
0.1	Project File	Ghella Abergeldie Joint Venture	Select Date

1. Information

1.1 Definitions and Abbreviations

Abbreviation	Detail
ASCNMP	Activity Specific Construction Noise Management Plan
CNVMP	Construction Noise and Vibration Management Plan
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
Noise	A sound that is unwanted by, or distracting to, the receiver.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 “Acoustics - Construction Noise”

2. Introduction

Watercare Services Limited ('**Watercare**') has designations (Designation 9466 – Central Interceptor Main Works) and resource consents for the construction of a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them across the Manukau Harbour to the Māngere Wastewater Treatment Plant ('**WWTP'**). Referred to as the Central Interceptor (or '**the Project**'), the Project arose from the Three Waters Plan which identified the need to provide trunk sewer capacity to central Auckland to provide capacity for growth, increase resilience and reduce wet weather wastewater overflows.

There are four construction areas in the vicinity of Keith Hay Park (see Figure 1):

- Main shaft site - **49 Arundel Street, Mt Roskill** (legal description Lot 2 DP 52047), **20 Gregory Place, Mt Roskill** (legal description Lot 28 DP 49583) and **22 Gregory Place, Mt Roskill** (legal description Lot 27 DP 49583);
- Branch 9B south site – within **Keith Hay Park, off Rainford Street;**
- Branch 9B north site - within **Keith Hay Park, off Rainford Street;** and
- Frost Road site – **66 Frost Road** (legal description RL SOUTHDOWN/AVONDALE, SEC 51 SO 419816 and Pt Lot 83 DP 3029, SEC 108 SO 419816).

Figure 1: Keith Hay construction sites

This Activity Specific Construction Noise Management Plan ('**ASCNMP**') relates to s**heet piling** works at the Keith Hay Park **main shaft site, Branch 9B south site, Branch 9B north site** and the **Frost Road site**.

This ASCNMP has been prepared in accordance with designation condition DES3.5 and resource consent condition RC1.15.

2.1 Purpose

The objective of this ASCNMP is to detail the best practicable option to avoid, remedy or mitigate adverse effects on sensitive receivers resulting from construction noise associated with sheet piling within the Keith Hay Park construction sites that are predicted not to comply with the Project noise limits defined in

conditions DES3.2 and RC1.12, and defined in Section 5.1 of the Keith Hay Park Construction Noise and Vibration Management Plan ('**CNVMP**').

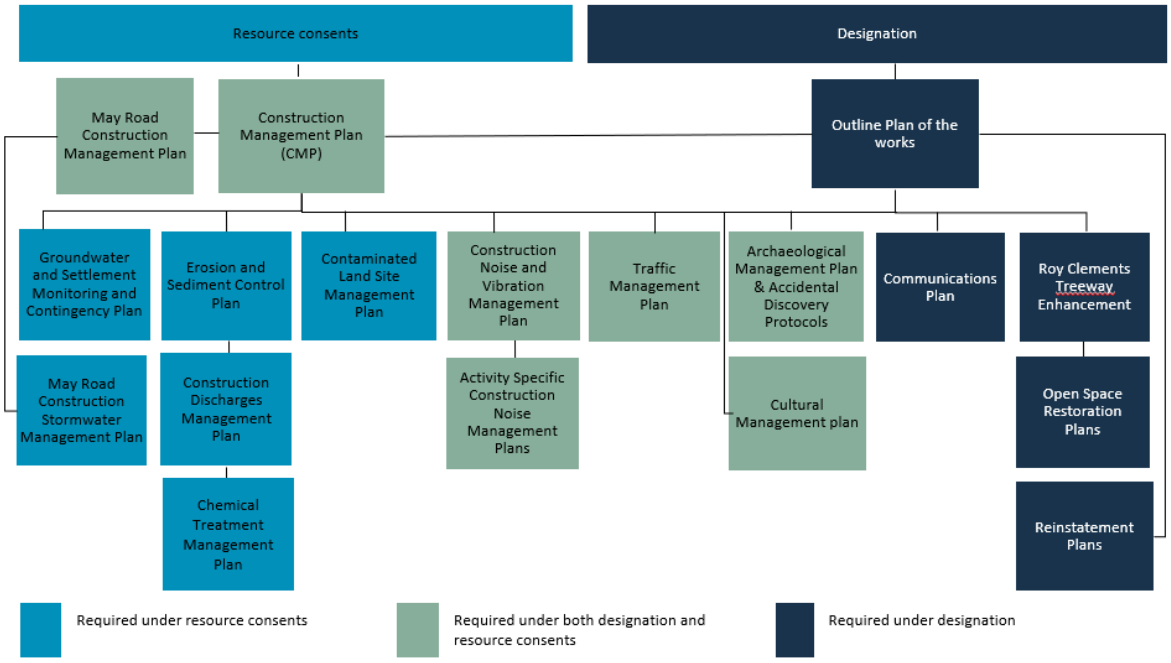
~~In accordance with conditions DES3.5 and RC1.15, this ASCNMP must be endorsed in writing by those parties affected by exceedances and approved by Council. This includes any amended versions of the ASCNMP.~~

2.2 Relationship to other plans

The ASCNMP is also required by the resource consent conditions. The Project is being delivered in stages, and this ASCNMP specifically addresses the Sheet Piling works at the Keith Hay Park sites, being one of the 16 surface works sites for the Project.

Figure 2 shows the construction management plans required by the designation and resource consents and their relationship to each other.

Figure 2: Construction management plan structure



2.3 Consent Requirements

Table 1: Resource consent and designation conditions relevant to the ASCNMP

Condition number	Condition	Plan section
DES3.2 **RC1.12**	Construction noise shall be measured and assessed in accordance with NZS6803:1999 Acoustics – Construction Noise, and shall comply with the following noise limits, unless otherwise agreed in writing with affected persons: **Monday to Saturday (0730-1800):** 70 dB L_{Aeq} 85 dBL_{Amax} **At all other times and public holidays:** 45 dB L_{Aeq} 75 dB L_{Amax}	Section 2.4 Section 4.2
DES3.3 **RC1.13**	Construction works which exceed a level of L_{Aeq} 45dB at the most exposed receiver(s) are restricted to between 0730 to 1800 on weekdays and Saturdays, with no noisy works permitted on Sundays and Public Holidays. Each CNVMP shall define which activities will comply with a limit of 45dB	Section 4.2

Condition number	Condition	Plan section
	L_{Aeq} and can therefore be undertaken outside of these hours in compliance with conditions DES8.2 and RC1.10.	
DES3.5 **RC1.15**	~~The ASCNMP(s) shall be endorsed with the written consent of those persons affected by the exceedances and shall be submitted to the Council for review and approval at least 7 working days prior to the proposed works commencing.~~ Works subject to the ASCNMP(s) shall not commence until approval is received from the Council. If monitoring shows that levels specified in an ASCNMP are being exceeded, work generating the exceedance shall stop and not recommence until further mitigation is implemented in accordance with an amended ASCNMP approved by the Council:	Section 8
DES3.5(a) **RC1.15(a)**	Describe the activity (including duration), plant and machinery that is expected not to comply with the noise limits in conditions DES3.2 and RC1.12.	Section 4.3
DES3.5(b) **RC1.15(b)**	Described the mitigation measures proposed to reduce the noise levels as far as practicable, including any options that have been discounted due to cost or any other reason.	Section 5.1 Section 5.2
DES3.5(c) **RC1.15(c)**	Provide predicted noise levels for all receivers where the noise levels will not be compliance with the limits in conditions DES3.2 and RC1.12, including the effect of mitigation specified in DES3.4(d) and RC1.14(d).	Section 6.1
DES3.5(d) **RC1.15(d)**	Provide a set of noise limits that are Activity – Specific.	Section 6.2
DES3.5(e) **RC1.15(e)**	Describe the noise monitoring that will be undertaken to determine compliance with the Activity – Specific noise limits.	Section 9
DES3.5(f) **RC1.15(f)**	Describe any additional noise mitigation measures that may be implemented to maintain compliance with Activity – Specific noise limits.	Section 7

2.4 Consented noise limits (DES3.2 and RC1.12)

The construction noise limits for the Project are defined in conditions DES3.2 and RC1.12.

Construction noise shall be measured and assessed in accordance with NZS6803:1999 Acoustics – Construction Noise and shall comply with the noise limits in Table 2 at occupied buildings, unless otherwise allowed through an ASCNMP.

Table 2: Construction Noise Limits

Time and Day	Noise Limits
Monday to Saturday **0730 – 1800**	70 dB L_{Aeq}
	85 dB L_{AFmax}
At All Other Times and Public Holidays	45 dB L_{Aeq}
	75 dB L_{AFmax}

3. Roles and Responsibilities

3.1 Environmental roles and responsibilities

Each person involved in the Project has equal responsibility to avoid, remedy or mitigate adverse environmental effects. There are three key groups with responsibility for environmental management of the Project:

- Watercare as the Project owner, requiring authority, and holder of the resource consents;
- Ghella Abergeldie Joint Venture ('**Ghella-Abergeldie JV**') undertaking the works; and
- Auckland Council to audit the works and monitor compliance with designation and resource consent conditions, the Construction Management Plan ('**CMP**') and sub-plans.

3.1.1 Specific roles and responsibilities

The key management roles for each organisation in relation to this ASCNMP during the construction of the Project are outlined in Table 3. Further responsibilities are set out in the CMP.

Table 3: CNVMP responsibilities

Organisation	Role	Role Responsibilities
Watercare Services Limited	Requiring Authority, Consent Holder and Project Manager	• Overall responsibility for project compliance and performance in relation to environment, quality assurance and incident management. •
Ghella Abergeldie Joint Venture	Project Director	• Overall responsibility for site environmental management. • Review and approve all relevant management plans.
	Stakeholder and Community Manager	• Responsible for notifying residents of works occurring within the near vicinity and managing mitigation as required. • Disseminates information to the public as approved by Watercare.
	Environmental Manager	• On-site compliance with consent conditions and other requirements and tracking compliance information. • Initial monitoring of noise and vibration levels generated from construction activity.
	Project and Site Engineers	• Development, management, and monitoring of construction procedures, including incorporating environmental and sustainability requirements. • Overseeing subcontractors.
	Site Managers	• Adherence to the CNVMP and any ASCNMPs
Subcontractors	Acoustic Specialist	• Additional monitoring of noise and vibration levels generated from construction activity in excess of relevant noise limits. • Review noise measurements undertaken within 3dB of the relevant noise limits. • Updating mitigation and management measures based on new information.

3.1.2 Contact details

Contact details for those with key responsibilities in the implementation of this ASCNMP including the Stakeholder and Community Manager are provided in the table below.

A Project representative will be contactable during works and contact details provided in communication to adjacent residents.

Table 4: Key contacts

Role	Name	Contact Details
Watercare Services Limited, Private Bag 92 521 Wellesley Street, Auckland, 1141		
Engineer to Contact	Tony Parsons	P: +64 27 447 3737 E*: Tony.Parson@water.co.nz*
Compliance Advisor	Xenia Meier	P: +64 21 574 585 E: *Xenia.Meier@water.co.nz*
Ghella Abergeldie Joint Venture, PO Box 10354, Dominion Road, Auckland, 1024		
Project Director	Francesco Saibene	P: +64 21 088 27237 E: *FSaibene@ghella.com*
Construction Manager	Stefano Vittor	P: 021 630 355 E: *SVittor@ga-jv.com*
Key Relationships Manager	Lesley Hopkins	P: +64 27 414 351 E: *lhopkins@ga-jv.com*
Environmental Manager	Sandra Edwards	P: +64 27 366 3884 E: *sedwards@ga-jv.com*
Stakeholder and Community Manager	Carol Moffatt	P: +64 27 703 0672 E: *CMoffatt@ga-jv.com*
Keith Hay Park Site Manager	Chris Baker	P: +64 22 010 5618 E: *cbaker@ga-jv.com*

4. Project Description

This section provides a summary of the proposed works at the Keith Hay Park construction sites that are relevant to this ASCNMP. A detailed description of the construction works is provided in the CMP.

4.1 Sheet Piling

Sheet piling is required for the main shaft and the bifurcation and control chambers as shown in Figure 3 and Figure 4. It is also required at the Branch 9B and Frost Road sites as shown in Figure 5 and Figure 6.

Figure 3: Sheet Piling Locations – Main Shaft (sheet piling location shown in red)

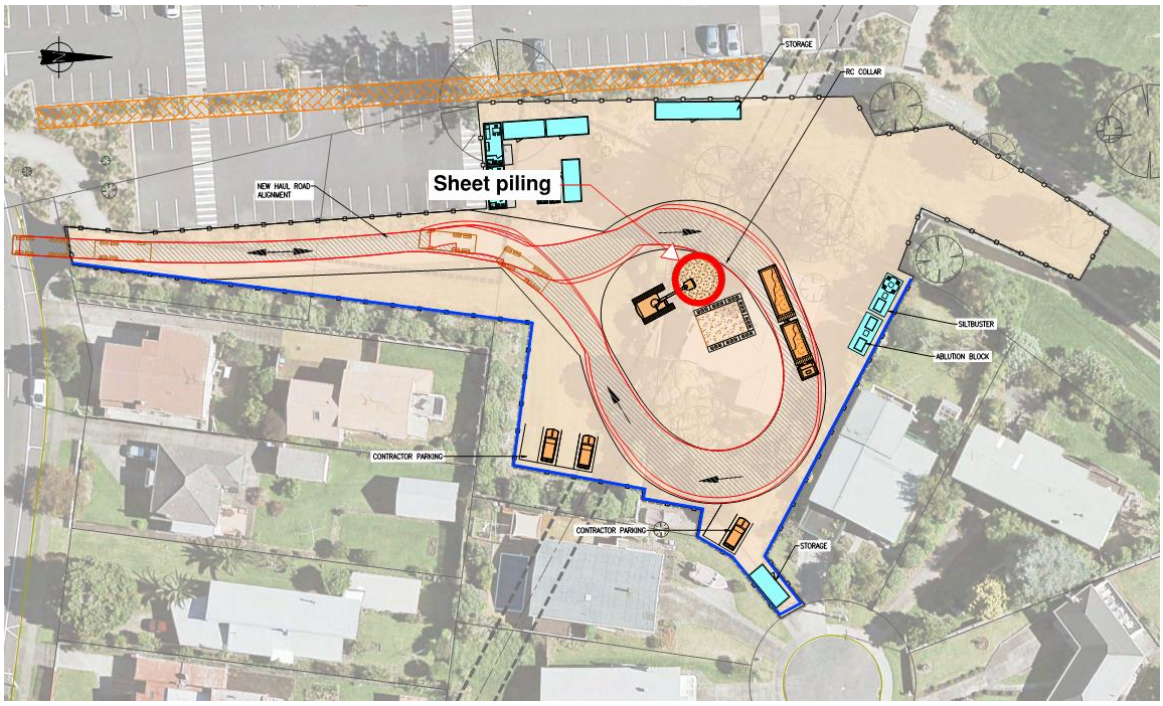


Figure 4: Sheet Piling Locations – Bifurcation and Control Chamber (sheet piling location shown in red)

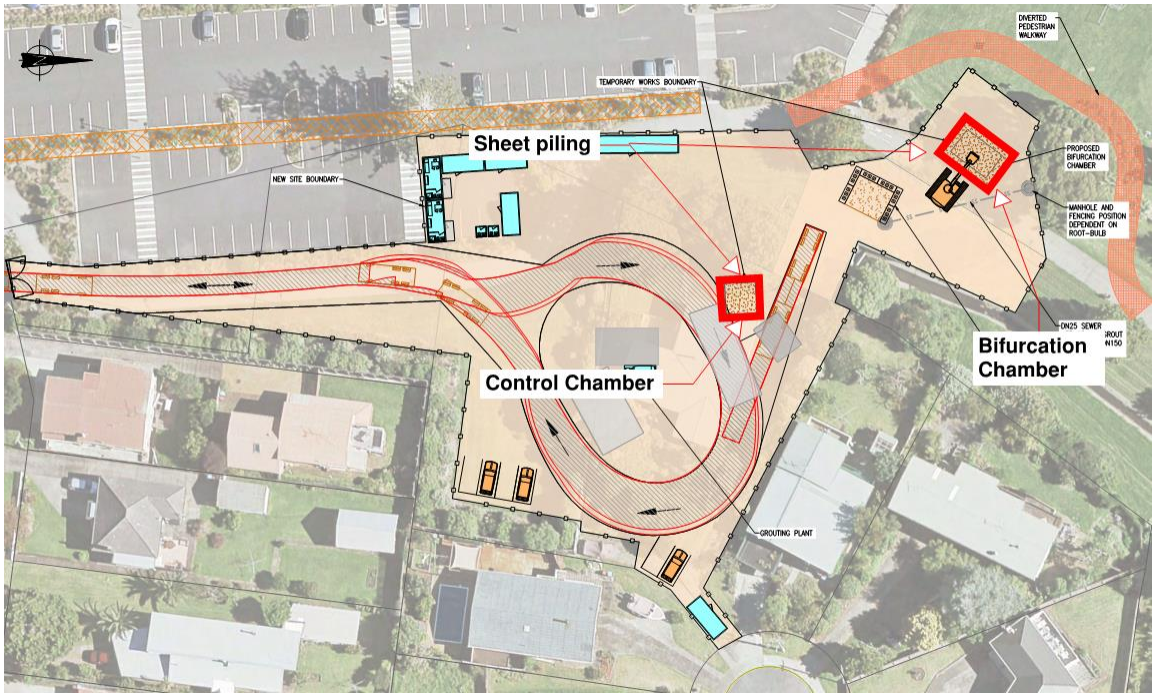


Figure 5: Sheet Piling Location – Branch 9B South Site (sheet piling location shown in red)

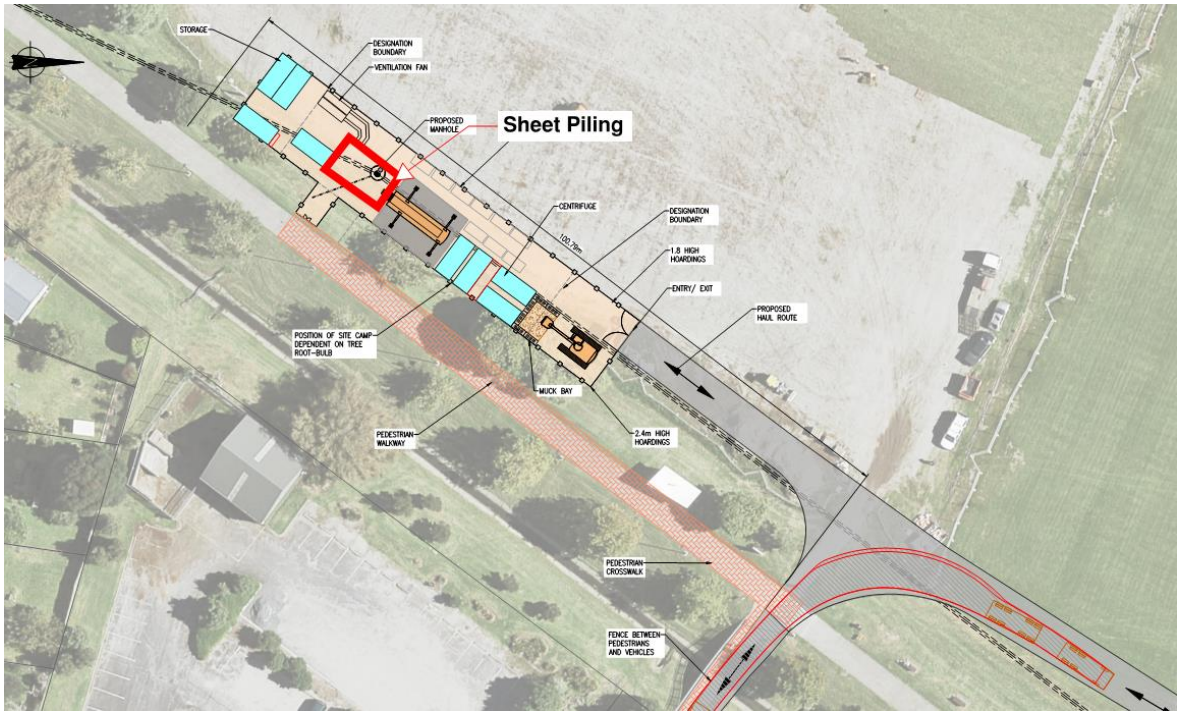
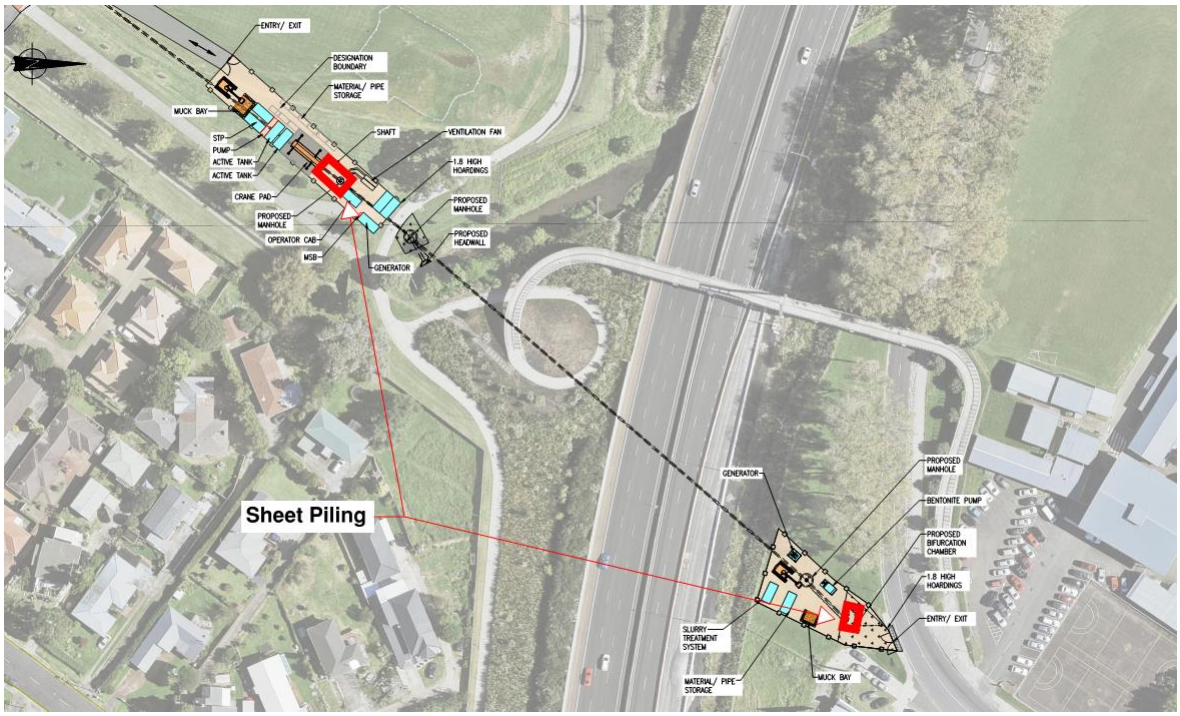


Figure 6: Sheet Piling Location – Branch 9B North and Frost Road Sites (sheet piling location shown in red)



4.2 Hours of operation and duration (DES3.2 and RC1.12)

The hours of construction are generally 7:00 to 18:00 Monday to Friday and 8:00 to 18:00 Saturday unless otherwise approved in accordance with the process set out in the Project consents.

Listed below are the estimated durations and dates of sheet piling at each location.

- Main Shaft site 8 non-consecutive days from March to August 2020
- Branch 9B South site 5 non-consecutive days in August 2020
- Branch 9B North site 5 non-consecutive days in August 2020
- Frost Road site 5 non-consecutive days in September 2020

4.3 Detail of non-compliant construction activities (DES3.5(a) and RC1.15(a))

Vibratory sheet piling is predicted to exceed the noise criteria (Section 2.4) at the following buildings:

Main Shaft site:

- 47 Arundel Street;
- 47A Arundel Street;
- 16 Gregory Place;
- 17 Gregory Place;
- 18 Gregory Place; and
- 19 Gregory Place.

Branch 9B South Site:

- 13 Vic Butler Street;
- 15 Vic Butler Street; and
- 17 Vic Butler Street.

Branch 9B North Site:

- 59B Stamford Park Road;
- 61 Stamford Park Road; and
- 73 Stamford Park Road.

Frost Road site:

- 56 Frost Road;
- 58 Frost Road; and
- Mount Roskill Grammar School.

5. Noise Mitigation Measures

General and site-specific noise and vibration mitigation measures are specified in the CNVMP.

5.1 Mitigation measures (DES3.5(b) and RC1.15(b))

No mitigation measures are proposed.

5.2 Discounted options DES3.5(b) and RC1.15(b)

An effective noise barrier would need to be 7.0m+ high to provide an appreciable reduction in noise (5 dB). This is because the noise source for vibratory sheet piling is at approximately 6.5m for this Project. A barrier of this size is not considered best practicable option due to time and cost required to construct a barrier of this size in relation to the effects.

6. Noise Receivers and Limits (DES3.5 and RC1.15)

This section provides a summary of the affected noise receivers and predicted level exceedance at each construction activity post mitigation as well as the proposed activity specific noise limits.

6.1 Affected noise receivers (DES3.5(c) and RC1.15(c))

The affected noise receivers and the predicted worst-case noise level are presented below.

Table 5: Predicted Noise Levels for main shaft site

Location	Building Use/Occupancy	Worst-Case Noise Level
47 Arundel Street	Dwelling	72 dB L_{Aeq}
47A Arundel Street	Dwelling	78 dB L_{Aeq}
16 Gregory Place	Dwelling	75 dB L_{Aeq}
17 Gregory Place	Dwelling	78 dB L_{Aeq}
18 Gregory Place	Dwelling	78 dB L_{Aeq}
19 Gregory Place	Dwelling	84 dB L_{Aeq}

Table 6: Predicted Noise Levels for Branch 9B south site

Location	Building Use/Occupancy	Worst-Case Noise Level
13 Vic Butler Street	Dwelling	71 dB L_{Aeq}
15 Vic Butler Street	Dwelling	73 dB L_{Aeq}
17 Vic Butler Street	Dwelling	73 dB L_{Aeq}

Table 7: Predicted Noise Levels for Branch 9B north site

Location	Building Use/Occupancy	Worst-Case Noise Level
59B Stamford Park Road	Dwelling	73 dB L_{Aeq}
61 Stamford Park Road	Dwelling	74 dB L_{Aeq}
73 Stamford Park Road	Various Dwellings	74-76 dB L_{Aeq}

Table 8: Predicted Noise Levels for Frost Road site

Location	Building Use/Occupancy	Worst-Case Noise Level
56 Frost Road	Commercial	74 dB L_{Aeq}
58 Frost Road	Commercial	81 dB L_{Aeq}
Mount Roskill Grammar School	School	73 dB L_{Aeq}

6.2 Activity specific limits (DES3.5(d) and RC1.15(d))

The following activity specific noise limits are proposed for the sites:

Table 9: Activity Specific Noise Limits for main shaft site

Location	Activity Specific Noise Limit
47 Arundel Street	74 dB L_{Aeq}
47A Arundel Street	80 dB L_{Aeq}
16 Gregory Place	77 dB L_{Aeq}
17 Gregory Place	80 dB L_{Aeq}
18 Gregory Place	80 dB L_{Aeq}
19 Gregory Place	86 dB L_{Aeq}

Table 10: Activity Specific Noise Limits for Branch 9B south site

Location	Activity Specific Noise Limit
13 Vic Butler Street	73 dB L_{Aeq}
15 Vic Butler Street	75 dB L_{Aeq}
17 Vic Butler Street	75 dB L_{Aeq}

Table 11: Activity Specific Noise Limits for Branch 9B north site

Location	Activity Specific Noise Limit
59B Stamford Park Road	75 dB L_{Aeq}
61 Stamford Park Road	76 dB L_{Aeq}
73 Stamford Park Road	78 dB L_{Aeq}

Table 12: Activity Specific Noise Limits for Frost Road site

Location	Activity Specific Noise Limit
56 Frost Road	76 dB L_{Aeq}
58 Frost Road	83 dB L_{Aeq}
Mount Roskill Grammar School	75 dB L_{Aeq}

6.3 Potential effects

The noise level received inside a noise sensitive space (e.g. office or living room) will depend on the external noise level, sound insulation performance of the façade (particularly the glazing) and room constants (such as the room dimensions and surface finishes). These factors can vary widely.

The Construction Noise Standard (NZS 6803) recommends noise limits assessed at 1m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, 20 decibels is particularly conservative for modern buildings. With knowledge of the façade glazing type, the sound insulation performance can generally be estimated as follows:

Sealed glazing	30 decibels façade sound level difference
Openable windows (closed)	20 – 25 decibels façade sound level difference
Open windows	15 decibels façade sound level difference

The tables below provide guidance on the effects in noise sensitive spaces during the day depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

- Typically acceptable
- Annoyance and reduction in communication quality for some occupants
- Annoyance and degradation of communication quality for most occupants

Table 13: Daytime noise levels in commercial & industrial buildings and habitable rooms in dwellings

External Noise Level (dB L_{Aeq})	Estimated Internal Noise Level (dB L_{Aeq})			
	Sealed glazing	Openable windows (modern building)	Openable windows (older building)	Open windows
90 – 95	60 – 65	65 – 70	70 – 75	75 – 80
85 – 90	55 – 60	60 – 65	65 – 70	70 – 75
80 – 85	50 – 55	55 – 60	60 – 65	65 – 70
75 – 80	45 – 50	50 – 55	55 – 60	60 – 65
70 – 75	40 – 45	45 – 50	50 – 55	55 – 60

Table 14: Worst Case Internal Noise Levels for main shaft site

Address	Estimated Internal Noise Level
47 Arundel Street	47 dB L_{Aeq}
47A Arundel Street	53 dB L_{Aeq}
16 Gregory Place	55 dB L_{Aeq}
17 Gregory Place	58 dB L_{Aeq}
18 Gregory Place	58 dB L_{Aeq}
19 Gregory Place	59 dB L_{Aeq}

Table 15: Worst Case Internal Noise Levels for Branch 9B south site

Address	Estimated Internal Noise Level
13 Vic Butler Street	51 dB L_{Aeq}
15 Vic Butler Street	53 dB L_{Aeq}
17 Vic Butler Street	48 dB L_{Aeq}

Table 16: Worst Case Internal Noise Levels for Branch 9B north site

Address	Estimated Internal Noise Level
59B Stamford Park Road	48 dB L_{Aeq}
61 Stamford Park Road	49 dB L_{Aeq}
73 Stamford Park Road	51 dB L_{Aeq}

Table 17: Worst Case Internal Noise Levels for Frost Road site

Address	Estimated Internal Noise Level
56 Frost Road	49 dB L_{Aeq}
58 Frost Road	56 dB L_{Aeq}
Mount Roskill Grammar School	48 dB L_{Aeq}

7. Additional Noise Measures (DES3.5(f) and RC1.15(f))

No additional noise mitigation measures are considered practicable or warranted. If construction cannot comply with the activity specific noise limits (Section 6.2) the ASCNMP will be revised in accordance with DES3.5 and RC1.15.

8. Written Consent (DES3.5 and RC1.15)

General communication measures are detailed in Section 10 of the Keith Hay Park CNVMP. Specific communication undertaken in relation to the specific construction activity are described in this section.

~~Conditions DES3.5 and RC1.15 requires written consent from the affected parties for exceeding the project noise limits.~~ Written consent has been provided by the following parties:

Main Shaft site:

- 47 Arundel Street;
- 16 Gregory Place;
- 17 Gregory Place;
- 18 Gregory Place; and
- 19 Gregory Place.

Branch 9B South Site:

- 13 Vic Butler Street;
- 15 Vic Butler Street; and
- 17 Vic Butler Street.

Branch 9B North Site:

- 59B Stamford Park Road;
- 61 Stamford Park Road; and
- 73 Stamford Park Road.

Frost Road site:

- 56 Frost Road;
- 58 Frost Road; and
- Mount Roskill Grammar School.

The written consent forms are provided in **Appendix A**.

8.1 Activity specific construction noise management plan communication and consultation

As part of obtaining written consent from the affected parties the following communication and consultation has been undertaken.

Table 18: Communication and Consultation – Main Shaft Site

Location	Date	Meeting or Written Communication	Matters discussed or conveyed	Outcomes
47 Arundel Street	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
47A Arundel Street	Ongoing	Letter	Initial letter setting out noise exceedance	Ongoing engagement
16 Gregory Place	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
17 Gregory Place	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed

Location	Date	Meeting or Written Communication	Matters discussed or conveyed	Outcomes
18 Gregory Place	10 Feb 2020	Letter	Initial letter setting out noise exceedance	Signed
19 Gregory Place	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed

Table 19: Communication and Consultation –Branch 9B South Site

Location	Date	Meeting or Written Communication	Matters discussed or conveyed	Outcomes
13 Vic Butler Street	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
15 Vic Butler Street	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
17 Vic Butler Street	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed

Table 20: Communication and Consultation –Branch 9B North Site

Location	Date	Meeting or Written Communication	Matters discussed or conveyed	Outcomes
59B Stamford Park Road	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
61 Stamford Park Road	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
73 Stamford Park Road	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed

Table 21: Communication and Consultation –Frost Road Site

Location	Date	Meeting or Written Communication	Matters discussed or conveyed	Outcomes
56 Frost Road	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
58 Frost Road	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed
Mount Roskill Grammar School	7 Nov 2019	Letter	Initial letter setting out noise exceedance	Signed

9. Noise Monitoring and Review (DES3.5(e) and RC1.15(e))

This section provides details of the methodology for noise monitoring, as well as review of the ASCNMP.

9.1 Noise monitoring

Construction noise levels will be monitored as follows:

- When sheet piling commences;
- In response to a reasonable noise complaint;
- At 1m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate for a representative duration;
- In accordance with the requirements of New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise"; and
- For a representative duration, reported with the measured level (e.g. 65 dB $L_{Aeq\ (30min)}$)

In the first instance the Ghella Abergeldie JV will measure construction noise, under the following circumstances an acoustic consultant will be engaged to review or undertake additional noise measurements.

- An acoustic consultant will undertake additional noise measurements if the Ghella Abergeldie JV measures a non-compliance with the relevant noise limit
- An acoustic consultant will review noise measurements undertaken by the Ghella Abergeldie JV that are within 3 dB of the relevant noise limit
- An acoustic consultant will review noise measurements undertaken in a proxy location that is further away from the noise source compared to the relevant assessment position

If the noise levels in Section 6 are exceeded, works shall halt and not recommence until further mitigation has been implemented to enable compliance with the limits or an amended ASCNMP has been approved by Auckland Council and endorsed with written consent by the affected party.

9.2 General review of the ASCNMP

This ASCNMP should be considered as a live document. It will be updated, with the necessary approvals, throughout the course of the Project to reflect material changes to construction methods, site conditions or the natural environment.

This document is an exact copy of the Council approved plan (with approval documentation inserted) and has been issued For Information only.

Drawings embedded in this document are from the tender package and are not to be used for construction.

Construction Noise and Vibration Management Plan

Keith Hay Park shaft site, 49 Arundel Street and 20 and 22 Gregory Place, Mount Roskill

Central Interceptor

Doc No: GAJV-PLN-00043 (previously CI-EN-2030)

Version: [0.4 Final]

Watercare
An Auckland Council Organisation

Ghella 5 Generations of Tunnelers
ABERGELDIE COMPLEX INFRASTRUCTURE

Sarah Blair

From: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Sent: Wednesday, 18 December 2019 1:27 PM
To: Tommy Ma <tma@ga-jv.com>
Cc: Lesley Hopkins <lhopkins@ga-jv.com>; Sandra Edwards <sedwards@ga-jv.com>; XMeier (Xenia) <Xenia.Meier@water.co.nz>
Subject: RE: Central Interceptor - Batch Two Management Plans

Thanks Tommy,

I can confirm CNVMP for Batch 2 is now approved.

Ngā mihi | Kind Regards

Randy Leung | Senior Compliance Monitoring Officer | Licensing & Regulatory Compliance
Auckland Council | T: +64 (09) 353 9101 | M: 027 272 0302
Location: Level 1 | 35 Graham Street | CBD Auckland
Postal: Private Bag 92300 | Wellesley Street | Auckland | 1036
mailto: randy.leung@aucklandcouncil.govt.nz |

From: Tommy Ma <tma@ga-jv.com>
Sent: Wednesday, 18 December 2019 12:01 PM
To: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Cc: Lesley Hopkins <lhopkins@ga-jv.com>; Sandra Edwards <sedwards@ga-jv.com>; XMeier (Xenia) <Xenia.Meier@water.co.nz>; J. Exeter <Jamie@stylesgroup.co.nz>
Subject: RE: Central Interceptor - Batch Two Management Plans

Sensitivity: General

Hi Randy

Please find attached the updated CNVMP for Dundale Avenue, Whitney Street, Miranda Reserve and Keith Hay Park.

Tommy Ma
Consenting Manager – Central Interceptor
M +64 21 196 5370

Ghella Abergeldie JV
360 Dominion Road,
Mt Eden 1024, New Zealand

Table of Contents

Appendices

Revision History

Review and Approval

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Prepared by	Acoustic Consultant, Marshall Day Acoustics	Shaun King		7/11/2019
Reviewed by	Key Relationship Manager, Ghella Abergeldie JV	Lesley Hopkins		8/11/2019
Approved by	Project Director, Ghella Abergeldie JV	Francesco Saibene		11/11/2019

Each page of this document bears a document number and revision date. When revisions to the document are issued, the following table will be updated to show the most recent revision level. The revised document will be forwarded to the holders of controlled copies. Recipients are responsible for destroying or marking "superseded" on the previous revision.

Revision Status

VERSION	DATE	STATUS	AMENDMENT DESCRIPTION
0.1	3/09/2019	Draft	Draft for internal review
0.2	11/10/2019	Revised draft	Draft for Watercare review
0.3	11/11/2019	Final	For submission to Auckland Council for approval
0.4	4/12/2019	Final	Incorporating Auckland Council feedback

Where review and revision is deemed warranted, i.e. such as comments received from the Client, or where necessary to reflect changes in contractual or Project requirements, or as a result of an incident then these revisions shall be reviewed by the respective Project Manager and approved by the Construction Manager.

Distribution (Controlled Copies)

COPY #	ISSUED TO	COMPANY / POSITION
01	Project File	Ghella Abergeldie Joint Venture
02	Client Rep	Engineer to Contract

1. Information

1.1 Definitions and Abbreviations

Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
L_{peak}	The peak instantaneous pressure level recorded during the measurement period (normally not A-weighted).
AS 2187-2: 1993	Australian Standard AS 2187-2: 1993 *"Explosives - Storage, transport and use. Part 2: Use of explosives"*
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into vertical (up and down vibration), horizontal transverse (side to side) and horizontal longitudinal direction (front to back) components.
PPV	Peak Particle Velocity (PPV) is the measure of the vibration amplitude, zero to maximum, measured in mm/s.
DIN 4150-3:1999	German Standard DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"*

2. Introduction

2.1 Project Background

Watercare Services Limited ('**Watercare**') has Designations (Designation 9466 – Central Interceptor Main Works) and Resource Consents for the construction of a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them across the Manukau Harbour to the Māngere Wastewater Treatment Plant ('**WWTP'**). Referred to as the Central Interceptor (or '**the Project**'), the Project arose from the Three Waters Plan which identified the need to provide trunk sewer capacity to central Auckland to provide capacity for growth, increase resilience and reduce wet weather wastewater overflows.

This Construction Noise and Vibration Management Plan ('**CNVMP**') has been prepared in accordance with Designation Conditions DES3.1 and Resource Consent Conditions RC1.11.

This CNVMP addresses the works at the Keith Hay Park shaft site located at **49 Arundel Street, Mount Roskill**.

2.2 Purpose

The purpose of this CNVMP is to outline the management of construction noise and vibration for the Keith Hay Park shaft site. This plan predicts noise and vibration levels resulting from activities in the Construction Management Plan ('**CMP**') and outlines mitigation measures to ensure best-practice is adopted.

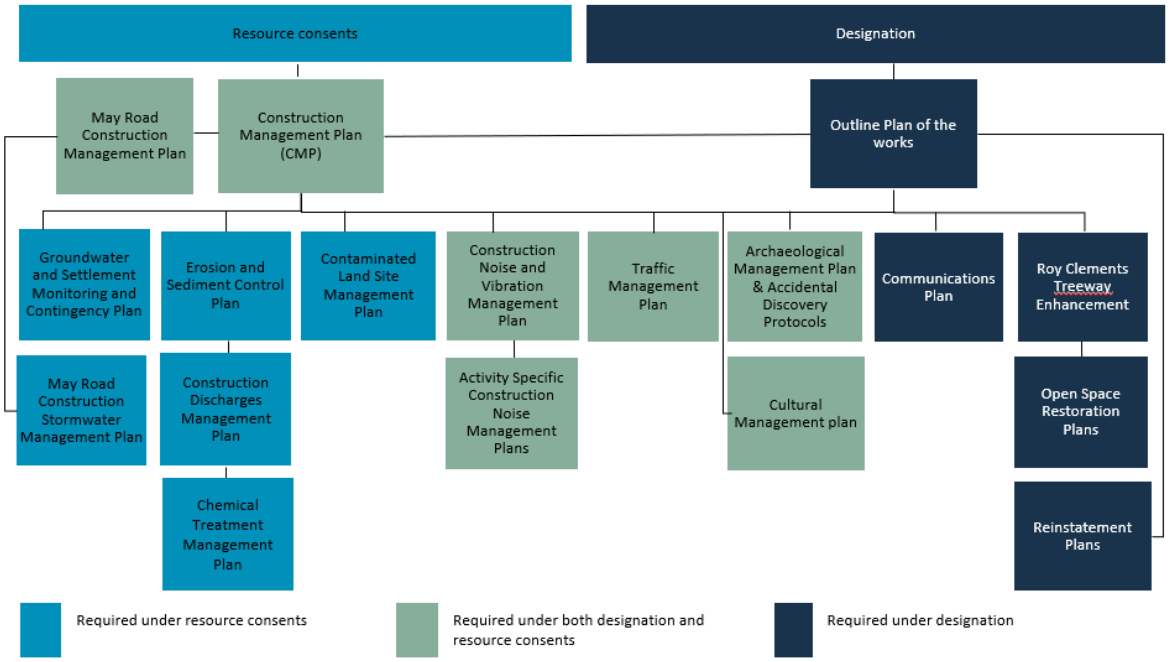
In cases where certain activities will exceed the specified noise limits, an Activity Specific Construction Noise Management Plan ('**ASCNMP**') will be prepared in accordance with conditions DES3.5 and RC1.15.

2.3 Relationship to other Plans

In accordance with DES1.8, the CNVMP is to be submitted with the Outline Plan of the work for the Project or for each Project stage. The CNVMP is also required by the resource consent conditions. The Project is being delivered in stages, and this CNVMP specifically addresses the site works at the Keith Hay Park shaft site, being one of the 16 surface works sites for the Project.

Figure 1 shows the construction management plans required by the designation and resource consents and their relationship to each other.

Figure 1: Construction management plan structure



2.4 Sustainability

Watercare is seeking an Infrastructure Sustainability Council of Australia ('**ISCA**') Infrastructure Sustainability rating for the Project. Full details about the rating scheme and methods to achieve the accreditation are included in the Project's Sustainability Management Plan. The sustainability management plan is not a designation/resource consent compliance requirement, however, this CNVMP does include Project sustainability aspects, and they are included in **Appendix E**.

2.5 Consent Requirements

A full set of the designation and resource consent conditions for the Project are appended to the CMP. Table 1 identifies the conditions that are relevant to this CNVMP and are referred to throughout this plan.

Table 1: Resource consent and designation conditions relevant to the CNVMP

Condition number	Condition	CNVMP section
RC1.8(l)	A Construction Noise and Vibration Management Plan ('CNVMP') for each site containing measures to address the management of construction noise and vibration as identified in Condition 1.10;	This Plan – Keith Hay Park shaft site
DES1.8(d)	The OPW shall include the following Management Plans for the relevant stage(s) of the Project: Site Specific Construction Noise and Vibration Management Plan (CNVMP).	CNVMP
DES8.1 **RC1.10**	Construction hours shall be as described below (1.10 a to i) except where work is necessary outside the specified days or hours for the purposes specified below:	4.4
DES8.1(a) **RC1.10(a)**	Tunnelling activities – 24 hours a day, 7 days a week operation for all tunnelling activities, including the main tunnel works and the link tunnels;	

Condition number	Condition	CNVMP section
DES8.1(b) **RC1.10(b)**	General site activities – 7 am to 6pm, Monday to Friday, 8am to 6pm Saturday; and	
DES8.1(c) **RC1.10(c)**	Truck movements – 7am to 6pm, Monday to Friday, 8am to 6pm Saturday, except that Truck movements are restricted from entering and exiting sites in proximity to schools and colleges between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times. This includes, although is not limited to the following sites: Mt Albert War Memorial Reserve (Car Park site), Walmsley Road (AS4), Motions Road (L1S1), Pump Station 25 (L3S1), Lyon Avenue (AS2), and Miranda Reserve (L3S2).	4.4
DES8.2(a) **RC1.10(d)**	Purposes for which work may occur outside of the specified days or hours are: where, due to unforeseen circumstances, it is necessary to complete an activity that has commenced;	Noted
DES8.2(b) **RC1.10(e)**	where work is specifically required to be planned to be carried out at certain times e.g. to tie into the existing network during periods of low flow, or to tie into tidal cycles for works in the CMA;	
DES8.2(c) **RC1.10(f)**	for delivery of large equipment or special deliveries required outside of normal hours due to traffic management requirements;	
DES8.2(d) **RC1.10(g)**	in cases of emergency; and	
DES8.2(e) **RC1.10(h)**	for the securing of the site or the removal of a traffic hazard; and/or	
DES8.2(f) **RC1.10(i)**	for any other reason specified in the CMP or a Traffic Management Plan required under Condition 1.22.	
DES3.1 **RC1.11**	A Construction Noise and Vibration Management Plan shall be prepared for each site for Council approval as part of the CMP and shall be prepared by a suitably qualified person. These documents shall be submitted to Council with the OPW to which it relates.	This Plan – Keith Hay Park shaft site
DES3.2 **RC1.12**	**Time and Day** / **Noise Limits** Monday to Saturday 0730 – 1800: 70 dB L_{Aeq} Monday to Saturday 0730 – 1800: 85 dB L_{Amax} At all other times and public holidays: 45 dB L_{Aeq} At all other times and public holidays: 75 dB L_{Amax}	5.1
DES3.3 **RC1.13**	Construction works which exceed a level of L_{Aeq} 45dB at the most exposed receiver(s) are restricted to between 0730 to 1800 on weekdays and Saturdays, with no noisy works permitted on Sundays and Public Holidays. Each CNVMP shall define which activities will comply with a limit of L_{Aeq} 45dB and can therefore be undertaken outside of these hours in compliance with conditions 1.10.	4.4
DES3.4 **RC1.14**	Each CNVMP shall, in demonstrating compliance with Designation Condition 3.2 and Resource Condition 1.12, as a minimum, address the below aspects (DES3.2(a) to (j) and RC1.14(a) to (j)), with regard to construction noise:	6.1
DES3.4(a) **RC1.14(a)**	a description of noise sources, including machinery, equipment and construction techniques to be used;	

Condition number	Condition	CNVMP section
DES3.4(b) **RC1.14(b)**	predicted construction noise levels;	6.1
DES3.4(c) **RC1.14(c)**	hours of operation, including times and days when noisy construction work and blasting would not occur in compliance with designation condition 3.2 and resource condition 1.12;	4.4
DES3.4(d) **RC1.14(d)**	physical noise mitigation measures, including prohibiting the use of tonal reverse alarms, maintenance of access roads (to ensure they are smooth), acoustic screening around the site, plant selection and maintenance procedures, and site layout;	8.2 8.4.3
DES3.4(e) **RC1.14(e)**	construction noise criteria for any specific areas and sensitive receivers such as schools, child care centres, medical or aged care facilities;	N/A
DES3.4(f) **RC1.14(f)**	the identification of activities and locations that will require the design of specific noise mitigation measures;	6.3
DES3.4(g) **RC1.14(g)**	the measures that will be taken by the Consent Holder to communicate and obtain feedback from affected stakeholders on noise management measures	8.1
DES3.4(h) **RC1.14(h)**	methods for monitoring and reporting on construction noise;	11.1 11.2
DES3.4(i) **RC1.14(i)**	methods for receiving and responding to complaints about construction noise; and	10.2
DES3.4(j) **RC1.14(j)**	construction operator training procedures.	8.4.2
DES3.5 **RC1.15**	Where a CNVMP predicts that noise levels from a particular activity will or will likely exceed the noise limits set out in designation condition 3.2 and resource consent condition 1.12, or where noise measurements show that compliance is not being achieved, the Consent Holder shall prepare and submit for the approval of the Council an Activity Specific Construction Noise Management Plan (ASCNMP).	7.1 9
DES3.6 **RC1.16**	Each CNVMP shall also describe measures adopted to meet the requirements of German Standard DIN4150-3:1999, and as a minimum shall address the following aspects with regard to construction vibration:	6.2
DES3.6(a) **RC1.16(a)**	vibration sources, including machinery, equipment and construction techniques to be used;	
DES3.6(b) **RC1.16(b)**	preparation of building condition reports on 'at risk' buildings prior to, during and after completion of works, where for the purposes of this condition an 'at risk' building is one at which the levels in the German Standard DIN4150-3: 1999 are likely to be approached or exceeded; Note: For the May Road site, internal and external building condition reports shall be prepared for the buildings identified on the diagram titled "Foodstuffs Pre-Condition Survey Recommendation" dated 11 August 2014, and submitted to the Environment Court on 22 September 2014, and any other building(s) identified as 'at risk' to identify and quantify any adverse effects in respect of vibration, dewatering, ground settlement and consequential damage to structures.	8.4.5
DES3.6(c) **RC1.16(c)**	use of building condition surveys to determine the sensitivity of the building(s) on the adjacent sites to ground movement in terms of the Line 1-3 criteria of the DIN standard;	6.2

Condition number	Condition	CNVMP section
DES3.6(d) RC1.16(d)	provision for the determination of buildings that require post-condition surveys to be undertaken following the commencement of blasting;	N/A
DES3.6(e) RC1.16(e)	identification of any particularly sensitive activities in the vicinity of the proposed works (e.g. commercial activity using sensitive equipment such as radiography or mass-spectrometry) including the NZ Institute for Plant and Food Research (at 118-120 Mt Albert Road, Mt Albert), the Institute of Environmental Science and Research (Hampstead Road, Sandringham) and Caltex Western Springs (at 778-802 Great North Road, Grey Lynn), along with the details of consultation with the land owners of the sites where the sensitive activities are located and any management measures that will be adopted based on this consultation;	N/A
DES3.6(f) **RC1.16(f)**	the measures that will be taken by the Consent Holder to communicate and obtain feedback from affected stakeholders on vibration management measures;	10.1
DES3.6(g) **RC1.16(g)**	methods for monitoring and reporting on construction vibration; and	11.2
DES3.6(h) **RC1.16(h)**	methods for receiving and responding to complaints about construction vibration.	10.2
DES3.7 **RC1.17**	Air overpressure levels from blasting shall comply with the following limits, measured and assessed in accordance with AS2187.2-2006 Explosives – Storage and Use Part 2: Use of Explosives:	N/A
DES3.7(a) **RC1.17(a)**	For buildings that are not occupied for any blast event, the air overpressure limit shall be 133 dBZ L_{peak} unless prior agreement is reached in writing with the owner(s) (in conjunction with a building pre-condition survey) that a higher limit may apply; and	
DES3.7(b) **RC1.17(b)**	For buildings that are occupied for any blast event, and where there are less than 20 blast events to be undertaken on the site over the entire project, the air overpressure limit shall be 128 dBZ L_{peak}; and	
DES3.7(c) **RC1.17(c)**	For buildings that are occupied for any blast event, and where there are more than 20 blast events to be undertaken on the site over the entire project, the air overpressure limit shall be 120 dBZ L_{peak}. Note: A blast event may comprise the detonation of one or more charges in a period not exceeding three seconds.	
DES3.8 **RC1.18**	The Guideline vibration limits set out in DIN 4150-3:1999 must be complied with for all blast events at all neighbouring buildings and infrastructure unless varied in accordance with designation condition 3.10 and resource consent condition 1.20.	5.2
DES3.9 **RC1.19**	Construction activities shall comply with the Guideline vibration limits set out in DIN 4150-3:1999 unless varied in accordance with designation condition 3.10 and resource consent condition 1.20.	5.2
DES3.10 **RC1.20**	The Guideline vibration limits set out in DIN4150 must not be exceeded except where the Consent Holder can demonstrate to the prior satisfaction of the Council:	7.2
DES3.10(a) **RC1.20(a)**	that the receiving building(s) are capable of withstanding higher levels of vibration and what the new vibration limit is. The investigation required to demonstrate this must include an assessment of the building(s) by a suitably experienced and qualified structural engineer and a full pre-condition survey; and	
DES3.10(b) **RC1.20(b)**	that the Consent Holder has obtained the written agreement of the building owner(s), that a higher limit may be applied.	

Condition number	Condition	CNVMP section
DES3.11 **RC1.21**	Each CNVMP shall be implemented and maintained throughout the entire construction period. Each CNVMP shall be updated when necessary and any updated CNVMP shall be submitted to the Council in accordance with designation condition 3.1 and resource consent condition 1.8.	11.2.3

3. Roles and Responsibilities

3.1 Environmental roles and responsibilities

Each person involved in the Project has equal responsibility to avoid, remedy or mitigate adverse environmental effects. There are three key groups with responsibility for environmental management of the Project:

- Watercare as the Project owner, requiring authority, and holder of the resource consents;
- Ghella Abergeldie Joint Venture ('Ghella-Abergeldie JV') undertaking the works; and
- Auckland Council to audit the works and monitor compliance with Designation and Resource Consent Conditions, the CMP and sub-plans.

3.1.1 Specific roles and responsibilities

The key management roles for each organisation in relation to this CNVMP during the construction of the Project are outlined in Table 2. Further responsibilities are set out in the CMP.

Table 2: CNVMP responsibilities

Organisation	Role	Role Responsibilities
Watercare Services Limited	Requiring Authority, Consent Holder and Project Manager	• Overall responsibility for project compliance and performance in relation to environment, quality assurance and incident management. •
Ghella Abergeldie Joint Venture	Project Director	• Overall responsibility for site environmental management. • Review and approve all relevant management plans.
	Stakeholder and Communications Manager	• Responsible for notifying residents of works occurring within the near vicinity and managing mitigation as required. • Disseminates information to the public as approved by Watercare.
	Environmental Manager	• Monitoring day to day construction noise and vibration levels as required • Monitoring noise and vibration levels following complaints
	Project & Site Engineers	• Development, management, and monitoring of construction procedures, including incorporating environmental and sustainability requirements. • Overseeing subcontractors.
Subcontractors	Site Managers	• Adherence to the CNVMP and any ASCNMPs
	Acoustic Specialist	• Monitoring noise and vibration levels generated from construction activity. • Updating mitigation and management measures based on new information.

3.1.2 Contact details

Contact details for those with key responsibilities in the implementation of this CNVMP including the Communication Manager are provided in the Table 3 below.

A Project representative will be contactable during works and contact details provided in communication to adjacent residents.

Table 3: Key contacts

Role	Name	Contact Details
Watercare Services Limited, Private Bag 92 521 Wellesley Street, Auckland, 1141		
Engineer to Contact	Tony Parsons	P: +64 27 447 3737 E: *Tony.Parson@water.co.nz*
Compliance Advisor	Xenia Meier	P: 021 574 585 E: *Xenia.Meier@water.co.nz*
Ghella Abergeldie Joint Venture, PO Box 10354, Dominion Road, Auckland, 1024		
Project Director	Francesco Saibene	P: 021 0882 7237 E: *APupi@ghella.com*
Construction Manager	Stefano Vittor	P: 021 630 355 E: *SVittor@ghella.com*
Key Relationships Manager	Lesley Hopkins	P: +64 27 414 351 E: *LHopkins@ga-jv.com*
Environmental Manager	Sandra Edwards	P: +64 27 366 3884 E: *sedwards@ga-jv.com*
Communications Manager	Carol Moffatt	P: +64 27 703 0672 E: *CMoffatt@ga-jv.com*

4. Project Description

This section provides a summary of the proposed works at Keith Hay Park construction site that are relevant to this CNVMP. A detailed description of the construction works is provided in the CMP.

4.1 Project background

The Central Interceptor main project works involve the construction and commissioning of a bulk wastewater interceptor and associated activities. This CNVMP relates to effects during the construction phase.

The Project involves constructing a 13 km gravity sewer tunnel with two link sewer tunnels extending from the main tunnel westward, a series of connections to the existing trunk sewer network to pick up wastewater flow, and a new pump station at the Māngere WWTP. Figure 2 provides a general location plan.

Figure 2: Central Interceptor location plan

4.2 Keith Hay Park shaft site

The Keith Hay Park site is located in close proximity to the Keith Hay Park sports facilities complex, parks, recreational areas and the playground of the Waikowhai Intermediate School.

The shaft location directly borders a number of neighbouring residential properties and also has a popular cycle path transecting the site footprint. The site will have a single access and egress point which will be marshalled during attended periods.

Enabling and construction works will take place over a period of 14 months, commencing in January 2020 and finishing in March 2021. As the works are independent of the TBM tunnelling until the final connection is made, there is no break in construction activities at this site. The final connection will be made from within the tunnel. The overall period of site establishment has been minimised.

Figure 3: Keith Hay Park site location

4.3 Works and sequencing

Details of the construction work and the staging for Keith Hay Park are provided in the CMP. The proposed construction programme for each phase of the project and the anticipated dates are provided in Table 4.

Table 4: Construction Programme

Construction works	Indicative start date	Indicative finish date
Main site setup	Mid-Jan-2020	Late-Feb-2020
Piling platform	Early-Apr-2020	Early-Apr-2020
Drill shaft	Late-Apr-2020	Late-May-2020
Install GRP liner and finish shaft top	Late-May-2020	Early-Jul-2020
Control chamber and manhole	Early-Jul-2020	Early-Aug-2020
Short pipejacks at shaft	Early-Aug-2020	Late-Jan-2020
Construct bifurcation chamber (MH2A)	Early-Aug-2020	Late-Sep-2020
Plant room construction	Early-Aug-2020	Late-Sep-2020
Construct Branch 9B chambers	Early-Oct-2020	Late-Oct-2020
Construct bifurcation chamber (MH84B)	Early-Dec-2020	Mid-Jan-2021
Pipe installation for Branch 9	Mid-Jan-2021	Late-Jan-2021
Temporary site reinstatement	Mid-Feb-2021	Mid-Mar-2021
TBM arrival at shaft	Late-Oct-2022	-
Shaft/tunnel connection (from main tunnel)	Late-Mar-2023	Late-Apr-2023
Commissioning	Late-Nov-2023	-

4.4 Hours of operation (DES8.1 and RC1.10)

The allowable hours of construction are defined as per conditions RC1.10 and DES8.1.

5. Noise and Vibration Limits

5.1 Noise limits (DES3.2 and RC1.12)

The construction noise limits for the Project are defined in DES3.2 and RC1.12.

Construction noise shall be measured and assessed in accordance with NZS6803:1999 Acoustics – Construction Noise and shall comply with the noise limits in Table 5 at occupied buildings, unless otherwise allowed through an ASCNMP.

Table 5: Construction Noise Limits

Time and Day	Noise Limits
Monday to Saturday 0730 – 1800	70 dB L_{Aeq}
	85 dB L_{AFmax}
At All Other Times and Public Holidays	45 dB L_{Aeq}
	75 dB L_{AFmax}

Construction activities will not commence until 0730, however toolbox meetings, administration tasks and setup may be conducted between 0700 and 0730.

5.2 Vibration limits (DES3.8, DES3.9, RC1.18 and RC1.19)

The construction and blasting vibration limits for the Project are defined in DES3.8, DES3.9, RC1.18 and RC1.19.

Construction activities shall comply with the Guideline vibration limits set out in German Standard DIN 4150-3:1999 "*Structural vibration – Part 3: Effects of vibration on structures*", unless varied in accordance with RC1.20. The short-term (transient)[1] vibration limits in Figure 4 apply at building foundations in any axis. The vibration limits in all other cases are summarised in Table 6.

[1] Short-term (transient) vibration is "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*"

Figure 4: Short-term (transient)[1] vibration at building foundations (DIN 4150-3 1999: Figure 1)

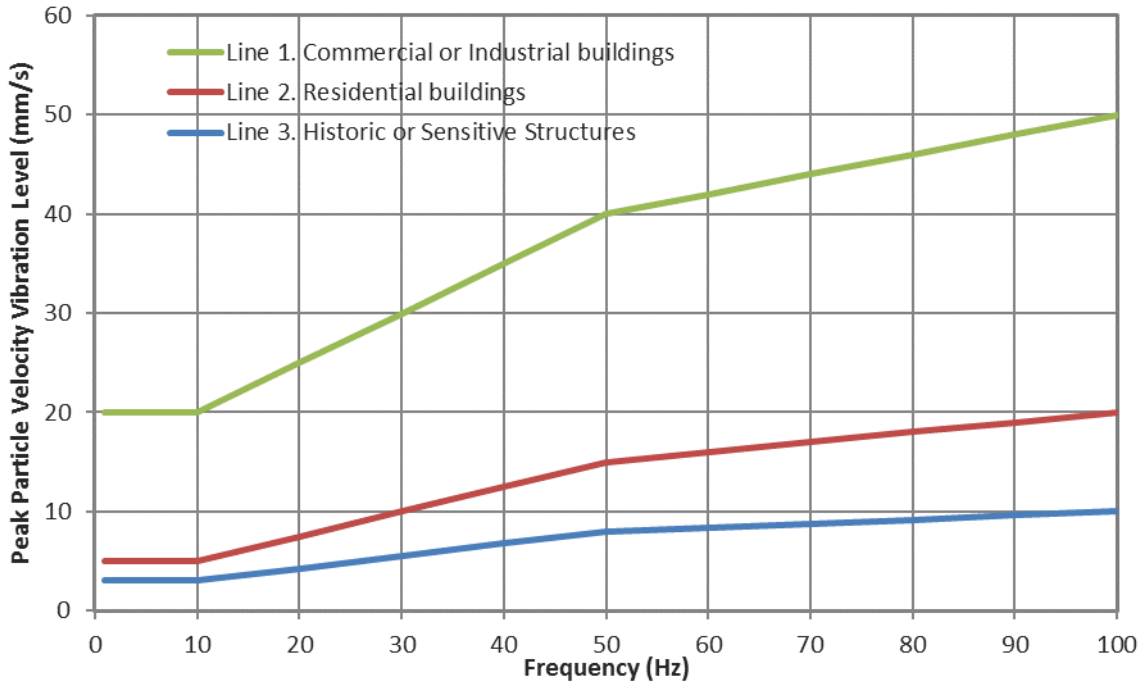


Table 6: Vibration at horizontal plane of highest floor (DIN 4150-3 1999: Tables 1 and 3)

Structure Type		Peak Particle Velocity Vibration Level (mm/s)	
		Short-term (transient)[1]	Long-term (continuous)[2, 3]
Line 1.	Commercial or Industrial buildings	40	10
Line 2.	Residential buildings	15	5
Line 3.	Historic or Sensitive Structures	8	2.5

The criteria relate to the avoidance of cosmetic building damage, such as cracking in paint or plasterwork. Cosmetic building damage effects are deemed 'minor damage' in the Standard and can generally be easily repaired. The cosmetic building damage thresholds are much lower than those that would result in structural damage. The Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*."

[2] Long-term (continuous) vibration includes types not covered by the short-term vibration definition
[3] The long-term (continuous) criteria can apply at all floor levels, but levels are normally highest at the top floor

6. Construction Equipment

6.1 Noise sources (DES3.4(a), DES3.4(b), RC1.14(a) and RC1.14(b))

Table 7 and Table 8 provide indicative construction noise levels for proposed activities with and without noise barriers. It will be used by the Construction Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when. It will be kept up to date by the Acoustic Specialist when new information becomes apparent through noise monitoring or other means.

Table 7: Indicative noise levels at 1m from a building façade[4] without noise barriers

Equipment	Sound Power Level (dB L_{Aeq})	Noise Level (dB L_{Aeq})			Setback (m)
		10 m	20 m	50 m	70 dB L_{Aeq}
Dingo with auger attachment	98	73	67	58	14
Chainsaw	114	89	83	74	69
Wood chipper	124	99	93	84	174
Franna	103	78	72	63	25
Roller	103	78	72	63	25
14t rock breaker	121	96	90	81	132
30t rock breaker	121	96	90	81	132
14t excavator	103	78	72	63	25
30t excavator	103	78	72	63	25
30t sheet piling	116	91	85	76	83
Drilling rig	114	89	83	74	69
50t crawler crane	98	73	67	58	14
100t mobile crane	98	73	67	58	14
8-wheel tip truck	91	66	60	51	6
Concrete pump	103	78	72	63	25
Concrete saw	115	90	84	75	76
Desander	110	85	79	70	48

[4] In accordance with the requirements of NZS 6803: 1999 (Section 5.1), inclusive of 3 decibels façade reflection

Table 8: Indicative noise levels at 1m from a building façade[5] with effective noise barriers[6]

Equipment	Sound Power Level (dB L_{Aeq})	Noise Level (dB L_{Aeq})			Setback (m)
		10 m	20 m	50 m	70 dB L_{Aeq}
Dingo with auger attachment	98	63	57	48	4
Chainsaw	114	79	73	64	28
Wood chipper	124	89	83	74	69
Franna	103	68	62	53	8
Roller	103	68	62	53	8
14t rock breaker	121	86	80	71	52
30t rock breaker	121	86	80	71	52
14t excavator	103	68	62	53	8
30t excavator	103	68	62	53	8
30t sheet piling	116	81	75	66	33
Drilling rig	114	79	73	64	28
50t crawler crane	98	63	57	48	4
60t mobile crane	98	63	57	48	4
8-wheel tip truck	91	56	50	41	2
Concrete pump	103	68	62	53	8
Concrete saw	115	80	74	65	30
Desander	110	75	69	60	18

6.2 Vibration sources (DES3.6(a), DES3.6(c), RC1.16(a) and RC1.16(e))

Table 9 provides indicative construction vibration levels for proposed activities that have the potential to result in vibration in building structures. It will be used by the Construction Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when. It will be kept up to date when new information becomes apparent through vibration monitoring or other means.

Table 9: Indicative distances to comply with vibration limits at building foundations

Equipment	Cosmetic Building Damage Setback (m) [7]		
	Heritage 2.5 mm/s PPV	Residential 5 mm/s PPV	Commercial 10 mm/s PPV
Vibratory Roller	30	14	6
Rock Breaker	16	10	7

[5] In accordance with the requirements of NZS 6803: 1999 (Section 5.1), inclusive of 3 decibels façade reflection

[6] Assuming 10 decibels shielding from effective noise barriers (Section 8.4.3)

[7] Based on regression analysis of available vibration measurements, plus a 100% safety factor

Equipment	Cosmetic Building Damage Setback (m) [7]		
Sheet Piling	30	11	4
Drilling	2	1	1
Excavator	15	4	1

6.3 Receiver specific noise and vibration limits

There are no receiver specific noise and vibration limits for the work at Keith Hay Park.

7. Noise and Vibration Levels

This section provides details of the noise and vibration receivers for the Project which are predicted to be non-compliant with the noise and vibration limits set up by the consent conditions. Details of addresses, building classification and locations are provided below.

7.1 Noise receivers and levels (DES3.5 and RC1.15)

7.1.1 Tree Removal (DES3.5 and RC1.15)

During site establishment several trees are to be removed. This requires the use of chainsaws and a woodchipper. These activities are predicted to exceed the noise limits at the adjacent buildings.

An ASCNMP is considered necessary for these activities and will be submitted to Auckland Council for approval 7 working days prior to the proposed work commencing in accordance with condition DES3.5 and RC1.15. Consultation will be undertaken with adjacent landowners affected by the exceedance and their written endorsement included. A template of an ASCNMP has been included in **Appendix A**.

The table below presents the buildings where exceedances are predicted and the worst-case noise levels including 3.0m high temporary noise barriers near the equipment. Additional mitigation and management measures will be implemented as part of the ASCNMP.

Table 10: Tree removal noise levels

Location	Occupancy	Noise Level
47 Arundel Place	Dwelling	75 dB L_{Aeq}
47A Arundel Place	Dwelling	71 dB L_{Aeq}
63C Arundel Place	YMCA Cameron Pool	77 dB L_{Aeq}
63B Arundel Place	Tristar Gym	78 dB L_{Aeq}
18 Gregory Place	Dwelling	71 dB L_{Aeq}
19 Gregory Place	Dwelling	73 dB L_{Aeq}

7.1.2 Sheet piling (DES3.5 and RC1.15)

Sheet piling might be required for the shaft, chamber and manhole construction. It is predicted to exceed the noise limits at the adjacent buildings.

If this activity is required, an ASCNMP is considered necessary and will be submitted to Auckland Council for approval 7 working days prior to the proposed work commencing in accordance with condition DES3.5 and RC1.15. Consultation will be undertaken with adjacent landowners affected by the exceedance and their written endorsement included. A template of an ASCNMP has been included in **Appendix A**.

The table below presents the buildings where exceedances are predicted and the worst-case noise levels without mitigation. Management measures will be implemented as part of the ASCNMP.

Table 11: Sheet piling noise levels

Location	Occupancy	Noise Level
47 Arundel Place	Dwelling	72 dB L_{Aeq}

47A Arundel Place	Dwelling	78 dB L_{Aeq}
56 Frost Road	Commercial	74 dB L_{Aeq}
58 Frost Road	Commercial	81 dB L_{Aeq}
16 Gregory Place	Dwelling	75 dB L_{Aeq}
17 Gregory Place	Dwelling	78 dB L_{Aeq}
18 Gregory Place	Dwelling	78 dB L_{Aeq}
19 Gregory Place	Dwelling	84 dB L_{Aeq}
Mount Roskill Grammar School	School	73 dB L_{Aeq}
59B Stamford Park Road	Dwelling	73 dB L_{Aeq}
61 Stamford Park Road	Dwelling	74 dB L_{Aeq}
73 Stamford Park Road	Various Dwellings	74-76 dB L_{Aeq}
13 Vic Butler Street	Dwelling	71 dB L_{Aeq}
15 Vic Butler Street	Dwelling	73 dB L_{Aeq}
17 Vic Butler Street	Dwelling	73 dB L_{Aeq}

7.1.3 Shaft Drilling (DES3.5 and RC1.15)

Shaft drilling is predicted to exceed the noise limits at the adjacent buildings. An ASCNMP is considered necessary for this activity and will be submitted to Auckland Council for approval 7 working days prior to the proposed work commencing in accordance with condition DES3.5 and RC1.15. Consultation will be undertaken with adjacent landowners affected by the exceedance and their written endorsement included. A template of an ASCNMP has been included in **Appendix A**.

The table below presents the buildings where exceedances are predicted and the worst-case noise levels without mitigation. Mitigation and management measures will be implemented as part of the ASCNMP.

Table 12: Shaft noise levels

Location	Occupancy	Noise Level
47A Arundel Place	Dwelling	75 dB L_{Aeq}
18 Gregory Place	Dwelling	76 dB L_{Aeq}
19 Gregory Place	Dwelling	75 dB L_{Aeq}

7.2 Vibration receivers and levels (DES3.9, DES3.10, RC1.19 and RC1.20)

No exceedances of the vibration limits are anticipated.

8. Construction Noise and Vibration Mitigation and Management

This section summarises noise and vibration mitigation and management measures. Where an exceedance of the noise limits is predicted activity specific noise management measures will be detailed in the relevant ASCNMP.

8.1 Consultation (DES3.4(g)and RC1.14(g))

General communication measures are detailed in 10.1 of this plan. Specific communication in relation to exceedances will be described in each ASCNMP (refer to **Appendix A** for the template).

As part of the ASCNMP, consultation with affected parties to understand their sensitivities, including times, activities and locations will be undertaken. Consultation will focus on a collaborative approach to managing the adverse effects from construction noise and vibration.

A project representative will be contactable during works.

Table 13 identifies sensitive receivers where noise is predicted to exceed the performance standards.

Table 13: Sensitive receivers

Address	Occupancy
43 Arundel Place, Mount Roskill	Dwelling
47 Arundel Place, Mount Roskill	Dwelling
47A Arundel Place, Mount Roskill	Dwelling
63C Arundel Place, Mount Roskill	YMCA Cameron Pool
63B Arundel Place, Mount Roskill	Tristar Gym
56 Frost Road, Mount Roskill	Commercial
58 Frost Road, Mount Roskill	Commercial
16 Gregory Place, Mount Roskill	Dwelling
17 Gregory Place, Mount Roskill	Dwelling
18 Gregory Place, Mount Roskill	Dwelling
19 Gregory Place, Mount Roskill	Dwelling
Mount Roskill Grammar School, Mount Roskill	School
59B Stamford Park Road, Mount Roskill	Dwelling
61 Stamford Park Road, Mount Roskill	Dwelling
73 Stamford Park Road, Mount Roskill	Various Dwellings
13 Vic Butler Street, Mount Roskill	Dwelling
15 Vic Butler Street, Mount Roskill	Dwelling
17 Vic Butler Street, Mount Roskill	Dwelling

8.2 Specific noise mitigation measures (DES3.4(d) and RC1.14(d))

8.2.1 Site Boundary Noise Barrier

A 4.0m high noise barrier will be installed along the southern boundary of the site and a 2.4m high noise barrier will be installed along the northern boundary of the site as shown in Figure 5. The smaller pipe jacking sites along Keith Hay Park will have 2.4m high noise barriers facing the dwellings to the south as shown in Figure 6 and Figure 7. These barriers will enable general site activities to comply with the noise limits.

Figure 5: Main site noise barriers

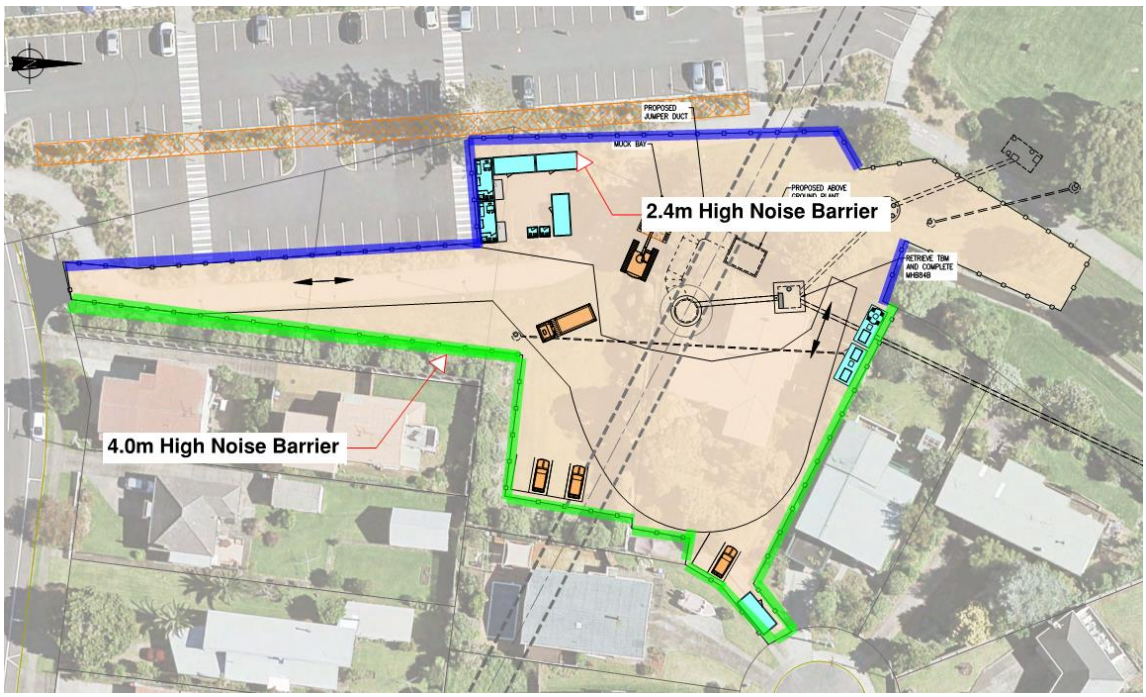


Figure 6: Pipe Jacking Noise Barriers

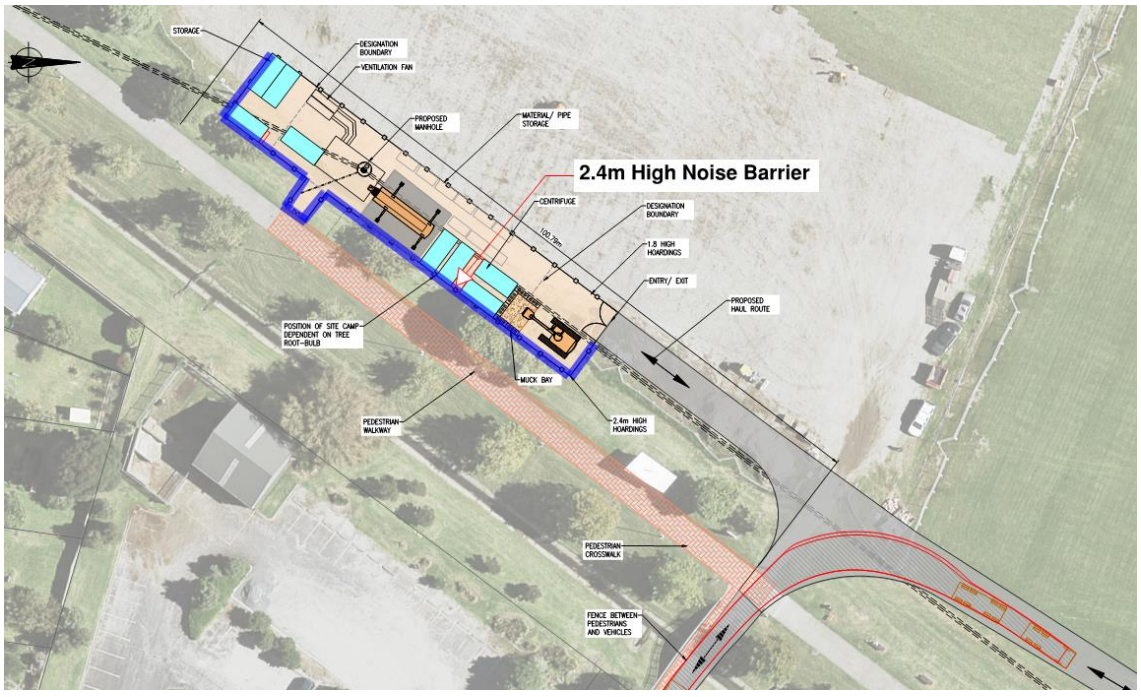
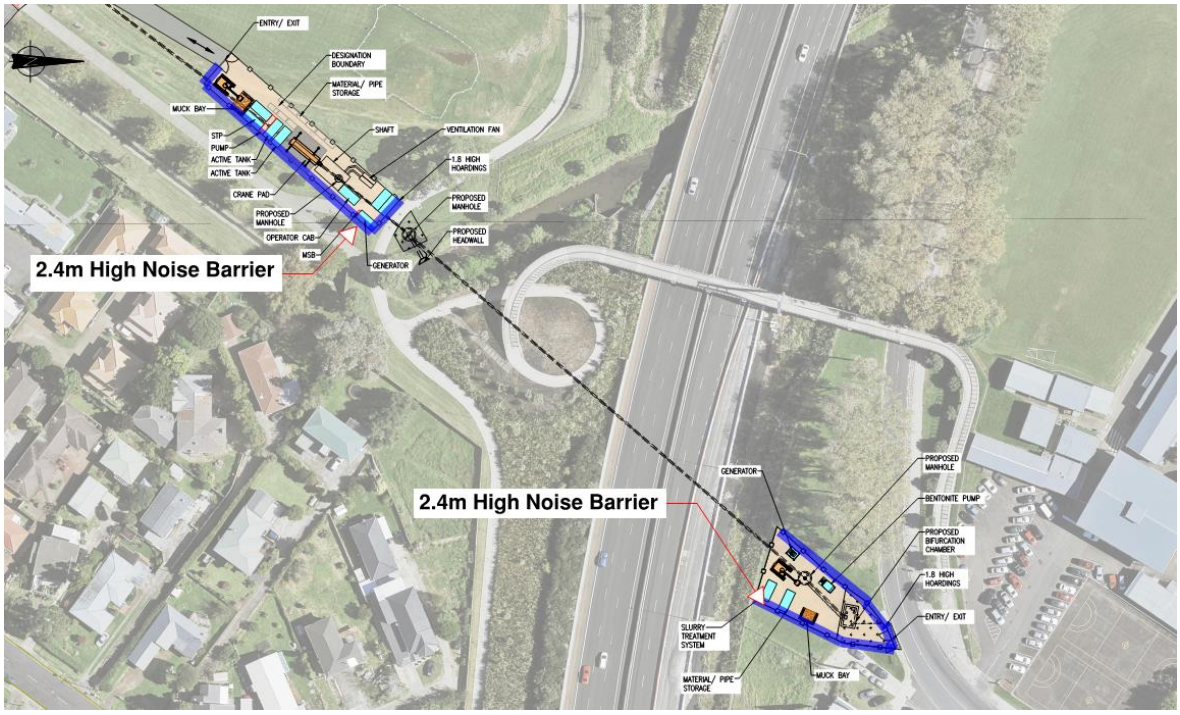


Figure 7: Pipe Jacking Noise Barriers



8.3 Specific vibration mitigation measures (DES3.6(e) and RC1.16(e))

8.3.1 Vibratory roller

For vibratory roller activities the following measures shall apply:

- Prioritise the use of static rollers over vibratory rollers or switch off the vibration function within predicted safe setback distances (Section 6.2);
- Match the size of roller to the scale of the works (i.e. large enough to undertake the works efficiently, but avoiding oversized units); and
- Match the vibration output to the scale of the works (i.e. combination of minimising the amplitude of the drum vibration and/or maximising the vibration frequency of operation).

8.4 General noise and vibration mitigation and management

8.4.1 General mitigation measures (DES3.4(e) and RC1.14(e))

Complaints can arise whether or not noise and vibration levels comply with the limits. To avoid complaints, general mitigation and management measures include, but are not be limited to, the following:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets;
- Avoid steel on steel contact such as during the loading of scaffolding on trucks;
- Avoid high engine revs through appropriate equipment selection and turning engines off when idle;
- Maintain site accessways to avoid pot holes and corrugations;
- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly);

- Minimise construction duration near sensitive receivers;
- Stationary equipment (e.g. generators) will be located away from noise sensitive receivers and site buildings and material stores used to screen them;
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators);
- Utilise noise barriers and enclosures where appropriate (Section 8.4.3); and
- Ensure advanced communication is complete (Section 10.1) prior to commencing construction.

8.4.2 Training (DES3.4(j) and RC1.14(j))

All staff will participate in an induction training session prior to the start of construction, with attention given to the following matters:

- Construction noise and vibration limits (Section 5);
- Activities with the potential to generate high levels of noise and/or vibration (Section 6);
- Noise and vibration mitigation and management procedures (Section 8);
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation (Section 6.3); and
- Best practice for night works including;
  - Keeping doors to the shed closed
  - Taking care when handling materials; and
  - No shouting or making other unnecessary noise.

Awareness of current noise and vibration matters on, or near active worksites, will be addressed during regular site meetings and/or 'toolbox' training sessions.

8.4.3 Noise barriers (DES3.4(d) and RC1.14(d))

Temporary noise barriers will be used where a construction noise limit is predicted to be exceeded (Section 6) and the barriers would noticeably reduce the construction noise level. They will be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 10 decibels.

Where practicable, the following guidelines will be incorporated in the design and utilisation of temporary noise barriers:

- The panels will be constructed from materials with a minimum surface mass of 6.5 kg/m^2. Suitable panels include 12 mm plywood or the following proprietary 'noise curtains':
  - Duraflex 'Noise Control Barrier - Performance Series' (www.duraflex.co.nz);
  - Soundex 'Acoustic Curtain - Performance Series' (www.ultimate-solutions.co.nz);
  - Flexshield 'Sonic Curtain with 4 kg/m^2 mass loaded vinyl backing' (www.flexshield.co.nz*);*
- Alternatives will be approved by a suitably qualified acoustic specialist because some proprietary noise curtains have insufficient surface mass for general use;
- The panels will be a minimum height of 2 m, and higher if practicable to block line-of-sight;
- The panels will be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels;
- The panels will be positioned as close as practicable to the noisy construction activity to block line-of-sight between the activity and noise sensitive receivers; and
- Where positioned on the site boundary, additional local barriers will be considered near the activity to ensure effective mitigation for sensitive receivers on upper floor levels.

8.4.4 Enclosures (DES3.4(d) and RC1.14(d))

Enclosures differ from barriers in that they surround the sound source on more than one side, and usually include a 'roof'. The effectiveness of noise enclosures depends on the extent that the noise source can be enclosed without constraining the operation of the equipment and resulting in an unacceptable occupational health and safety environment (e.g. noise exposure, heat, dust, poor lighting etc). Enclosures can also result in traffic management issues and increase construction duration, particularly for short term or transient activities.

The following guidelines will be incorporated in the design and utilisation of noise enclosures where practicable and effective:

- Enclosures will be used where a noise barrier is not sufficient to achieve compliance with the noise limits and it is practicable to do so (e.g. stationary plant such as compressors, pumps, generators, air tools and concrete cutting activities)
- A suitably qualified and experienced acoustic specialist (such as MASNZ) will be involved in the enclosure design (an example is included as Figure B.3 in NZS 6803: 1999).

8.4.5 Building condition surveys (DES3.6(d) and RC1.16(d))

At this stage, no building condition surveys are required for vibration.

The Construction Manager will request in writing the approval of the property owner to undertake a building condition survey at the following times:

- Where vibration is predicted to exceed the cosmetic building damage limits (Section 5.2)
- Where vibration is measured to exceed the cosmetic building damage limits in (Section 5.2) and/or in response to a reasonable claim of damage from construction vibration (Section 10.2)
- Post construction to avoid subsequent claims of damage from construction vibration

Each building condition survey will:

- Be undertaken by a suitably qualified person;
- Provide a description of the building;
- Determine the appropriate structure type classification[8] with respect to DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"* (i.e. historic/sensitive, residential or commercial/industrial); and
- Document and photograph the condition of the building, including any cosmetic and/or structural damage.

[8] Classifications with respect to Tables 1 and 3 of DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"* (i.e. historic/sensitive, residential or commercial/industrial)

9. ASCNMPs (DES3.5 and RC1.15)

The ASCNMPs need to be compliant with condition DES3.5 and RC1.15 the following needs to apply:

Where a CNVMP predicts that noise levels from a particular activity will or will likely exceed the noise limits set out in condition DE3.2 and RC1.12, or where noise measurements show that compliance is not being achieved, the Consent Holder shall prepare and submit for the approval of the Auckland Council an ASCNMP.

Three ASCNMPs will be prepared to cover the following non-compliant activities:

- ASCNMP 1 – Tree removal
- ASCNMP 2 – Shaft drilling
- ASCNMP 3 – Sheet piling

The ASCNMPs will be submitted to Auckland Council for approval at least 7 working days prior to the proposed work commencing. Consultation will be undertaken with adjacent landowners affected by the exceedance and their written endorsement included.

10. Communication and Complaints

This section details the communication procedures relating to noise and vibration for the Keith Hay Park shaft site as well as the complaints process. The CMP and Communications Plan contain a more detailed discussion of communication activities for the Project.

10.1 Communication

Written communication (e.g. newsletter) shall be provided to occupiers of buildings within 100 m of the site at least 1 week prior to the Project works commencing. It will acknowledge that some activities are predicted to generate high noise and/or vibration levels that may result in disturbance for short periods. It will include details of the overall works, its timing, duration and contact details for where complaints and enquiries should be directed.

Written communication during the works:

- Public site signage will include contact details;
- Regular project updates will include details of impending activities that may result in disturbance, including tree removal, sheet piling and drilling. It will include scheduled timing and duration of these activities and contact details where complaints and enquiries should be directed; and
- Occupants of buildings within 100m of night works will be advised at least 5 days prior to the works commencing.

10.2 Complaints (DES3.4(i), DES3.6(h), RC1.14(i) and RC1.16(h))

All construction noise and/or vibration complaints will be recorded in a complaints file that is available to Auckland Council on request. For each complaint, an investigation will be undertaken involving the following steps as soon as practicable:

- Acknowledge receipt of the concern or complaint and record:
  - Time and date the complaint was received and who received it;
  - Time and date of the activity subject to the complaint (estimated where not known);
  - The name, address and contact details of the complainant (unless they elect not to provide);
  - The complainant's description of the activity and its resulting effects; and
  - Any relief sought by the complainant (e.g. scheduling of the activity)
- Identify the relevant activity and the nature of the works at the time of the complaint;
- If a reasonable complaint relates to building damage, inform the on-duty site manager as soon as practicable and cease associated works pending an investigation;
- Review the activity noise and/or vibration levels (Section 7) to determine if the activity is predicted to comply with the relevant performance standards (Section 5) at the complainant's building. Consider attended monitoring to verify the underlying reference level assumptions;
- If the activity is measured to be non-compliant with the noise and/or vibration limits (Section 5) the following shall be undertaken;
- Implement mitigation measures (Section 8) and undertake additional monitoring to determine compliance (Section 11.2);
- If compliance cannot be achieved, halt works and prepare an ASCNMP (if not already prepared);
- Report the findings and recommendations to the Construction Manager, implement changes and update this CNVMP or the relevant ASCNMP as appropriate; and
- Report the outcomes of the investigation to the complainant, identifying where the relief sought by the complainant has been adopted or the reason(s) otherwise.

In most cases, ceasing the activity would provide immediate relief. In some cases, this may not be practicable for safety or other reasons. The complainant shall be kept updated regularly during the time it takes to resolve the matter.

11. General Noise and Vibration Monitoring and Review

This section provides details of the methodology for noise and vibration monitoring as well as review of the CNVMP.

11.1 General noise and vibration review (DES3.4(h), DES3.6(g), RC1.14(h) and RC1.16(g))

This CNVMP shall be implemented and maintained throughout the entire construction period and updated when necessary. The CNVMP shall be updated as follows:

- When working conditions become clearer;
- Alternative construction methodologies are adopted;
- Following noise and/or vibration monitoring; and
- Yearly to ensure best practicable option is still being adopted.

Following any material updates, the CNVMP shall be issued to Auckland Council in accordance with the project conditions.

11.2 Noise and vibration monitoring (DES3.4(h), DES3.6(g), RC1.14(h) and RC1.16(g))

11.2.1 Noise monitoring

Construction noise levels will be monitored as follows:

- In accordance with the relevant ASCNMP;
- In response to a reasonable noise complaint;
- At 1m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate for a representative duration when required;
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance with the requirements of New Zealand Standard NZS 6803: 1999 “Acoustics - Construction Noise”;
- For a representative duration, reported with the measured level (e.g. 65 dB L_{Aeq} (30min)); and
- The results will be used to update Section 6.1 if appropriate.

11.2.2 Vibration monitoring

Construction vibration will be monitored:

- In response to a reasonable vibration complaint (Section 10.2);
- At the closest building foundations and/or the top floor level as appropriate where consent to access the building of interest has been requested and granted for a representative duration when required;
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance the requirements of German Standard DIN 4150-3:1999 “Structural vibration – Part 3: Effects of vibration on structures”;
- For a representative construction duration, measured in 2-second intervals; and

- The results will be used to update Section 6.2 if appropriate.

11.2.3General review of the CNVMP (DES3.11 and RC1.21)

This CNVMP should be considered as a live document. It will be updated, with the necessary approvals, throughout the course of the project to reflect material changes to construction methods, site conditions or the natural environment.

APPENDIX A - ACTIVITY SPECIFIC CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLANS

APPENDIX B - REVIEW RECORDS

Review records

The table below is a register of all construction related communication with Stakeholders, including complaints that have been received during the construction period.

Date/Time	Nature of Communicator (e.g. complaint)	Name and address of stakeholder	Details of communications	Action taken	Resolved (date)

APPENDIX C - NOISE MONITORING RECORDS

NOISE MONITORING FIELD SHEET

Monitoring Information					
Site:			**Date:**		
Address/ Location:			**Meter:**		
Reason for Monitoring	Routine	SSCNVMP Requirement	Complaint	Attenuation	Background

Site Information			
Description of Works: (Include source on noise and location of source)			
Description of Receiver:			
Background Sound (s):			
Distance Between Measurement and Source:		**Distance between Measurement and Receiver:**	

Weather			
Temperature:		**Cloud Cover (%):**	
Wind Direction:		**Rainfall:**	

Wind speed: (tick the box)
□ Calm. Smoke rises vertically (1 Km/h).
□ Smoke drift indicates wind direction. Leaves and wind vanes are stationary (1-5 Km/h).
□ Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move (6-11 Km/h).
□ Leaves and small twigs constantly moving, light flags extended (12-19 Km/h).
If wind speeds are greater than those indicated above, do not carry out monitoring.

Location Consideration	
Proximity to unrelated noise sources (e.g. road traffic)	
Height of noise sampling location (as close to 1.2m above ground surface as possible)	
Location of any reflective surfaces (e.g. walls / buildings)	

NOISE MONITORING FIELD SHEET

Monitoring Results					
Location	**Distance to Noise Source**	**Duration (Default 15min)**	**L_{Amax}**	**L_{Aeq}**	**Comments**
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
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		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	
		_ _ min	_ _ . _ dB	_ _ . _ dB	

The measurement sample should not exceed one hour. For constant sound measurement of 15 minutes will often be adequate.
Refer to Construction Noise and Vibration Management Plan and NZS 6803:1999 Acoustics - Construction Noise

Comments:

Completed By:			
Name		**Signature**	

APPENDIX D - VIBRATION MONITORING RECORDS

VIBRATION MONITORING FIELD SHEET

Monitoring Information					
Site:			**Date:**		
Address/ Location:			**Meter:**		
Reason for Monitoring	Routine	CNVMP Requirement	Complaint	Attenuation	Background

Site Information			
Description of Works			
Source of Vibration (Include details of plant)			
Description of Receiver (I.e. structure of property, foundation type)			
Ground Conditions (If Known)			
Distance between measurement and source:		**Distance between measurement and receiver:**	

Meter Positioning			
Position of Meter	Foundations	Ground	Floor
Secured to surface	Clamped	Sand bagged	Other
Other Notes			

	Monitoring Results					
ID	Start Time	Duration	Vibration Source/Activity	Distance to Source	V-SUM	Dominant Frequency
1						
2						
3						
4						
5						
6						
Comments:						

Completed By:			
Name		**Signature**	

APPENDIX E - SUSTAINABILITY ASPECTS

Sustainability Aspects

Table A below Identifies the ISCA Credit Requirements relevant to this CNVMP and where they are addressed in the documents.

Table A: ISCA Requirements

Credit	Requirement *	Relevant section	Other relevant information / comments
Noise			
DIS-2 Level 1	DIS2.1.1 Baseline studies of existing noise environment have been carried out for the project.	-	Pages 14 and 42 of Environmental Investigations Programme – Noise Impact Assessment, prepared Marshall Day Acoustic and dated 23 July 2012
DIS-2 Level 1	DIS2.1.2 Predictions for noise developed for construction	Sections 7.1	-
DIS-2 Level 1	DIS2.1.3 Measures to mitigate noise during construction have been identified and implemented	Sections 8.2 and 8.4	-
DIS-2 Level 1	DIS2.1.4 Monitoring of noise is undertaken at appropriate intervals and in response to complaints	Section 11.2.1	Refer also to the Communications Plan
Vibration			
DIS-3 Level 1	DIS3.1.1 Building condition surveys have been undertaken for properties potentially impacted by vibration	Section 8.4.5	Refer also to the Construction Management Plan
DIS-3 Level 1	DIS3.1.2 Predictions for vibration have been enveloped	Section 7.2	-
DIS-3 Level 1	DIS3.1.3 Measures to mitigate vibration during construction have been identified and implemented	Sections 8.3.1	-
DIS-3 Level 1	DIS3.1.3 Monitoring of vibration is undertaken at appropriate intervals and in response to complaints	Section 11.2.2	-

* Refer to ISCA Rating Tool for full details of the requirement.

Appendix G: CI Construction Traffic Management Plan

This document is an exact copy of the Council approved plan (with approval documentation inserted) and has been issued For Information only.

Drawings embedded in this document are from the tender package and are not to be used for construction.

Construction Traffic Management Plan

Haycock Avenue, Walmsley Park, Dundale Avenue, Keith Hay Park, Whitney Street and Miranda Reserve

Central Interceptor

Doc No: GAJV-PLN-00129 (previously CI-EN-2031)

Version: [0.4 Final]

Watercare
An Auckland Council Organisation

Ghella 5 Generations of Tunnelers
ABERGELDIE COMPLEX INFRASTRUCTURE

Sarah Blair

From: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Sent: Wednesday, 11 December 2019 3:18 p.m.
To: Tommy Ma
Cc: Sarah Blair; Lesley Hopkins
Subject: RE: Central Interceptor - CTrafficMP (Batch Two)

Thanks Tommy,

I can confirm the submitted Construction Traffic Management Plan (batch 2) is now approved.

Ngā mihi | Kind Regards

Randy Leung | Senior Compliance Monitoring Officer | Licensing & Regulatory Compliance
Auckland Council | T: +64 (09) 353 9101 | M: 027 272 0302
Location: Level 1 | 35 Graham Street | CBD Auckland
Postal: Private Bag 92300 | Wellesley Street | Auckland | 1036
mailto: randy.leung@aucklandcouncil.govt.nz |

From: Tommy Ma <tma@ga-jv.com>
Sent: Tuesday, 10 December 2019 4:32 PM
To: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Cc: Sarah Blair <sblair@ga-jv.com>; Lesley Hopkins <lhopkins@ga-jv.com>
Subject: RE: Central Interceptor - CTrafficMP (Batch Two)

Sensitivity: General

Hi Randy

Please find attached a copy of the latest amendments.

Tommy Ma
Consenting Manager – Central Interceptor
M +64 21 196 5370

Ghella Abergeldie JV
360 Dominion Road,
Mt Eden 1024, New Zealand

Table of Contents

Appendices

Revision History

Review and Approval – Beca Limited

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Prepared by	Traffic Engineer, Beca Limited	Ben Zmijewski		23/08/2019
Reviewed by	Technical Director, Beca Limited	Darren Wu		1/10/2019
Approved by	Job Director, Beca Limited	Quintin Blackburn		3/10/2019

Review and Approval – Ghella Abergeldie JV

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Co-ordinated by	Consents Manager, Ghella Abergeldie JV	Tommy Ma		10/10/2019
Reviewed by	Key Relationship Manager, Ghella Abergeldie JV	Lesley Hopkins		11/11/2019
Approved by	Project Director, Ghella Abergeldie JV	Francesco Saibene		11/11/2019

Each page of this document bears a document number and revision date. When revisions to the document are issued, the following table will be updated to show the most recent revision level. The revised document will be forwarded to the holders of controlled copies. Recipients are responsible for destroying or marking "superseded" on the previous revision.

Revision Status

VERSION	DATE	STATUS	AMENDMENT DESCRIPTION
0.1	6/09/2019	**Draft**	Draft for internal JV review
0.2	4/10/2019	**Revised draft**	Draft for Watercare review
0.3	11/11/2019	**Final**	For submission to Auckland Council for approval
0.4	05/12/2019	**Revised final**	Updated with Auckland Councils comment for approval

Where review and revision is deemed warranted, i.e. such as comments received from the Client, or where necessary to reflect changes in contractual or Project requirements, or as a result of an incident then these revisions shall be reviewed by the respective Project Manager and approved by the Construction Manager.

Distribution (Controlled Copies)

COPY #	ISSUED TO	COMPANY / POSITION	DATE
0.1	Project File	Ghella Abergeldie Joint Venture	Select Date
0.2	Client Rep	Engineer to Contract	Select Date

1. Information

1.1 Definitions and Abbreviations

Abbreviation	Detail
AADT	Average Annual Daily Traffic
AEE	Assessment of Effects on the Environment
ATOC	Auckland Transport Operations Centre
CAR	Corridor Access Request
CMP	Construction Management Plan
CoPTTM	Code of Practice for Temporary Traffic Management
CTMP	Construction Traffic Management Plan
DES	Designation Condition
LoS	Level of Service
MTBM	Micro Tunnel Boring Machine
NZTA	New Zealand Transport Agency
RC	Resource Consent
RCA	Road Controlling Authority
SSTMP	Site Specific Traffic Management Plan
TBM	Tunnel Boring Machine
TMD	Traffic Management Diagram
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan

2. Introduction

Watercare Services Limited ('**Watercare**') has a designation (Designation 9466 – Central Interceptor Main Works) and resource consents for the construction of a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them across the Manukau Harbour to the Māngere Wastewater Treatment Plant. Referred to as the Central Interceptor (or '**the Project**'), the Project arose from the Three Waters Plan which identified the need to provide trunk sewer capacity to central Auckland to provide capacity for growth, increase resilience and reduce wet weather wastewater overflows.

This plan addresses six construction sites that will provide connections to the main tunnel and link sewers. This group of sites are known as **'Batch Two'** sites. The sites are generally located around the southern and central regions of the Project and include:

- **Walmsley Park**
- **Keith Hay Park**
- **Haycock Avenue**
- **Dundale Avenue**
- **Whitney Street**
- **Miranda Reserve**

This Construction Traffic Management Plan[1] ('**CTMP**') has been prepared by Beca Limited for the Ghella Abergeldie Joint Venture ('**Ghella Abergeldie JV**' or '**the Contractor**'), the construction contractor for the Project.

2.1 Purpose (RC1.22)

The purpose of this CTMP is to outline the standards and agreed approach and measures that will be taken to mitigate, minimise and manage the traffic effects associated with construction works at the Batch Two sites of the project. The CTMP also establishes a framework that can be used to support the development of the Site-Specific Traffic Management Plans ('**SSTMP**') which, when approved by Auckland Transport, will enable physical works in the road corridor. It is generally consistent with the Traffic Assessment report prepared by Traffic Design Group as part of the resource consent application (Technical Report E of the Assessment of Effects on the Environment ('**AEE**') report). Updates have been made where the construction methodology has changed and/or where alternative measures have been identified.

This CTMP is consistent with the New Zealand Transport Agency Code of Practice for Temporary Traffic Management ('**CoPTTM**'). Where applicable, works within transport corridors will be undertaken in accordance with the National Code of Practice for Utility Operators Access to Transport Corridors (November 2011), unless otherwise agreed between the consent holder and the Corridor Manager.

In addition to addressing the site-specific management consent conditions, the CTMP describes the measures required to reduce the impacts of construction and maintain the safety of road users, active road users such as pedestrians, residents and businesses that may result from potential road closures, temporary

[1] Within this plan the term Construction Traffic Management Plan has been used to differentiate this designation/resource consent mandated plan from the traffic management plans that are required as part of the Auckland Transport process.

restrictions, detours or diversions for general traffic and buses. This will entail the implementation of strategies to maintain, or minimise the impact on, traffic capacity during weekdays and weekends, while managing the effects on project delivery.

This CTMP does not enable physical works to take place. Approved Corridor Access Requests ('**CAR**') and SSTMPs will be required for each activity to enable live works on the road corridor. Refer to Section 9 for more details.

This CTMP is a live document which may be updated during the project if traffic and working conditions change.

2.2 Scope of the Construction Traffic Management Plan

The scope of the CTMP relates to construction activities of the Central Interceptor wastewater tunnel located at the sites listed in Section 2. The CTMP specifically addresses the effects caused by the traffic activities arising from the construction methodology of the wastewater tunnel. This includes the permanent works (if any) and construction works at each site. Further details are provided in Section 7 and Section 8.

The objectives of this CTMP are in accordance with designation conditions DES5.2 and RC1.23. The conditions are listed in Section 2.6. For the avoidance of doubt, this report's reference of a CTMP is equivalent to the definition of a Traffic Management Plan ('**TMP**') as noted in the designation and resource consent conditions.

The remainder of this document is structured as follows:

- **Section 2.6** outlines the relevant Resource Consents and Designation Conditions;
- **Section 3** defines the roles and responsibilities that will apply for the Project site;
- **Section 4** outlines the Project works and summary of construction activities;
- **Section 5** details the existing conditions relevant to the Project site such as current traffic conditions, road characteristics and active road user concerns;
- **Section 6** discusses any other proposed developments that may generate additional construction traffic near the Project site during the same time period as the Project;
- **Section 7** outlines the key traffic activities associated with construction works at the Project site;
- **Section 8** details the management activities required to mitigate the anticipated impacts of construction activity;
- **Section 9** details the procedures that will apply for the operation and management, governance, development of SSTMPs, approvals and monitoring of the traffic management throughout the life of the Project; and
- **Section 10** details key stakeholders for the specific Project site, communications and engagement forums.

2.3 Construction traffic management plan philosophy and parameters

2.3.1 Philosophy

This CTMP has been developed in general accordance with the traffic management recommendations put forward in the Traffic Assessment report prepared for the resource consent application (Traffic Design Group: Technical Report E of the AEE) and consent conditions. Updates have been made where the construction methodology has changed and/or where alternative measures have been identified.

In practical terms, this means providing for the connectivity and access described in the resource consent application wherever and whenever possible and in particular for main road movements. Additional turn bans or changes to connectivity or access have been restricted to those imposed by safe operational practice, and geometric or spatial constraints for traffic management.

Concurrent public and private developments being undertaken in the vicinity of the Project may impact overall traffic conditions especially as developments continue to evolve. A practical approach involves assuming that the true cumulative effects of the Project may not be fully realised at the time of CTMP completion.

Monitoring will be an important aspect of this CTMP and will enable the evaluation of construction effects as the Project evolves. Given the duration of the project and the potential for changing conditions and environment, the CTMP will remain a live document to be updated when necessary.

Further to the designation and resource consent conditions, the following objectives have been set as a summary of the philosophy for this CTMP:

- Maintain safe operations and interaction between construction activities and any existing traffic movements (including active road users such as pedestrians);
- Maintain existing travel capacity and minimise the impact on travel times on roads adjacent to the work site where practicable;
- Develop and plan temporary traffic management activities with consideration for key stakeholders; and
- Remediate and maintain the current condition of road assets where damage has been directly caused by construction activity.

The full list of designation and resource consent conditions relevant to the Batch Two sites is detailed in Section 2.6.

2.4 Relationship to other Plans

This CTMP forms part of a comprehensive suite of environmental controls within the Construction Management Plan ('**CMP**') for the construction phase of the Project.

The CTMP addresses the potential traffic effects associated with construction activities at the Batch Two sites.

The management plan structure highlights the role that this document plays in complying with the specified Resource Consents and Designations as shown in Figure 1.

Additionally, the relationships between this CTMP and other traffic management related documents is shown in Figure 2 in Section 2.5.

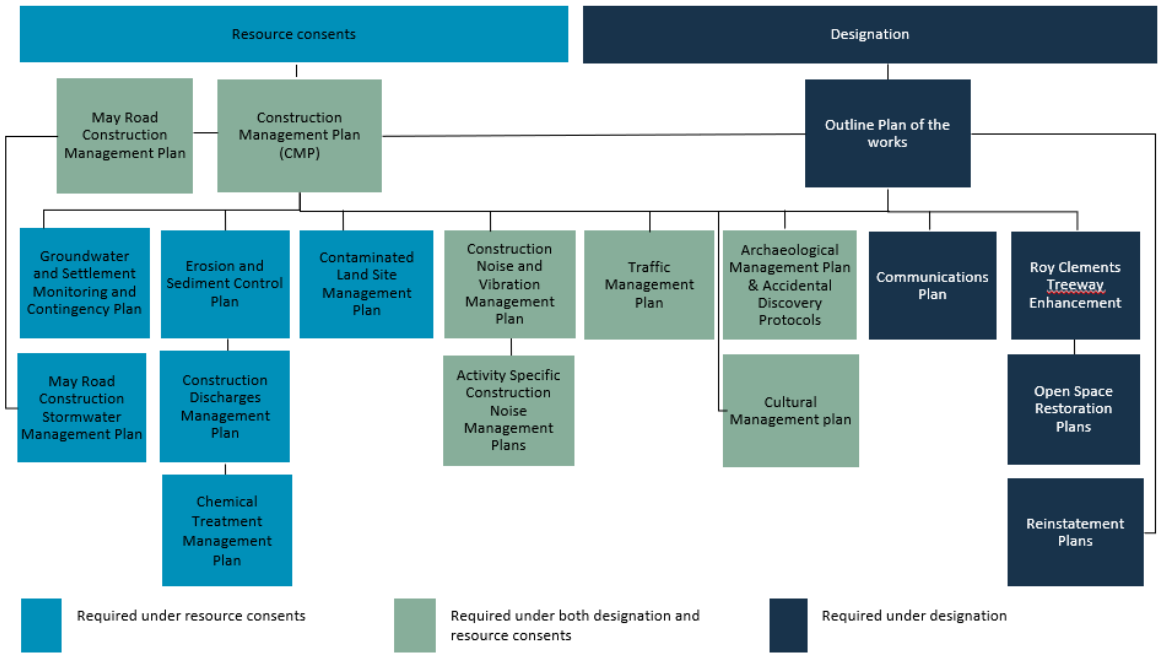


Figure 1: Construction management plan structure relevant to Batch Two sites

2.5 Sequence of traffic management documents

Figure 2 shows the relationship between the sequence of documents relating to traffic management activities. It is important to note that the CTMP does not enable physical works to take place on the road corridor but rather sets the philosophy as to how traffic management for this project, and particularly the Batch 2 sites will be addressed.

SSTMPs and Corridor Access Requests ('**CAR**') approved by Auckland Transport enable physical works to take place within the road corridor. These will be developed in accordance with the philosophy documented in this CTMP.

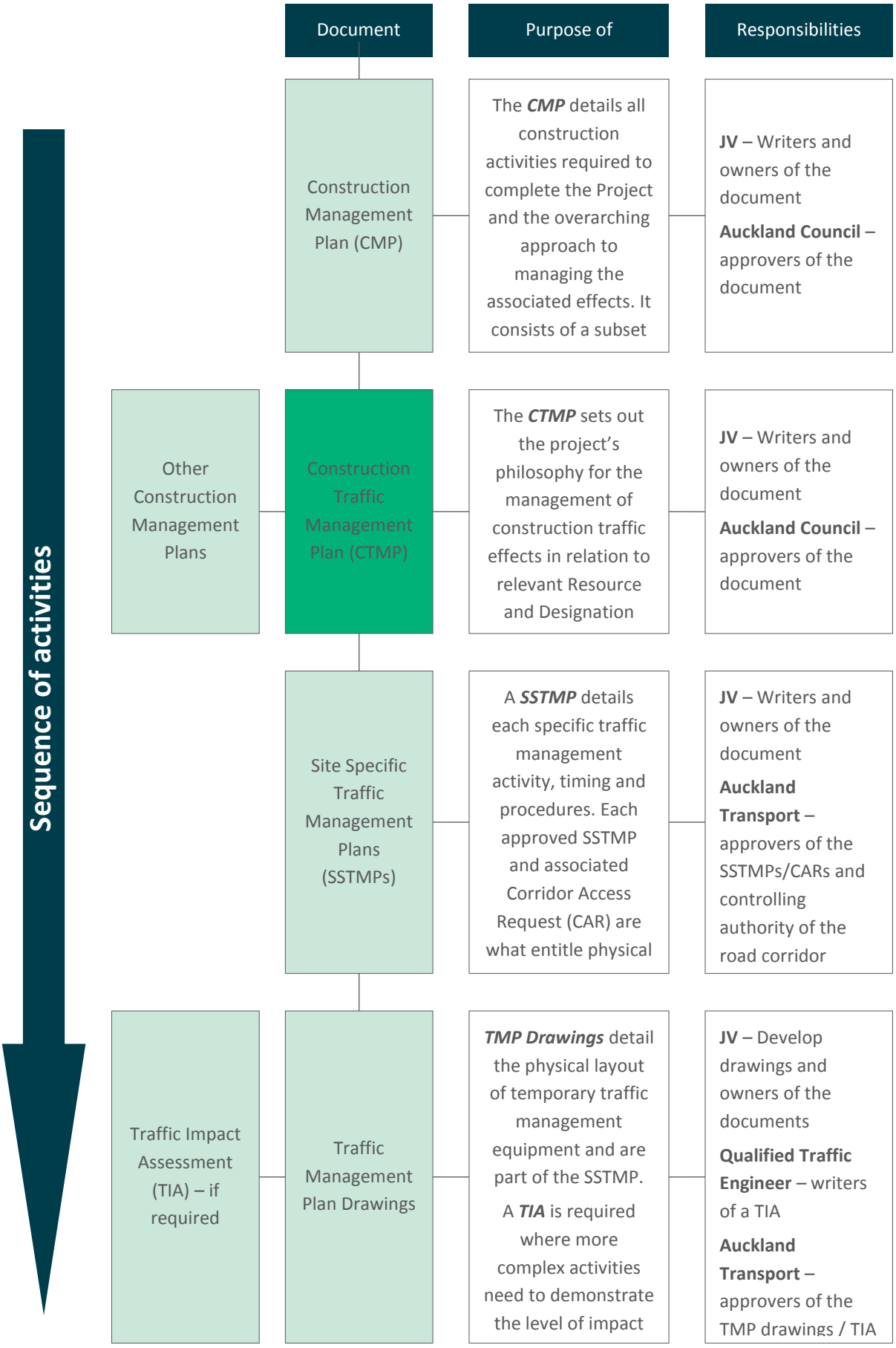


Figure 2: Sequence of activities for traffic management related documents

2.6 Consent requirements

The CTMP addresses the requirements set out in the relevant designation and resource consents conditions as detailed in Annex H – Watercare Consents Compliance Schedule (March 2019). The designation and resource consent conditions applicable to the Project and site-specific conditions are shown in Table 1.

The section of the CTMP with applicable management strategies that address each designation and resource condition are shown in Table 1.

The management strategies are in general accordance with the information provided by the Notices of Requirement 1 and 2 (August 2012) and Part D of the supporting documents submitted as part of the resource consent application including Technical Report E: Traffic Impact Assessment, prepared by Traffic Design Group (dated July 2012).

Table 1: Resource and designation consents conditions relevant to the CTMP

Condition Number	Condition	CTMP Section
RC 1.22	A detailed Traffic Management Plan (TMP) or plans shall be prepared for the Project or relevant Project stage for Council approval as part of the CMP and shall be prepared by a suitably qualified person.	2.1 3.1
DES 5.1	A detailed Traffic Management Plan (TMP) or plans shall be prepared for the Project or relevant Project stage by a suitably qualified person and submitted as part of the CMP.	3.1
DES 5.2 **RC 1.23**	The TMP(s) shall describe the measures that will be taken to avoid, remedy or mitigate the traffic effects associated with construction of the Project or Project stage. In addition to the matters described below, the site-specific traffic management Conditions 5.5 to 5.20 shall also be addressed where those site(s) are included by the Requiring Authority in the relevant Project stage. In particular, the TMP(s) shall describe:	8.2
	a) Traffic management measures to maintain traffic capacity or minimise the impact on traffic capacity during weekdays and weekends;	8.2.1
	b) Any road closures that will be required and the nature and duration of any traffic management measures that will result, including any temporary restrictions, detours or diversions for general traffic and buses;	8.2.1 8.2.2
	c) Methods to manage the effects of the delivery of construction material, plant and machinery;	8.2.2
	d) Measures to maintain, existing vehicle access to property where practicable, or to provide alternative access arrangements;	8.2.2
	e) Measures to maintain pedestrian and cyclist movements and reduce the impact on mobility impaired users on roads and footpaths adjacent to the construction works. Such access shall be safe, clearly identifiable and seek to minimise significant detours;	8.2.2
	f) Measures to manage any potential effects on children at / around education facilities;	8.2.2
	g) Measures to manage any potential construction traffic related effects on pedestrians and/or traffic associated with large-scale events in parks, reserves, Western Springs Stadium, and Mt Albert War Memorial Reserve;	8.2.1 8.2.2
	h) Any proposed monitoring to measure the impact of the works on traffic and the impact of the traffic management measures. If safety or operational issues are evident, measures to be implemented to address these issues;	3.1 9.1 9.4

	i) Measures to manage the proposed access to the site should the access be unable to cater for two-way traffic passing at the same time, and in particular to minimise reverse movements and blocking of the road; and	8.2.2
	j) The availability of on-street and off-street parking if the designated site is unable to accommodate all contractor parking. This shall include an assessment of available parking (if any) for contractors on street and identify measures to meet and/or reduce contractor parking demand should it be found that there is insufficient on-street parking to meet this demand.	8.2.1 8.2.2
DES 5.3 **RC 1.24**	The TMP(s) shall be consistent with the New Zealand Transport Agency *Code of Practice for Temporary Traffic Management,* which applies at the time of construction.	8.1
DES 5.4 **RC 1.25**	Any damage in the road corridor directly caused by heavy vehicles entering or exiting construction sites shall be repaired as within two weeks or within an alternative timeframe to be agreed with Auckland Transport.	8.2.2
DES 8.1 **RC1.10 (a) – (c)**	Construction hours shall be as follows, except where work is necessary outside the specified days or hours for the purposes specified in Condition 8.2 below. a) Tunnelling activities – 24 hours a day, 7 days a week operations for all tunnelling activities, including the main tunnel works and the link tunnels. b) General site activities – 7am to 6pm, Monday to Friday, 8am to 6pm Saturday. c) Truck movements – 7am to 6pm, Monday to Friday, 8am to 6pm Saturday, except as noted in 8.3.	8.2.1 8.2.2
DES 8.2 **RC1.10 (d) – (i)**	Purposes for which work may occur outside of the specified days or hours are: (d) where, due to unforeseen circumstances, it is necessary to complete an activity that has commenced; (e) where work is specifically required to be planned to be carried out at certain times e.g. to tie into the existing network during periods of low flow, or to tie into tidal cycles for works in the CMA; (f) for delivery of large equipment or special deliveries required outside of normal hours due to traffic management requirements; (g) in cases of emergency; (h) for the securing of the site or the removal of a traffic hazard; and/or (i) for any other reason specified in the CMP or TMP. Where any work is undertaken pursuant to paragraphs (a) – (f), the Consent Holder shall, within five working days of the commencement of such work, provide a report to Council detailing how the work was authorised under those paragraphs.	8.2.1
DES 8.3 **RC1.10(c)**	Truck movements are restricted from entering and exiting sites in proximity to schools and colleges between 8:15am and 9:15am and 2:45pm and 3:15pm Monday to Friday during school and college term times. This includes, although is not limited to the following sites: Mt Albert War Memorial Reserve, Walmsley Road, Motions Road, Pump Station 5, Lyon Avenue, and Miranda Reserve.	8.2.2
Dundale Avenue		
RC1.10(c)	Truck movements - 7am to 6pm, Monday to Friday, 8am to 6pm Saturday, except that Truck movements are restricted from entering and exiting sites in proximity to schools and colleges between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times. This includes, although is not limited to the following sites: Mt Albert War Memorial Reserve (Car Park site), Walmsley Road (AS4), Motions Road (L1S1), Pump Station 25 (L3S1), Lyon Avenue (AS2), and Miranda Reserve (L3S2).	8.2.1

Keith Hay Park		
DES 5.11	a) Contractor parking (associated with the construction works) is not permitted on Rainford Street during events and periods of high use at Keith Hay Park (including Saturdays).	8.2.2
	b) No vehicles related to the construction works shall access the Keith Hay Park site via Gregory Place during construction.	8.2.2
	c) The Requiring Authority will initiate construction driver education programmes, particularly in relation to access to adjacent community facilities.	8.2.1
Miranda Reserve		
DES 5.18	The TMP for the site shall include a suitably qualified traffic controller who will assist pedestrians across the vehicle crossing during times that vehicles are accessing the site during construction.	8.2.2
RC 1.10 (c)	c) Truck movements - 7am to 6pm, Monday to Friday, 8am to 6pm Saturday, except that Truck movements are restricted from entering and exiting sites in proximity to schools and colleges between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times. This includes, although is not limited to the following sites: Mt Albert War Memorial Reserve (Car Park site), Walmsley Road (AS4), Motions Road (L1S1), Pump Station 25 (L3S1), Lyon Avenue (AS2), and Miranda Reserve (L3S2).	8.2.1
Whitney Street		
DES 5.19	The TMP for the site shall provide safe pedestrian access to and from the local shops and across Whitney Street north of the construction site.	8.2.2
Walmsley Park		
RC 1.10 (c)	c) Truck movements - 7am to 6pm, Monday to Friday, 8am to 6pm Saturday, except that Truck movements are restricted from entering and exiting sites in proximity to schools and colleges between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times. This includes, although is not limited to the following sites: Mt Albert War Memorial Reserve (Car Park site), Walmsley Road (AS4), Motions Road (L1S1), Pump Station 25 (L3S1), Lyon Avenue (AS2), and Miranda Reserve (L3S2).	8.2.1
Pedestrian Management		
DES 6.1	Where works in parks or reserves impact on existing pedestrian or cycle ways, alternative temporary accessways shall be provided.	8.2.1
DES 6.3	Any temporary accessways shall be designed as far as practicable in accordance with CPTED (Crime Prevention Through Environmental Design) principles and provide appropriate lighting and signage where necessary.	8.2.2
RC 1.26	Where works in parks or reserves impact on existing pedestrian or cycle ways, alternative temporary accessways shall be provided. Any temporary accessways shall be designed as far as practicable in accordance with Crime Prevention Through Environmental Design ('CPTED') principles and provide appropriate lighting and signage where necessary.	8.2.1
RC 1.27 **DES 7.2**	Works within transport corridors shall be undertaken in accordance with the National Code of Practice for Utility Operators Access to Transport Corridors (November 2011), unless otherwise agreed between the Consent Holder and the Corridor Manager.	8.1

3. Roles and Responsibilities

3.1 Defined Roles and Delegated Level of Responsibility (DES5.1, DES5.2(h), RC1.22 and RC1.23(h))

General roles and responsibilities for the Project are outlined in the Construction Management Plan as referenced in Section 2.4. Specific roles and responsibilities relating to the implementation of this CTMP are detailed in Table 2.

Table 2: Batch two shaft sites roles and responsibilities

Role	Responsibility
Traffic manager	• Responsible for establishing and maintaining safe processes for all traffic management activities • Responsible for coordinating all temporary traffic management activities for the project • Responsible for preparation, submission, and coordination of all traffic management plans for the project • Responsible for arranging any Traffic Impact Assessments ('**TIA**') that are required for the SSTMP • Responsible for the management of all temporary traffic site crew and operations • Liaise with Auckland Transport (and any other Road Controlling Authority ('**RCA**') as required) throughout the process (in each of the preparation, submission and coordination phases) to ensure the best possible traffic management result for each party (principle, RCA and contractor) • Provide the approved SSTMPs to the STMS to implement on site
Site traffic management supervisor (STMS)	• Responsible for onsite implementation, maintenance and removal of the approved SSTMPs in accordance with the requirements of COPTTM • Be onsite during attended periods and monitor traffic flows • Provide feedback to the traffic manager regarding how the SSTMP is operating to the traffic manager can make any amendments to improve traffic flows or safety • Monitor the site at regular intervals (minimum of every 12 hours) to ensure that safety is maintained
Traffic controllers (TC)	• Traffic Controllers are responsible for assisting the STMS with their responsibilities and in accordance with the requirements of COPTTM
External traffic engineers and planners	• The Project may draw on a wider group of experts to undertake Traffic Impact Assessments and assist with planning and review of SSTMPs and planned Temporary Traffic Management ('**TTM**').

3.1.1 Contact details

Table 3 provides the contact details for key staff as they relate to this CTMP, along with the Project hotline, for general queries or complaints. Further Project contact details are provided in the Construction Management Plan.

Table 3: Key contacts for Batch Two sites

Role	Name	Contact Details
Watercare Services Limited **Private Bag 92 521 Wellesley Street, Auckland, 1141**		
Engineer to Contact	Tony Parsons	P: +64 27 447 3737 E: *Tony.Parson@water.co.nz*
Compliance Advisor	Xenia Meier	P: +64 21 574 585 E: *Xenia.Meier@water.co.nz*
Ghella Abergeldie Joint Venture **PO Box 10354, Dominion Road, Auckland, 1024**		
Project Director	Alfonso Pupi	P: +64 21 668 639 E: *apupi@ghella.com*
Construction Manager	Stefano Vittor	P: +64 21 633 030 E: *SVittor@ghella.com*
Key Relationships Manager	Lesley Hopkins	P: +64 27 414 351 E: *LHopkins@ga-jv.com*
Environmental Manager	Sandra Edwards	P: 027 366 3884 E: *sedwards@ga-jv.com*
Communications Manager	Carol Moffatt	P: 027 703 0672 E: *CMoffatt@ga-jv.com*
Ghella Abergeldie Joint Venture **Site managers Batch Two sites**		
Walmsley Park Site Manager	To be confirmed	To be confirmed
Keith Hay Park Site Manager	Chris Baker	To be confirmed
Haycock Avenue Site Manager	To be confirmed	To be confirmed
Dundale Avenue Site Manager	To be confirmed	To be confirmed
Whitney Street Site Manager	To be confirmed	To be confirmed
Miranda Reserve Site Manager	To be confirmed	To be confirmed

4. Project Description

4.1 Project location

Batch Two sites of the Project are located throughout southern Auckland Isthmus area in the suburbs of Mount Roskill, New Windsor, Blockhouse Bay, Hillsborough and Avondale.

The following sites are located on the main tunnel alignment of the Project:

- Walmsley Park
- Keith Hay Park

The following sites are located on Link Sewer C which connects to the main tunnel at May Road:

- Miranda Reserve
- Whitney Street
- Dundale Avenue
- Haycock Avenue

Batch Two sites and overall layout of the Central Interceptor is shown in Figure 3.

Figure 3: Central Interceptor location plan for Batch Two sites

4.2 Summary of works

The two sites on the main tunnel alignment (Keith Hay Park and Walmsley Park) are access shaft sites for which permanent access to the tunnel will be provided. Enabling and construction works at these sites ranges between 7-15 months.

The other four sites (Haycock Avenue, Dundale Street, Whitney Street and Miranda Reserve) are required for the construction of Link Sewer C. Works will consist of micro-tunnelling, pipejacking and in some cases temporary construction shafts. Enabling and construction works are expected to last between 11-19 months at these sites.

Keith Hay Park and Walmsley Park will be connected to the main tunnel of the Central Interceptor in 2023 and 2024 respectively. Link Sewer C will be connected to the main tunnel at the Haycock Avenue site in 2023.

Works will proceed in three main stages as described below. Works do not always proceed in a chronological order with tunnelling sometimes occurring alongside site reinstatement.

Stage 1 involves the enabling and construction works and includes the following items:

- Site establishment including building demolition (where required)
- Site access formation including temporary accessways and acoustic sheds

Stage 2 at each of the Batch Two sites include the following activities:

- Shaft construction
- Construction of bifurcation chambers, adjacent sewers and manholes
- Tunnel excavation through the use of the Micro-Tunnelling Boring Machine ('**MTBM**') and pipejacking

Shaft excavation and tunnelling will be performed during the consented times as per DES 8.1 and RC1.10. Micro-tunnelling for Link Sewer C will be performed over 24 hours per day, six days per week.

Spoil generated through shaft construction will be transported to Puketutu Island for all Batch Two sites. Approximately 120 loads of spoil generated at Keith Hay Park will be transported to Ridge Road Quarry, Pokeno.

Stage 3 will involve the following activities:

- Shaft/tunnel connection to the main tunnel
- Tunnel commissioning
- Site reinstatement including removal of all construction materials from site

4.3 Construction programme summary

A high-level summary of the construction programme across each of the Batch Two sites is shown in Figure 3. Works involved with livening the connection of the wastewater tunnels and commissioning have been omitted.

A detailed breakdown of the traffic activities associated with each construction stage is described in Section 7.

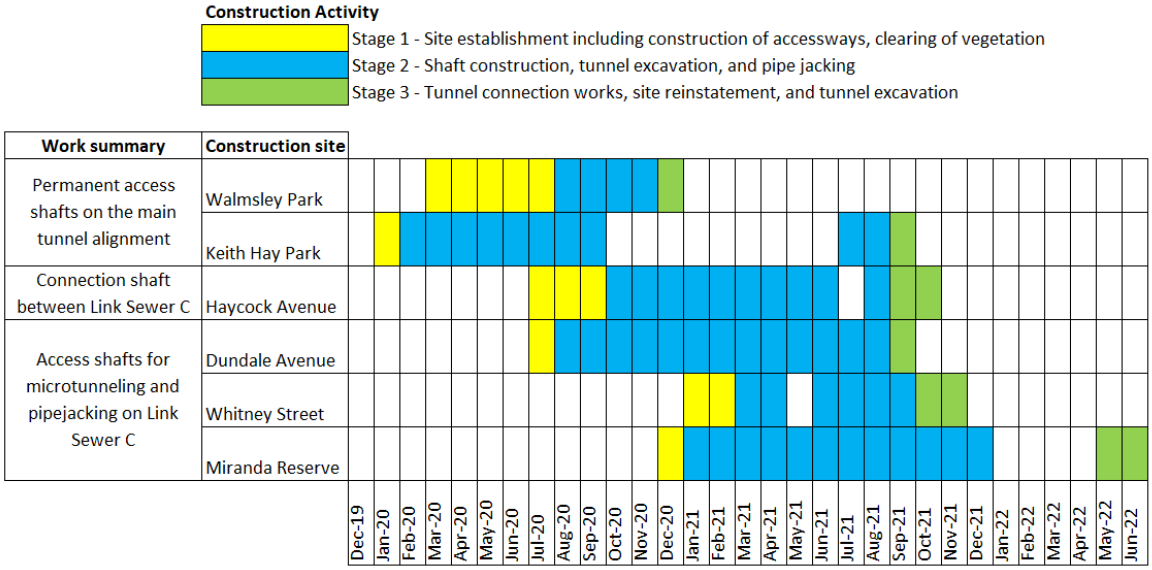


Figure 3: Construction programme summary for Batch Two sites

5. Existing Conditions

Existing conditions for each of the Batch Two sites are detailed in the following sections. Existing conditions includes the following subsections:

- Site location and land use
- Surrounding road network
- Active users including pedestrians and cyclists
- Public transport
- Freight

Site visits were carried out from 1pm - 5pm on Monday 24th June 2019 and 9am - 12pm on Tuesday 25th June 2019 for all Batch Two sites except Walmsley Park.

A site visit to Walmsley Park was carried out at 11am - 12:30pm on Friday 2nd August between. There was temporary traffic management on Sandringham Road Extension in operation during the site visit.

5.1 Site location and land use

Site location and land use describes the following items:

- Site location
- Land use as defined by the Auckland Unitary Plan
- Nearby schools
- Local shops and businesses
- Parks and reserves

Figure 4 shows the spatial proximity of construction sites to schools, local shops, and parks and reserves. Table 4 provides further description of the items listed above.

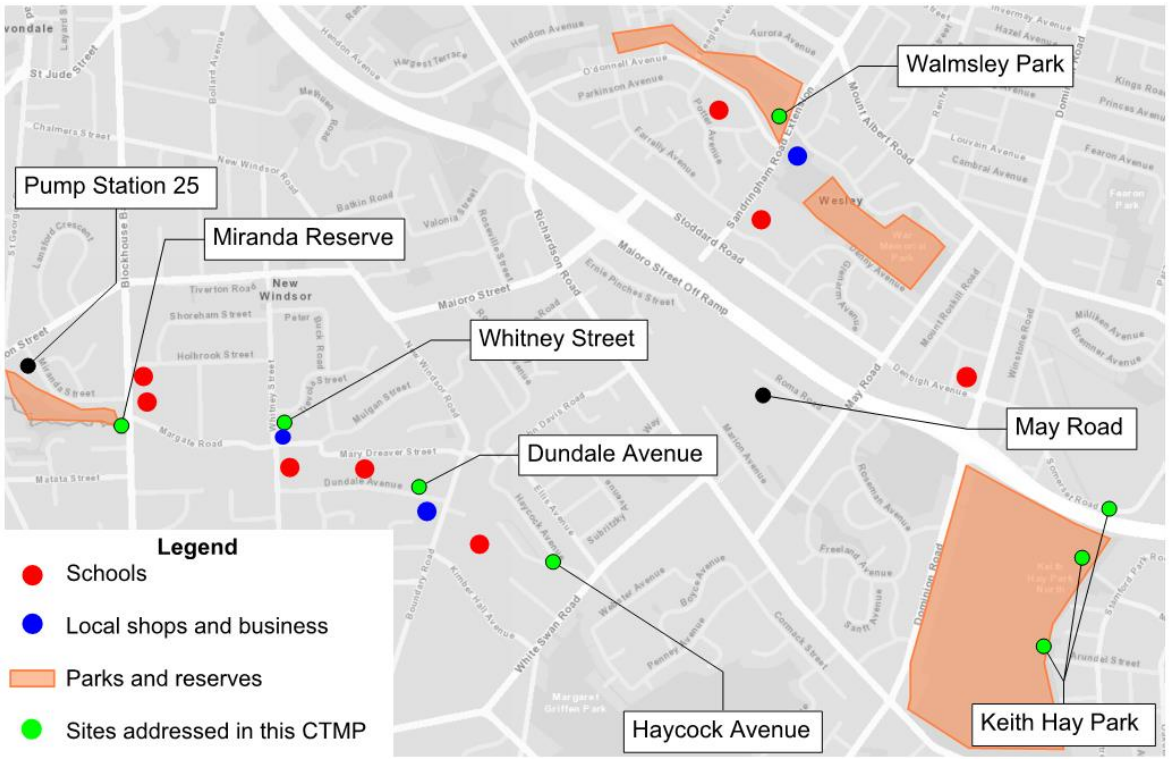


Figure 4: Location of schools, local shops, businesses and parks and reserves near Batch Two sites

Table 4: Site location and land use for the Batch Two sites

Construction site	Site location and land use	Schools	Local activities, shops and businesses	Parks and reserves
Walmsley Park	The site is located within Walmsley Park on the south side of Oakley Creek and adjacent to Sandringham Road Extension. The site is in an Open Space – Informal Recreation Zone surrounded by Residential – Terrace Housing and Apartment Buildings Zone.	Wesley Kindergarten and Wesley Primary School are located on O'Donnell Avenue 300m west of the site. Wesley Intermediate School is approximately 300 metres south of the site on Sandringham Road Extension.	The Wesley Community Centre, Roskill Youth Zone and Owairaka Athletics are very close to the site on the opposite side of Sandringham Road Extension. The Wesley Market is held every Tuesday and Friday between 7.30am - 1pm at the Wesley Community Centre.	Walmsley Park is adjacent to a site which is used recreationally. A shared pathway runs alongside the northern side of Oakley Creek. There are numerous sports fields 350m east of the site at the War Memorial Park.
Keith Hay Park	The site is located within Keith Hay Park, Hillsborough. There are four individual work sites including 49 Arundel and 20 and 22 Gregory Place, two areas near Rainford Street and a site off Frost Road north of SH20. Access to these sites is via Arundel Street, Rainford Street and Frost Road respectively. The area east of the site Residential - Mixed Housing Suburban Zone and Sport while the area west of the site is Open Space - Active Recreation Zone.	Waikowhai Intermediate School and Mount Roskill Grammar School are approximately 600m from the Arundel Street Site. Hay Park School and Hillsborough Kindergarten.	Three Kings United Football Club Cameron Pool and Leisure Centre Tri Star Gymnastics	There are numerous football fields and cricket wickets north and south of the proposed site location. There is a large amount of parking available at Keith Hay Park recreation complex and at the Keith Hay Car park on Rainford Street.
Haycock Avenue	The site is located at 2-4 Haycock Avenue in Mount Roskill 60m east of the intersection with White Swan Road. The site is surrounded by Residential – Mixed Housing Suburban Zone and Residential – Mixed Housing Urban Zone.	The Marshall Laing Primary School is located 250m from the site. There is no direct vehicle access from the school to Haycock Avenue.	There are no shops on Haycock Avenue. There is a small cluster of shops on Ellis Avenue which is the street immediately north of the site location.	A watercourse runs to the south of Haycock Avenue directly adjacent to the site boundary.

Dundale Avenue	The site is located within the grassed road reserve on the northern side of Dundale Avenue in Blockhouse Bay. The site is 170m east of the intersection with Boundary Road. There are two driveways either side of the site that provide access to properties on the northern side of the watercourse.	The Blockhouse Bay Community Church and Kindergarten are adjacent to the shaft excavation site.	There is a small cluster of shops 100m east of the site at the corner of the Boundary Road – Dundale Avenue intersection.	The grassed road reserve east of the site is the only reserve in the vicinity of the site.
Whitney Street	The site is located within the road reserve of Whitney Street, New Windsor and is 25m north of the intersection with Mulgan Street and Margate Road. The land use in the area is Residential – Mixed Housing Suburban Zone.	Glenavon School and Glenavon Early Childhood Centre are located 400m west of the site on Blockhouse Bay Road. Kids Land Educare is 180m south of the construction site on Whitney Street.	The Alpine Superette Dairy is adjacent to the proposed site.	There are no parks or reserves near the site.
Miranda Reserve	The Miranda Reserve site is located immediately south of 337 Blockhouse Bay Road, Avondale. The proposed site location for the Miranda Reserve is in the Miranda Reserve, located South of 337 Blockhouse Bay Road, Avondale. The land use is Residential – Mixed Housing Suburban Zone.	Glenavon School and Glenavon Early Childhood Centre are located 180m north of the site on Blockhouse Bay Road.	There is a small number of shops 170m south of the site on the corner of Blockhouse Bay Road and Matata Street.	The site is located within the Miranda Reserve. Construction works will require the temporary removal of the children's playground which will be reinstated as part of the site commissioning.

5.2 Surrounding road network

The surrounding road network has been described in this section. The following items are discussed:

- Road name
- Road classification (NZTA One Network Road Classification)
- Parking
- Traffic volume on each of the roads
- Typical levels of congestion during the AM and PM peak periods
- Other factors that may impact traffic mitigation measures

Traffic volumes were sourced from *http://www.trafficcounts.co.nz/* which sources its data directly from Auckland Transport's traffic count programme and database. If traffic counts were not available, *https://mobileroad.org/desktop.html* was used to determine estimated traffic volumes. Road classification and traffic volume for each road of interest is shown in Table 5.

Typical traffic conditions for arterial roads has been obtained using traffic information from Google Maps. The information provides a snapshot of typical conditions and should not be used as a basis for any level of service or performance assessments.

Observations from site visits have been used to support the description of the existing conditions in the subsequent sections.

5.2.1 Summary of the surrounding road network

All roads immediately adjacent to or near the Batch Two sites have the following characteristics:

- A posted speed limit of 50 km/h
- On-street parking is generally unrestricted near the site

A full description of each site is provided in Table 5 below with a key to the various levels of traffic congestion summarised below.

- **No congestion** – road is generally free flowing
- **Some congestion** – traffic is moderate but there no significant queues or delays
- **Moderate congestion** – traffic is heavy and slow moving queues and delays can be expected
- **Heavy congestion** – heavy traffic conditions with notable queues and delays experienced

Table 5: Road classification and traffic volume for roads near the Batch 2 site

Construction site	Road name	Road classification	Road layout	Parking	Average Daily Traffic	Typical level of congestion AM Peak	Typical level of congestion PM Peak	Comments
Walmsley Park	Sandringham Road Extension	Arterial	2-lane two-way	Parking is restricted through the use of no stopping lines	16360	Some	Moderate	Sandringham Road Extension is a school zone area near the site access. Whilst parking is restricted where the proposed site access will be, pockets of parallel car parks within close proximity nearby are still available
	Mount Albert Road	Arterial	2-lane two-way	Parking is restricted through the use of no stopping lines	19256	Moderate	Moderate	
	Gifford Avenue	Secondary collector	2-lane two-way	Restricted street parking on the northern side on Tuesday and Friday from 7am-1pm.	1768	No data available	No data available	The Wesley Market generates significant on-street parking demand. This was estimated at approximately 80% for parking areas adjacent to the Wesley Community Centre. This results in congested and often illegal parking on surrounding side streets during market times. Clearways are in place Tuesday and Friday from 7am-1pm to manage market parking demand
	O'Donnell Avenue	Primary collector	2-lane two-way	Parking available on both sides.	3838	Moderate	Moderate	Clearways are in place Tuesday and Friday from 7am-1pm to manage market parking demand
	Stoddard Road	Arterial	4-lane two-way	Parking is restricted through the use of no stopping lines	15355	Some	Some	
Keith Hay Park	Arundel Street	Secondary collector	2-lane two-way	Large car park used by the sport and recreation complex is accessed via Arundel Street	2600	No data available	No data available	

Construction site	Road name	Road classification	Road layout	Parking	Average Daily Traffic	Typical level of congestion AM Peak	Typical level of congestion PM Peak	Comments
	Stamford Park Road/Rogan Street	Primary collector	2-lane two-way		1645	No congestion	Some	
	Rainford Street	Low volume	2-lane two-way	Keith Hay Car Park is accessed via Rainford Street	100	No data available	No data available	Cul-de-sac with pedestrian access to football fields at the western end of the street
	Somerset Road / Frost Road	Arterial	2-lane two-way	Parking is restricted through the use of no stopping lines	7387	Some	No congestion	
Haycock Avenue	Haycock Avenue	Secondary collector	2-lane two-way		1395	Some	Some	Road width is approximately 7m
	White Swan Road	Arterial	2-lane two-way	Parking is restricted through the use of no stopping lines	14914	No congestion	No congestion	
	Ellis Avenue	Secondary collector	2-lane two-way		2424	Some	Some	Right turn bay from White Swan Rd into Ellis Ave
Dundale Avenue	Dundale Avenue	Secondary collector	2-lane two-way		2343	Some	Some	
	Boundary Road	Primary collector	2-lane two-way	Parking is restricted through the use of no stopping lines at the Dundale Avenue – Boundary Road intersection	4310	Some	No congestion	

Construction site	Road name	Road classification	Road layout	Parking	Average Daily Traffic	Typical level of congestion AM Peak	Typical level of congestion PM Peak	Comments
Whitney Street	Whitney Street	Primary Collector	2-lane two-way	Parking is restricted through the use of no stopping lines on both sides of Whitney Street	3630	No congestion	Some	The site is on a road with a steep grade which may impact sight distance when approaching from the north
	Margate Road	Primary Collector	2-lane two-way		6130	Some	Some	Multiple speed bumps along the length of Margate Road
	Holbrook Street	Secondary Collector	2-lane two-way		1330	No data available	No data available	Multiple speed bumps along the length of Margate Road
	Hertford Street	Access	2-lane two-way		2564	No data available	No data available	Road width is approximately 7m
	Trevola Street	Secondary Collector	2-lane two-way		1173	No data available	No data available	
	Mulgan Street	Secondary Collector	2-lane two-way		2510	No congestion	No congestion	
Miranda Reserve	Miranda St	Primary Collector	2-lane two-way		3120	Some	Some	
	Blockhouse Bay Road	Arterial	2-lane two-way	Parking is restricted through the use of no stopping lines around the Margate Road and Miranda Street intersections	12217	Moderate	Moderate	
	Margate Road	Primary Collector	2-lane two-way		5617	Some	Some	

Note: No congestion = free flowing traffic, Some = minor delays, Moderate = moderate delays, Heavy = slow, heavily congested traffic

5.3 Active users

This section describes the volume of active users such as pedestrians, cyclists and scooter riders as well as the active mode infrastructure provided within the vicinity of each Batch Two site. Active user volumes have been estimated using observations made during the site visits. Volumes noted here may differ from peak times such as school drop off and pick up times, weekends etc.

Walmsley Park, Keith Hay Park and Miranda Reserve had the highest volumes of pedestrian and cyclist traffic. This is generally due to a combination of recreational facilities such as parks or sporting complexes, shared paths and schools located near the construction site.

The volume of active mode users has been categorised for each location:

- High user volumes – the site is within or immediately adjacent to multiple and significant pedestrian generators such as schools, community centres, shared paths and recreation reserves
- Medium user volumes – the site is near some pedestrian generators
- Low user volumes – the site is not close to any significant pedestrian generators although facilities such as footpaths are still available

Table 6: Active user considerations

Construction site	Active user volumes	Active user facilities	Points of interest
Walmsley Park	High	Shared path for southbound users on Sandringham Road Ext. On road cycle lane for northbound users. There is a zebra crossing directly outside the proposed site boundary. There is a midblock pedestrian crossing located 100m south of the site.	The Wesley Market held every Tuesday and Friday generated a significant amount of pedestrian traffic Many market shoppers were observed using the zebra crossing outside the site boundary
Keith Hay Park	High	Footpaths on both sides of Arundel Street Shared path with a pedestrian crossing at the entrance to the recreation complex car park Pedestrian only bridge used to access Keith Hay Park from Rainford Street Shared path and pedestrian bridge across SH20 immediately opposite site on Frost Road	Shared path links to the SH20 Cycleway to the north Parents were observed picking up school children at the Keith Hay Car Park on Rainford Street School children at Mount Roskill Grammar School utilise the overpass bridge on SH20 to access Keith Hay Park
Haycock Avenue	Medium	Footpaths provided on both sides of the street Children crossing sign is present directly adjacent to the construction site access	The Marshall Laing School may generate increased pedestrians before and after school hours
Dundale Avenue	Low	Footpaths provided on both sides of the street Children crossing sign is present directly adjacent to the construction site access	Footpaths have been recently widened Kindergarten and community church adjacent to the site is likely to generate pedestrian traffic

Construction site	Active user volumes	Active user facilities	Points of interest
Whitney Street	Medium	Footpaths are provided on both sides of street Pedestrian crossing islands on the southern, eastern and western legs of the roundabout There is a midblock pedestrian crossing on Whitney Street adjacent to the construction site	The Glenavon School near this site is likely to generate pedestrian traffic before and after school hours Sandringham Cycleway is accessed via Margate Road and Mulgan Street
Miranda Reserve	High	Shared paths are provided on both sides of Blockhouse Bay Road. There is a footpath shared path transition point immediately next to the construction site. Midblock pedestrian crossing immediately next to the construction site Pedestrian crossing on Blockhouse Bay Road 100m north of the construction site	The Glenavon School near this site is likely to generate high volumes of pedestrian traffic before and after school hours Sandringham Cycleway is accessed via Margate Road

5.4 Public transport

The Auckland Transport bus network passes several of the Batch Two sites as shown in Figure 5. A description of the route and its proximity to the construction site is available in Table 7. Bus routes in close proximity to a site are defined as those that share a heavy vehicle construction route and are within approximately 500m of the site access.

The following construction sites have bus services that directly pass the site:

- Walmsley Park
- Whitney Street
- Miranda Reserve

The frequency of construction vehicles movements at all sites will be low. As such the effect on public transport bus operations are expected to be no more than minor.

Figure 5: Batch Two sites in relation to the Central Auckland bus network

Table 7: Public transport bus services in close proximity to the Batch Two sites

Construction site	Route name and number	Route description	Type of service	Route proximity to site
Walmsley Park	24B	Sandringham Shops, Sandringham Rd, City	Frequent, Connector	Direct
	670	New Lynn, Avondale, Stoddard Rd, Carr Rd, Onehunga, Church St, Otahuhu	Connector	In close proximity
	66	Pt Chevalier Beach, Mt Albert, Mt Roskill, Three Kings, Royal Oak, Penrose, Sylvia Park	Frequent	In close proximity
Keith Hay Park	670	New Lynn, Avondale, Stoddard Rd, Carr Rd, Onehunga, Church St, Otahuhu	Connector	In close proximity
	68	New Lynn, White Swan Rd, Blockhouse Bay, Richardson Rd, Onehunga	Frequent	In close proximity
	27W	Waikowhai, Three Kings, Mt Eden Rd, City	Connector	In close proximity
	25B	Mt Roskill, Dominion Rd, City	Frequent	In close proximity

Construction site	Route name and number	Route description	Type of service	Route proximity to site
Haycock Avenue	68	New Lynn, White Swan Rd, Blockhouse Bay, Richardson Rd, Onehunga	Frequent	In close proximity
Dundale Avenue	24B	Sandringham Shops, Sandringham Rd, City	Frequent	In close proximity
Whitney Street	107	New Lynn, Avondale Peninsula, Whitney St, Blockhouse Bay, New Lynn (one way loop)	Local	Direct
Miranda Reserve	195	New Lynn, Green Bay, Blockhouse Bay, Great North Rd, City	Connector	Direct
	209	Titirangi, Green Bay, Blockhouse Bay, Mt Albert, New North Rd, Bond St, City	Peak period	Direct

5.5 Freight

None of the Batch Two sites form part of the over-dimensional road network. There were very few to no heavy vehicles observed for freight purposes at any of the Batch Two sites. For most of the Batch Two sites, the adjacent road network comprised collector roads which are generally not used as key freight routes.

6. Concurrent projects and developments

6.1 Public and private developments

There are three known developments that may overlap with construction at some of the Batch Two sites as listed in Table 8.

The Glenavon School is currently undergoing an expansion with construction immediately west of Hertford Street. During the site visit on-street parking was being heavily utilised by construction staff. Construction of the school is expected to finish prior to site establishment works at Whitney Street.

The planned $9.2million redevelopment of Three Kings United Football Club clubhouse may cause the number of construction vehicles accessing Keith Hay Park to increase. There are currently no timelines set in place for this project with funding still needed.

Keith Hay Park may undergo development in line with Auckland Council's Puketapapa Local Board Long-Term Plan. There is no information available regarding likely construction programmes for this project.

Table 8: Known concurrent projects near Batch Two sites

Concurrent project	Description of project	Sites potentially effected
Redevelopment of Three Kings United Football Club clubhouse	Upgrade and construction of new clubhouse	Keith Hay Park
Daylighting of Keith Hay Park shared path	Upgrade of lighting along the shared path corridor that runs alongside Keith Hay Park	Keith Hay Park
Glenavon School upgrade	Upgrade of the Glenavon School	Whitney Street & Miranda Reserve

7. Batch Two sites - key traffic activities

7.1 Core temporary traffic management activities

The Project will involve construction activities at the Batch Two sites as described in Section 4. These activities will have a number of associated traffic activities that may require temporary traffic management to mitigate, minimise and manage the effects of construction traffic on the surrounding road network.

The core traffic activities that may require some level of mitigation, based on the proposed construction methodologies are:

- Partial and/or full road closures that will impact normal traffic conditions including public transport;
- Access and egress of heavy vehicles across or near pedestrian and cyclist facilities;
- Delivery of construction equipment throughout all stages of construction using heavy vehicles such as medium sized trucks, large rigid trucks and semi-trailers;
- Excavation of tunnel spoil and transfer to an appropriate drying facility depending on the moisture content of the excavated material;
- Construction of temporary and permanent site access and egress points;
- Temporary removal of parking due to site access arrangements;
- Impact on the performance of key intersections due to increased traffic volumes; and
- Parking required for construction staff and the effect on the parking capacity of the surrounding road network.

7.2 Construction traffic generation and workforce

7.2.1 Construction traffic generation

The expected number of heavy vehicle movements generated from the core traffic activities at the Batch Two sites is shown in Table 9. Vehicles used at each of the sites may include the following heavy vehicles:

- Light vehicles associated with contractors and project management staff
- Truck and trailer for spoil removal and material import
- Semi-trailer for delivery of larger items such as sheet piles and reinforcement
- Low loader for large plant delivery and pick-up

Construction vehicle movements are expected to be relatively consistent throughout each stage of construction. Heavy vehicle movements will be generally consistent throughout the day. The location for which spoil will be transferred to is also shown in Table 9.

Table 9: Estimated traffic movements for each stage of construction at Batch Two sites

Site	Heavy vehicle movements per day	Location of spoil site
Walmsley Park	5-10 per day	Puketutu Island
Keith Hay Park	• Arundel Street: 8-12 per day • Rainford Street: 5-10 per day • Frost Road: 4-8 per day	• Puketutu Island (approx. 600 loads) • Ridge Road Quarry (approx. 120 loads)
Haycock Avenue	10-15 per day	Puketutu Island
Dundale Avenue	5-10 per day	Puketutu Island
Whitney Street	5-10 per day	Puketutu Island
Miranda Reserve	5-15 per day	Puketutu Island

7.2.2 Workforce planning

Light vehicle movements for Project staff, inbound and outbound, are likely to be tidal due to staff arrivals and departures as follows:

- 80% inbound / 20% outbound distribution for light vehicles during the morning peak hour and vice versa during the evening peak hour

Construction staff numbers throughout the Project are expected to be relatively stable. All Batch Two sites will have 10-15 workers on-site at any one time except for Whitney Street which will have 5-10 workers on-site at any one time.

7.3 Special events

Special events are defined as construction activities that generate a major peak in construction traffic or a change in vehicle access that may require a further level of planning for traffic impacts. These are generally non-typical and occur infrequently over the course of the construction programme.

Special events will include the following events:

- Major delivery and pick up of large plant including piling rigs, cranes, pre-cast panels, GRP liner sections and the MTBM; and
- Large concrete pours that require a greater volume of truck movements.

7.4 Potential cumulative traffic effects

The six sites addressed in this CTMP are located within 2km of each other and are all located on Link Sewer C. May Road and Pump Station 25 sites are also in the general vicinity of the Batch Two sites. The proximity to each site is shown in Figure 6.

Construction traffic heading to and from Miranda Reserve, Whitney Street, Walmsley Park and Dundale Avenue will use the Maioro Street interchange with SH20. This interchange is well designed for large trucks and can cater for the small increase in traffic expected from the construction work at these sites.

It is highly unlikely that all six sites will be in peak operation at the same time. Given these two factors, it is expected that concurrent construction works to have a minimal impact on the operation of the entire network.

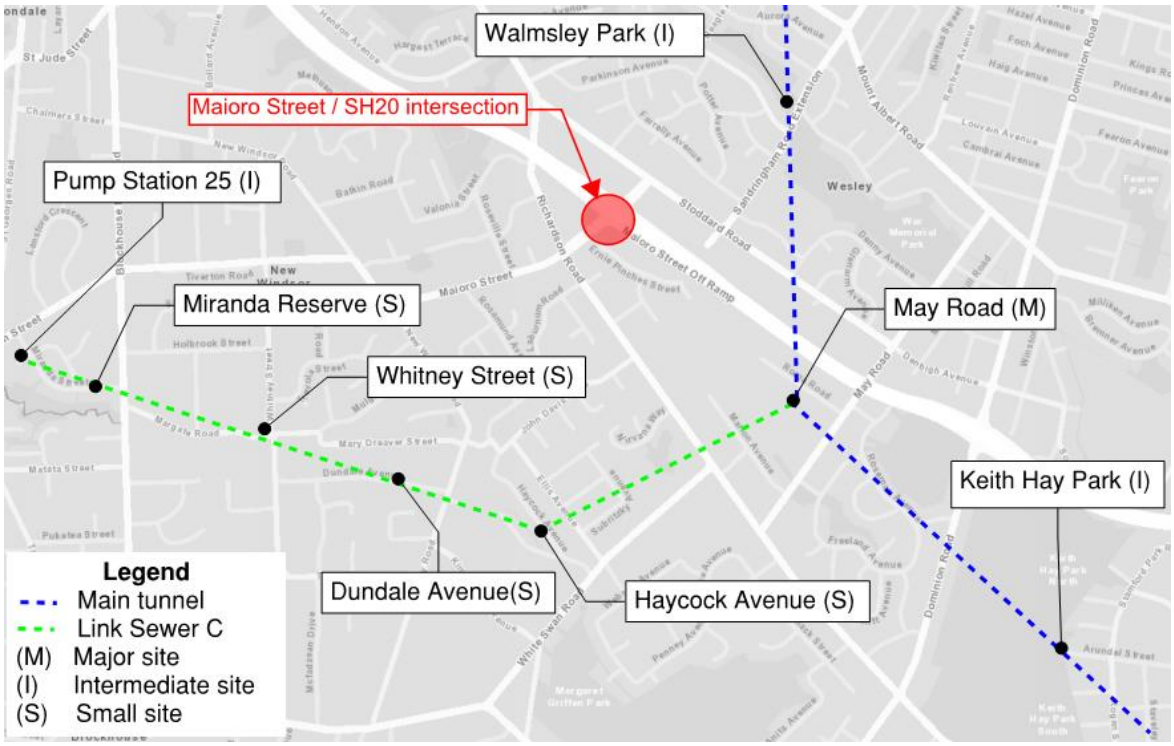


Figure 6: Batch Two and May Road sites potential for cumulative traffic effects

8. Traffic Management Strategies

This section sets out the general traffic management strategies applicable to the Batch Two sites including:

- Applied standards
- Site specific management activities
- Temporary traffic management elements

For further details on the traffic management philosophy and key parameters used to develop the strategies refer to Section 2.3. Details on the development and structure of the SSTMPs are provided in Section 9.

8.1 Applied standards (DES5.3, DES7.2, RC1.24 and RC1.27)

Temporary Traffic Management is governed by New Zealand legislation, in particular, the Land Transport Act 1998. Land Transport Rules made pursuant to that act, which relate to Temporary Traffic Management, include:

- Land Transport (Road User) Rule 2004
- Land Transport Rule: Traffic Control Devices 2004

The project shall adopt the following standards and guidelines insofar as they are relevant:

- NZTA Traffic Control Devices Manual
- CoPTTM
- National Code of Practice for Utility Operators Access to Transport Corridors (November 2011)

This document and the SSTMPs shall be consistent with the applicable version of the CoPTTM. Where it is not possible to adhere to this standard, the CoPTTM's prescribed Engineering Exception Decision process will be followed. This will include appropriate mitigation measures that shall be agreed with the Auckland Transport Asset Manager.

8.2 Site specific activities (DES5.2 and RC1.23)

This section summarises the agreed approach and measures that will be taken to mitigate, minimise and manage the traffic effects associated site-specific activities at the Batch Two sites. The agreed approach and measures will be used to inform the construction site set-up, operations and development of SSTMPs.

Section 8.2.1 provides general management strategies that are applicable to all sites to mitigate the traffic effects of construction activities.

Section 8.2.2 details site specific management strategies where the general strategies are not sufficient. In case of a conflict between general and site-specific management strategies, the site specific management strategies always take precedence.

8.2.1 General management strategies (DES5.2(a), DES5.2(b), DES5.2(g), DES5.2(j), DES5.11(c), DES6.1, DES8.1, DES8.2, DES8.3, RC1.23,(a), RC1.23(b), RC1.23(g), RC1.23(j), RC1.10, RC1.10(c) and RC1.26)

The following key traffic management activities and general management strategies are discussed in Table 10. These strategies apply to all Batch Two sites.

Table 10: General management strategies for Batch Two sites

Traffic management activity	General management strategies
Partial and/or full road closures	• Partial and/or full road closures have been avoided where possible • TIA's will be required where partial or full road closures are considered necessary for construction works to take place and where closure times are likely to result in disruption to the traffic network • SSTMPs will be developed to manage and mitigate the effects of partial and/or full road closures
Site access and egress	• Construction driver education programmes will be implemented particularly in relation to access and egress of sites adjacent to community facilities • Traffic marshals are required for all sites near significant pedestrian generators such as schools and community facilities • Any damage to the road corridor directly caused by heavy vehicles entering or exiting construction sites shall be repaired within two weeks or within an alternative timeframe to be agreed with Auckland Transport • Stop/Go traffic management is recommended to assist with the transport of large loads to the site • Left-In-Left-Out of site access points is required to mitigate uncontrolled right turns as far as reasonably practicable
Construction vehicle movements, routes and hours of operation	• Truck routes will generally follow arterial roads closest to the site with right turns occurring at either signalised intersections or roundabouts when available • Where possible, truck layover areas will be provided within the site • Temporary removal of parking on surrounding streets will occur if a truck layover area is unable to be provided on site • Larger, adjacent sites such as Pump Station 25 and May Road will be used as truck layover areas where a truck layover area is unable to be provided on surrounding streets • All over dimension vehicle routes to be agreed with Auckland Transport • Procedures shall be developed to ensure any spill of materials being transported to or from the site are contained • Major construction activities that generate peaks of traffic, such as significant concrete pours will, as far as practicable, be scheduled to avoid the morning and peak evening periods

Traffic management activity	General management strategies
	• Any works that may need to take place outside of the specified days or hours shall provide a report to Council, within five working days prior to the commencement of such work, detailing how the work was authorised under those paragraphs listed in designation consent 8.2
Traffic signals and intersection performance	• The Maioro Street interchange with SH20 is a key intersection for the Batch Two sites given the potential for cumulative traffic effects. Communicate with the Auckland System Management (ASM) in advance to advise of potential operational impacts • Monitor the performance of the Maioro Street interchange with SH20 with the Auckland Transport Operations Centre (ATOC) and review signal phasing and timing if required
Parking	• There will be minor temporary loss of on-street parking at all sites to accommodate heavy vehicle entry and exit • Traffic resolutions will be developed and approved to facilitate removal of on-street parking for the duration of the construction at each site • Workforce parking will be located within the site boundary. Each site has the following on-site parking capacity – Walmsley Park – 5 spaces – Keith Hay Park – 6 spaces – Haycock Avenue – 3 spaces – Dundale Avenue – 0 spaces – Whitney Street – 0 spaces – Miranda Reserve – Less than 5 spaces • If required, site staff overflow parking will be on residential streets near the construction site. • Full reinstatement of any car park spaces that have been impacted during construction activities
Emergency vehicle access	• Emergency vehicle access will include provisions for Fire and Emergency Services New Zealand and other specialised emergency services such as the Mines Rescue Service. • If requested by the emergency services, any vehicles within the sites will be removed to provide for emergency vehicle access. Vehicles will not be moved unless load is secured and safe to move • Emergency vehicles will have unrestricted access to the site for any emergencies that occur at ground level and when the site is attended • The emergency services (notably the Fire Service and Emergency NZ) will be notified of the appropriate contact for 24hr site access prior to the works through the Construction Management Plan and individual Traffic Management Plan application processes. • For further details of an emergency involving an excavation or tunnelling incident please refer to the Mines Emergency Plan.
Active user requirements	• SSTMPs will be developed to manage this effect with alternative access arrangements to be implemented • Temporary access in accordance with CoPTTM • Temporary detours that are as short as possible and as convenient as practicable, having regard to safety of all users • Full reinstatement of the any footpaths, shared paths or cycle paths that have been impacted during construction
Parks and reserves	• Access to parks and reserves shall be maintained at all times
Public transport	• In general, public transport near the Batch Two construction sites will be unaffected • Any temporary diversion routes will be agreed with Auckland Transport including the relocation of temporary bus stops

Traffic management activity	General management strategies
Property access	• In general, access to adjacent properties will be unaffected by construction works at the Batch Two sites • Where properties are affected at specific sites, mitigation measures have been discussed in Section 8.2.2

8.2.2 Site specific management strategies (DES5.2(b), DES5.2(c), DES5.2(d), DES5.2(e), DES5.2(f), DES5.2(g), DES5.2(i), DES5.2(j), DES5.4, DES5.11(a), DES5.11(b), DES5.18, DES5.19, DES6.3, DES8.3, RC1.10(c), RC1.23(b), RC1.23(c), RC1.23(d), RC1.23(e), RC1.23(f), RC1.23(g), RC1.23(i), RC1.23(j), RC1.25 and RC1.26)

Table 11 details the recommended site-specific management strategies required to mitigate the effects of the construction activities at each site. Site specific activities and mitigation measures are mentioned if the general management strategies do not suffice.

Table 11: Impact and mitigation of site-specific management activities at the Batch Two sites

Site affected	Site specific activity	Description of impact	Mitigation measures
Walmsley Park	Partial road closure	• Partial road closure to remove the zebra pedestrian crossing for one day in April 2020 • Partial road closure to reinstate the zebra pedestrian crossing for one day in October 2020 • Partial road closures to deliver GRP liners for one week in late-June 2020	• Partial road closures should avoid the Walmsley Tuesday and Friday market • A TIA will be completed to assess the effects of the full and partial road closures on the surrounding road network • A SSTMP will be developed to manage the effects of the partial road closure including the cycle lane • Details of the partial road closures are to be communicated to Wesley Community Centre • Pedestrian access across and on both sides of Sandringham Extension Road will be maintained at all times
	Site access and egress	• Site access and egress will be immediately north of the existing zebra pedestrian crossing	• A traffic controller will manage vehicle entry and exit movements • The pedestrian crossing will be relocated south of the site entrance. Coordination with AT and AT Metro is required to ensure there is not conflict with the bus stop on the eastern side of Sandringham Road Extension.
	Construction vehicle movements, routes and hours of operation	• The Wesley Kindergarten, Wesley Primary School and Wesley Intermediate School generate a significant number of vulnerable users near the site access • Walmsley Market generates significant pedestrian traffic and parking demand near the site on Tuesday and Friday from 7am-1pm.	• Heavy vehicle movements to and from the site will be restricted from entering and exiting the site between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times • Engage with the Walmsley Market to notify of construction works. Potential relocation of market to alternative time and/or location during periods of major construction

Site affected	Site specific activity	Description of impact	Mitigation measures
	Traffic signals and intersection performance	• Poor intersection performance due to increased heavy vehicles	• Heavy vehicles cannot turn right onto Mount Albert Road when departing from the site. Vehicles will continue north and turn right onto Balmoral Road then use Dominion Road to access SH20
	Active user requirements	• Connectivity and access of the shared path will be impacted due to site access establishment works	• An SSTMP will be developed to ensure shared path users are catered for and connectivity off the path is maintained throughout all stages of construction
	Public transport	• Heavy vehicles will impact the bus stop on the adjacent side of the road when accessing and leaving the site	• AT and AT Metro shall be engaged with on the temporary or permanent relocation of the bus stop on the eastern side of Sandringham Road Extension and regarding potential impacts resulting from heavy vehicle movements.
Keith Hay Park	**Partial and full road closures**	• Full day partial road closure of Arundel Street in late-January 2020 • Half day partial road closure of Arundel Street during late-May 2020 • Two half day full road closures of Arundel Street during mid-April and mid-May 2020. Access to Keith Hay Sporting Complex will be unavailable during full road closures for general traffic	• A TIA will be completed to assess the effects of the full and partial road closures on the surrounding road network • An SSTMP to manage and mitigate the effects of the partial and full road closures will be developed • Works requiring road closures shall be scheduled to avoid busy periods at Keith Hay Park • Early notification of full road closure events shall be communicated to Keith Hay Park users. Alternative parking arrangements made available at parking areas at Norton Road and Rainford Street • Access for residents on Arundel Street will be maintained at all times • Footpaths on both sides of Arundel Street will be maintained at all times
	Site access and egress	• Site access and egress will be via 49/51 Arundel Street for works near the Cameron Pool and Leisure Centre • Construction of manholes and bifurcation chambers at the north-eastern end of Keith Hay Park will be accessed via Rainford Street • Construction of manhole north of SH20 will be accessed via Somerset Road	• No vehicles related to the construction works shall access the Keith Hay Park site via Gregory Place during construction. • Traffic marshals will manage vehicle entry and exit movements at all points where there is a shared path and construction vehicle interaction • A long-term maintenance access will be established from Gregory Place to allow the shared path to be reinstated, and properties at 49 and 51 Arundel Street to be reinstated
	Active user requirements	• The continuity of the shared path will be impacted by the site access and egress from Arundel Street	• Connect the shared path by constructing a temporary diversion route through the car park adjacent to the site fence • A SSTMP will be developed to ensure pedestrian access to the recreation complex is maintained on the west side of Arundel Street

Site affected	Site specific activity	Description of impact	Mitigation measures
	Parking	• The area surrounding the site is heavily utilised by recreational users • Loss of 8 parking spaces in the recreational facility car park due to site establishment	• Contractor parking (associated with the construction works) is not permitted on Rainford Street during events and periods of high use at Keith Hay Park (including Saturdays) • A car-pooling area will be used for all contractor and staff parking to manage vehicles arriving at the site. The proposed area is at Radha Soami Satsang Beas, a Buddhist temple, located on the corner of the Olsen Avenue – Littlejohn Street intersection.
Haycock Avenue	**Partial and full road closures**	• Partial road closure from July 2020 to May 2021. The westbound lane of Haycock Avenue will be closed for shaft excavation works • Full road closure from May 2021 to August 2021 for the construction of the diversion chamber • The extent of both types of road closure is between Battersby Avenue and White Swan Road	• A SSTMP will be developed to ensure an appropriate alternative route is signed • Resident access will be maintained at all times from both Battersby Avenue end and White Swan Road end. • A TIA will be completed to assess the effects of the full and partial road closures on the surrounding road network • Details of full and temporary road closures are to be communicated to Marshall Laing Primary School • Pedestrian access on the northern footpath on Haycock Avenue will be maintained at all times
	Construction vehicle movements, routes and hours of operation	• The Marshall Laing Primary School is located 250m from the site.	• Heavy vehicle movements to and from the site will be restricted from entering and exiting the site between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times
	Active user requirements	• Footpaths are provided on both sides of Haycock Avenue and will continue to serve pedestrians where possible	• SSTMPs will be developed to ensure pedestrian and cyclist access is maintained on both sides of Haycock Avenue
	Site access and egress	• Limited site access, narrow residential streets, and limited forward visibility provide little room for storage of heavy vehicles	• Develop a SSTMP to ensure forward visibility and road widths are not compromised by waiting heavy vehicles • A traffic controller will manage vehicle entry and exit movements
	Parking	• Temporary loss of on-street car parking on Haycock Avenue	• An SSTMP should be developed to manage the temporary removal of parking on Haycock Avenue for the duration of construction
	Property access	• The construction site will affect access to properties directly due to the partial and full road closures	• Access for residents at the affected properties will be maintained at all times through the use of gates

Site affected	Site specific activity	Description of impact	Mitigation measures
			• Communication of special events such as large deliveries that may affect resident access shall be communicated to all residents at least 5 working days prior to construction. • The JV will continue to liaise and consult with affected residents throughout the construction period
Dundale Avenue	**Partial road closure**	• Two partial road closure events for mobilisation of the MTBM in mid-February 2021 and demobilisation in mid-June 2021	• A SSTMP will be developed to manage and mitigate the effects of the partial road closure • Pedestrian access will be maintained at all times on both sides of Dundale Avenue
	Site access and egress	• The site boundary borders the access to several community facilities located north of the watercourse	• Access to Blockhouse Bay Christian Kindergarten and Community Church will be maintained at all times • Construction driver education programmes will be provided, particularly in relation to access to adjacent community facilities • The Blockhouse Bay Community Kindergarten operates from 8:30am till 2:30pm. They will be engaged as a stakeholder to confirm heavy vehicle movement restrictions during school and college term times
	Active user requirements	• Footpaths are provided on both sides of Dundale Avenue	• Pedestrian access will be maintained at all times
	Parking	• Loss of approximately 100m of parking space on the north side of Dundale Avenue	• A SSTMP is required to allow the temporary removal of parking for site access and contractor parking
Whitney Street	**Partial and full road closures**	• Full road closure of Whitney Street for shaft excavation works from January 2021 to April 2021 • Partial road closure of the southbound lane of Whitney Street for retrieval of the MTBM from June 2021 to September 2021	• A TIA will be developed to understand the effects of both full and partial road closure events during AM and PM peak periods • A SSTMP shall be developed to manage and mitigate the effects of the full and partial road closure events
	Public transport	• Bus route 107 and two bus stops will be impacted due to the full closure of Whitney Street	• An alternative bus route along Holbrook Street – Hertford Street – Margate Road will be implemented. A TIA for Whitney Street will also assess the effects of these changes and confirm temporary bus stop arrangements with AT and AT Metro. • Relocation of the southbound bus stop north to immediately north of Holbrook Street on Whitney Street

Site affected	Site specific activity	Description of impact	Mitigation measures
			• Relocation of the northbound bus stop to immediately south of the roundabout on Whitney Street • A traffic controller will manage vehicle entry and exit movements
	Active user requirements	• Footpaths are provided on both sides of Whitney Street • The midblock pedestrian crossing on Whitney Street will be removed to accommodate construction works	• A SSTMP will be developed to manage and mitigate the effects of construction on pedestrians • Pedestrian access to and from the Alpine Superette Dairy and across Whitney Street north of the construction site will be maintained at all times • Pedestrian access will be maintained on the western side of Whitney Street at all times
	Parking	• Parking impacted due to southbound lane closure	• Alpine Superette Dairy will have parking maintained for northbound traffic only • Four on-street parking spaces for residents at 120, 122, 124 and 126 Whitney Street will be maintained at all times.
	Property access	• Properties 120, 122, 122A and 124 on Whitney Street will be impacted by the construction works	• Access for residents at the affected properties will be maintained at all times through the use of gates • Communication of special events such as large deliveries that may affect resident access shall be communicated to all residents at least 5 working days prior to construction starting • The JV will continue to liaise and consult with affected residents throughout the construction period
Miranda Reserve	**Site access and egress**	• The site is near several significant pedestrian generators with vulnerable users such as schools and shared paths	• A traffic controller will manage vehicle entry and exit movements
	Construction vehicle movements, routes and hours of operation	• Proximity of the site to Glenavon School and Glenavon Early Childhood Centre • Limited space for truck layover areas on Blockhouse Bay Road	• Heavy vehicle movements will be restricted from entering and exiting the site between 8:15 am and 9:15 am and 2:45pm and 3:15 pm Monday to Friday during school and college term times • The Glenavon Early Childhood Centre shall be engaged with as a stakeholder to confirm pick up and drop off times to ensure heavy vehicle movement restrictions are applicable • The Pump Station 25 site will be used to hold large construction vehicles to ensure they do not wait on Blockhouse Bay Road
	Active user requirements	• There are footpaths and shared paths on both sides of the Blockhouse Bay Road. There is a	• Footpaths and shared paths providing through access for pedestrians and cyclists will be maintained where possible

Site affected	Site specific activity	Description of impact	Mitigation measures
		footpath/shared path transition point immediately next to the construction site road frontage • There are footpaths on both sides of Miranda Street • Midblock crossing located adjacent to the site access	• A traffic controller or Site Traffic Management Supervisor will assist pedestrians across the vehicle crossing during times that vehicles are accessing the site during construction • Construction driver education programme must be implemented at this site due to proximity to community facilities and high volume of vulnerable users • Access to the Miranda Reserve will be maintained at all times from Blockhouse Bay Road and Miranda Street • A temporary midblock crossing will be provided south of the site access during construction works
	Parks and reserves	• Temporary loss of playground on Blockhouse Bay Road	• Full reinstatement of the playground in the new configuration within the reserve site

9. Temporary traffic management operating framework

Section 9 sets out the general operational procedures for temporary traffic management activities for the Batch Two sites discussed in this CTMP.

9.1 Site specific traffic management plan development (DES5.2(h) and RC1.23(h))

SSTMPs will be required (under the Local Government (Auckland Council) Act 2009) for all work or physical controls that occur within the road corridor at any of the Batch Two sites.

The SSTMPs will be prepared for discrete stages of work within the road corridor and will follow the format set in the CoPTTM. They will describe the measures to be implemented to manage the temporary traffic effects associated with the movement of construction traffic, or particular works.

SSTMPs will be submitted to, and approved by, Auckland Transport's Traffic Management Coordinator. The SSTMPs will be assessed by the Traffic Management Coordinator for compliance with CoPTTM and the ability to avoid adverse effects on the travelling public.

During the development of each SSTMP, the Project personnel will liaise directly with Auckland Transport to ensure that the overall concept of the TTM is acceptable to all parties. This will, in turn, assist with timely approvals of SSTMPs from the Road Controlling Authority (**'RCA'**).

The general framework for the submission of a SSTMP is as follows:

- Initial liaison with internal Project personnel to determine scope of SSTMP
- Depending on the projected disruption to traffic, consultation with the RCA may be required immediately, otherwise the development of initial draft Traffic Management Diagrams (**'TMD'**) shall begin
- Liaison between internal Project personnel to confirm work areas shown on draft TMDs are correct and allow for the construction works to proceed
- Consultation with the relevant RCA(s) utilising the agreed draft TMDs. This stage will allow the RCA to determine if a TIA is required, as well as notification from the RCA(s) of any other additional specific requirements (note that the TIA may be identified as necessary in (bullet point 2) above as well)
- If a TIA has been requested (in (bullet point 5) above) then this is when development of it would commence - (if it was identified in (bullet point 2) above, then it would start immediately at the earlier stage)
- Finalising of the SSTMP (and TIA if required) as well as any other RCA requirements and then submission to the RCA for official approval
- Any further liaison with the RCA as required
- Receiving the approved SSTMP from the RCA and dissemination to the wider Project team in preparation of implementation

9.2 Site specific traffic management plan structure

The following four elements summarise the structure of a typical SSTMP:

SSTMP Pro-forma

This is the text of the document, which outlines the requirements, methodologies and standards required in observing the SSTMP. Details included in each SSTMP Pro-forma will vary depending on the activity requiring traffic control.

Engineering Exception Decisions

All Engineering Exception Decisions applicable will be appended to the SSTMP.

CAD drawings

CAD drawings will be employed for illustrating the closures defined by the pro-forma and will include all relevant road features that require consideration in managing the impacts of construction.

Communications strategy

The communications strategy will outline the proposed strategy for informing the public of the works. This may include public notifications in local newspapers, advertisements, radio communications, flyer or posters, variable message signs strategies, or driver information signage installed.

A template can be found in **Appendix A.**

9.3 Review and approvals

SSTMPs once fully developed and ready for final approval, will be submitted to the RCA. Generally, this will be to Auckland Transport. MyWorksites, an online TMP submission system, will be used to submit and manage SSTMPs relevant to the Project.

Following submission of the SSTMPs to the RCA, we will work with the RCA Traffic Management Coordinators to resolve any remaining issues prior to final approval. Most of these items should be covered off during the initial liaison period with the RCA while developing the SSTMP.

Any SSTMPs or CARs obtained from Auckland Transport will be forward to Auckland Council's compliance monitoring officer for record.

9.4 Monitoring and audits (DES5.2(h) and RC1.23(h))

The Site Traffic Management Supervisor will continuously monitor the site they are responsible for while works are ongoing. This will be recorded in the form of 2 hourly checks each day and will include any issues, and actions taken to rectify them.

The Traffic Manager will conduct official audits, in compliance with CoPTTM, specifically Section A8, on a weekly basis of all Project work sites. The Traffic Manager will then discuss the results of these audits with the relevant Site Traffic Management Supervisor and ensure any issues are understood and rectified.

Copies of the audits will be kept by the Project and be made available to the Watercare (or their representative) on request.

10. Stakeholders

The following section outlines the key stakeholders affected by the traffic related activities for the proposed work. Please refer to the Communication Plan for more details on the consultation and engagement process for key stakeholders where required.

10.1 Key stakeholders

This CTMP has been developed in consultation with the following parties in relation to specific components of this CTMP. Table 12 highlights the key stakeholders and specific issues that will be engaged with prior to and during construction.

Key themes and topics of relevance for the key stakeholders relating to traffic related construction activities include:

- Where construction related vehicle movements may impact normal operations of the key stakeholders
- Any impacts upon access or parking due to traffic management measures on roads adjacent to the site
- Any construction related activities that may impact upon the safety of key stakeholders at any time during the Project
- Communication of significant construction works and vehicle movements that may impact key stakeholders to ensure safety is maintained

Table 12: Key stakeholders and issues to be discussed during the development of the Batch Two sites

Key stakeholder	Sites affected	Specific issues to be discussed
Auckland Transport	All	• Partial road closure at Walmsley Park • Partial and full road closures at Keith Hay Park • Partial and full road closures at Haycock Avenue • Partial road closure at Dundale Avenue • Partial and full road closures at Whitney Street
AT Metro	Whitney Street Walmsley Park Miranda Reserve	• Impact on bus route 107 • Potential impacts on bus route 24B • Potential impacts on bus route 195 and bus route 209 • Temporary and permanent relocation of bus stops during construction works
Owners and occupiers of neighbouring properties	All	• Timing and duration of construction
Local boards	All	• Timing and duration of construction
Auckland Council – Parks, Sports and Recreation	Keith Hay Park Miranda Reserve Walmsley Park	• Impact on footpaths and shared paths
Auckland Transport Operations Centre	Dundale Avenue Whitney Street	• Performance of key intersections near the partial or full road closures
Mount Roskill Grammar School	Keith Hay Park	• Advise of greater construction traffic volumes at specific times throughout the Project around the recreation complex

		• Advise of changes to shared paths throughout the park and measures taken to avoid conflict with pedestrians
Keith Hay Park Users Group	Keith Hay Park	• Advise of greater construction traffic volumes at specific times throughout the Project around the recreation complex • Advise of changes to shared paths throughout the park and measures taken to avoid conflict with pedestrians
Keith Hay Park School	Keith Hay Park	• Advise of greater construction traffic volumes at specific times throughout the Project around the recreation complex • Advise of changes to shared paths throughout the park and measures taken to avoid conflict with pedestrians
Waikowhai Intermediate	Keith Hay Park	• Advise of greater construction traffic volumes at specific times throughout the Project around the recreation complex • Advise of changes to shared paths throughout the park and measures taken to avoid conflict with pedestrians
Hillsborough Kindergarten	Keith Hay Park	• Advise of greater construction traffic volumes at specific times throughout the Project around the recreation complex • Advise of changes to shared paths throughout the park and measures taken to avoid conflict with pedestrians
Glenavon School and Glenavon Early Childhood Centre	Whitney Street Miranda Reserve	• Advise of greater construction traffic volumes at specific times throughout the Project • Confirm pick up and drop off times to ensure heavy vehicle movement restrictions are applicable
Blockhouse Bay Christian Kindergarten and Community Church	Dundale Avenue	• Advise of greater construction traffic volumes at specific times throughout the Project • Confirm pick up and drop off times to ensure heavy vehicle movement restrictions are applicable
Alpine Superette Dairy	Whitney Street	• Partial and full road closures at Whitney Street • Impact on pedestrian movements and on-street parking • Timing and duration of construction
Marshall Laing Primary School	Haycock Avenue	• Advise of greater construction traffic volumes at specific times throughout the Project
Wesley Community Centre	Walmsley Park	• Timing and duration of construction • Advise of greater construction traffic volumes at specific times throughout the Project
Wesley Intermediate School	Walmsley Park	• Timing and duration of construction • Advise of greater construction traffic volumes at specific times throughout the Project
Wesley Primary School	Walmsley Park	• Timing and duration of construction • Advise of greater construction traffic volumes at specific times throughout the Project

10.2 Stakeholder engagement

The Communications Plan sets out the communications and consultation procedures and periods that will be followed to advise affected parties and the general public of the proposed temporary traffic management works. The following parties are noted for early and specific consultation and agreement in regard to traffic matters:

- Auckland Transport
- Auckland Council – Community Facilities
- Schools in close proximity to the site to advise them of greater construction traffic volumes at specific times throughout the Project)
- Community facilities near the works (e.g. Wesley Community Centre and Cameron Pools)
- The Alpine Superette Dairy on Whitney Street

11. Review and Update

This CTMP should be considered as a live document. It will be updated, with the necessary approvals, throughout the course of the project to reflect material changes to construction methods, site conditions or the natural environment.

APPENDIX A - SSTMP TEMPLATE

TRAFFIC MANAGEMENT PLAN (TMP) – FULL FORM

Use this form for complex activities. Refer to the NZ Transport Agency's Traffic control devices manual, part 8 Code of practice for temporary traffic management (CoPTTM), section E, appendix A for a guide on how to complete each field.

1. Organisations / TMP reference	**TMP reference:**	**Contractor (Working space):** Ghella 5 Generations of Tunnelers; ABERGELDIE COMPLEX INFRASTRUCTURE	**Principal** *(Client)*: Watercare An Auckland Council Organisation
		Contractor (TTM):	**RCA:** Auckland Transport

2. Location details and road characteristics	**Road names and suburb**	**House no./RPs** *(from and to)*	**Road level**	**Permanent speed**

3. Traffic details (main route)	**AADT** data from Mobile Roads	**Peak flows** Morning, 06:00 to 09:00 hrs, Mon – Fri Evening, 16:00 to 18:00 hrs, Mon – Thu (15:30 Friday)

4. Description of work activity

5. Planned work programme

Start date	Click or tap to enter a date.	**Time**	**09:00**	**End date**	12/07/2019	**Time**	Click or tap to enter a date.
Consider significant stages, for example: • road closures • detours • no activity periods.							
Alternative dates if activity delayed	No alternative dates (outside the planned dates above) required.						

6. Road aspects affected (delete either Yes or No to show which aspects are affected)

Pedestrians affected?	N/A	**Property access affected?**	N/A	**Traffic lanes affected?**	N/A
Cyclists affected?	N/A	**Restricted parking affected?**	N/A	**Delays or queuing likely?**	N/A

7. Proposed traffic management methods	
Installation *(includes parking of plant and materials storage)*	
Attended (day)	
Attended (night)	
Unattended (day & night)	
Detour route	
	Does detour route go into another RCA's roading network? Not Applicable *If Yes, has confirmation of acceptance been requested from that RCA?* Not Applicable ***Note:*** *Confirmation of acceptance from affected RCA must be submitted prior to occupying the site.*
Removal	

8. Proposed TSLs (see TSL decision matrix for guidance)				
	TSL details as required Approval of Temporary Speed Limits (TSL) are in terms of Section 6 of Land Transport Rule: Setting of Speed Limits 2017, Rule 54001/2017 *(List speed, length and location)*	**Times** *(From and to)*	**Dates** *(Start and finish)*	**Diagram ref. no's** *(Layout drawings or traffic management diagrams)*
Attended day/night				
Unattended day/night				
TSL duration	Will the TSL be required for longer than six months? ***If yes**, attach the completed checklist from section I-18: Guidance on TMP Monitoring Processes for TSLs to this TMP.*			N/A

9. Contingency plans		
Generic contingencies for: ● major incidents ● incidents ● pre-planned detours. *Remove any options which do not apply to your job*	**Major Incident** A major incident is described as: ● Fatality or notifiable injury - real or potential ● Significant property damage, or ● Emergency services (police, fire, etc) require access or control of the site.	**Actions** The STMS must immediately conduct the following: ● stop all activity and traffic movement ● secure the site to prevent (further) injury or damage ● contact the appropriate emergency authorities ● render first aid if competent and able to do so ● notify the RCA representative and / or the engineer ● under the guidance of the officer in charge of the site, reduce effects of TTM on the road or remove the activity if safe to do so ● re-establish TTM and traffic movements when advised by emergency authorities that it is safe to do so ● Comply with any obligation to notify WorkSafe.
	Incident An incident is described as: ● excessive delays - real or potential ● minor or non-inquiry accident that has the potential to affect traffic flow ● structural failure of the road.	**Actions** The STMS must immediately conduct the following: ● stop all activity and traffic movement if required ● secure the site to prevent the prospect of injury or further damage ● notify the RCA representative and / or the engineer ● STMS to implement a plan to safely remove TTM and to establish normal traffic flow if safe to do so ● re-establish TTM and traffic movements when it is safe to do so and when traffic volumes have reduced.
	Detour If because of the on-site activity, it will not be possible to remove or reduce the effects of TTM once it is established a detour route must be designed. This is likely for: ● excessive delays when using an alternating flow design for TTM ● redirecting one direction of flow and / or	**Actions** When it is necessary to implement the pre-planned detour the STMS must immediately undertake the following: ● Notify the RCA and / or the engineer when the detour is to be established ● Drive through the detour in both directions to check that it is stable and safe

	● total road closure and redirection of traffic until such time that traffic volumes reduce, and tailbacks have been cleared. The risks in the type of work being undertaken, the risks inherent in the detour, the probable duration of closure and availability and suitability of detour routes need to be considered. The detour and route must be designed including: ● pre- approval forms the RCA's whose roads will be used or affected by the detour route ● ensure that TTM equipment for the detour - signs etc are on site and pre-installed.	● Remove the detour as soon as it practicable and safe to do so and the traffic volumes have reduced, and tailbacks have cleared ● Notify the RCA and / or the engineer when the detour has been disestablished and normal traffic flows have resumed.
	Note also the requirements for no interference at an accident scene: In the event of an accident involving serious harm the STMS must ensure that nothing, including TTM equipment, is removed or disturbed and any wreckage article or thing must not be disturbed or interfered with, except to: ● save a life of, prevent harm to or relieve the suffering of any person, or ● make the site safe or to minimise the risk of a further accident; or ● maintain the access of the public to an essential service or utility, or ● prevent serious damage to or serious loss of property, or ● follow the direction of a constable acting in his or her duties or act with the permission of an inspector.	
Other contingencies to be identified by the applicant *(i.e. steel plates to quickly cover excavations)*	**<u>Weather</u>** Sustained bad weather resulting in reduced visibility (less than clear sight distance) will result firstly in bolstering of delineation if possible to provide better worksite visibility. Whilst this occurs every effort will be made to remove the closure however if it is hazardous to open to road (i.e. immobile work vehicles/excavation etc. remain) work may cease and as much cleared from the worksite as possible to reduce risk. TC/STMS staff equipped with glow wands may also be employed from safe positions to caution approaching drivers if visibility is a concern. If bad weather that reduces visibility or creates a hazardous environment is present at the time the closure is due to be installed, the closure may be delayed or cancelled if the weather does not improve. Excess traffic delays (more than 5minutes) Delays are unlikely however in the event of congestion; effort will be made to open additional lane space in the direction of most delay by minimising the work area and attempting to open further drivable area to the public. **<u>Work running late</u>** Hold points, milestones and 'last safe moments' will be utilised throughout the operation to ensure closure removal times are not breached. In the event of breakdown or unforeseen circumstance, the contingency of 'excess traffic delays' above will apply along with informing the RCA immediately. The priority will be given to the opening of lane width as soon as safe to do so, followed by vehicle recovery, followed by TTM equipment removal. **<u>Emergency Vehicle Access / Movements or On-Site Emergency</u>** Emergency vehicles will be given the right of way always and will be assisted through emergency stop/go activity or the use of the onsite TTM vehicle if appropriate and required. Emergencies onsite or nearby will first be made safe, then if appropriate moved from any live lanes, then attended to in detail with an emergency modified TTM setup by the STMS if required. **<u>Unable to complete the works</u>** If for any reason that the works cannot be complete on the night or we have reached the point where we know that we will not be able to do the works within the allocated time frame, we will remove all plant and make sure that the carriageway is left in a safe and trafficable condition until we return and continue, complete the works or we will revise how the works are to be done.	

10. Authorisations				
Parking restriction(s) alteration authority	**Will controlled street parking be affected?**	N/A	**Has approval been granted?**	N/A
Authorisation to work at permanent traffic signal sites	**Will portable traffic signals be used, or permanent traffic signals be changed?**	N/A	**Has approval been granted?**	N/A
Road closure authorisation(s)	**Will full carriageway closure continue for more than 5 minutes (or other RCA stipulated time)?**	N/A	**Has approval been granted?**	N/A
Bus stop relocation(s) – closure(s)	**Will bus stop(s) be obstructed by the activity?**	N/A	**Has approval been granted?**	No
Authorisation to use portable traffic signals	**Make, model and description/number**	Not Applicable		
	NZTA compliant?			

11. EED			
Is an EED applicable?	N/A	**EED attached?**	N/A

12. Delay calculations/trial plan to determine potential extent of delays

13. Public notification plan	
Public notification plan attached?	N/A

14. On-site monitoring plan	
Attended *(day and/or night)*	
Unattended *(day and/or night)*	

15. Method for recording daily site TTM activity (egg CoPTTM on-site record)

16. Site safety measures

17. Other information

18. Site specific layout diagrams

Number	Title

19. Contact details

	Name	24/7 contact number	CoPTTM ID	Qualification	Expiry date
Principal					
TMC					
Engineers' representative					
Contractor					
STMS					

20. TMP preparation

Preparation						
	Name (STMS qualified)	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*
This TMP meets CoPTTM requirements				**Number of diagrams attached**		
TMP returned for correction *(if required)*						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*

Approved by TMC/Engineer						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*
Acceptance by TMC *(only required if TMP approved by engineer)*						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*

Qualifier for engineer or TMC approval

Approval of this TMP authorises the use of any regulatory signs included in the TMP or attached traffic management diagrams.

This TMP is approved on the following basis:

1. To the best of the approving engineer's/TMC's judgment this TMP conforms to the requirements of CoPTTM.
2. This plan is approved on the basis that the activity, the location and the road environment have been correctly represented by the applicant. Any inaccuracy in the portrayal of this information is the responsibility of the applicant.
3. The TMP provides so far as is reasonably practicable, a safe and fit for purpose TTM system.
4. The STMS for the activity is reminded that it is the STMS's duty to postpone, cancel or modify operations due to the adverse traffic, weather or other conditions that affect the safety of this site.

Notification to TMC prior to occupying worksite/Notification completed

Type of notification to TMC required		**Notification completed**	Date Time

ON-SITE RECORD On-site record must be retained with TMP for 12 months.		**Today's date**	
Location details	**Road names(s):**	**House number/RPs:**	**Suburb:**

Working space

Person responsible for working space		
	Name	*Signature*
Where the STMS/TC is responsible for both the working space and TTM they sign above and in the appropriate TTM box below		

TTM

STMS in charge of TTM					
	Name	*ID Number*	*Warrant expiry date*	*Signature*	*Time*
Worksite handover accepted by replacement STMS					
	Name	*ID Number*	*Warrant expiry date*	*Signature*	*Time*
	Tick to confirm handover briefing completed				

Delegation

Worksite control accepted by TC/STMS-NP					
	Name	*ID Number*	*Warrant expiry date*	*Signature*	*Time*
	Tick to confirm briefing completed				

Temporary speed limit

Street/road name (RPs or street numbers):	**TSL action:**	**Date:**	**Time:**	**TSL speed:**	**Length of TSL (m):**
From:	TSL installed				
	TSL remains in place		▨		
To:	TSL removed				

Street/road name (RPs or street numbers):	**TSL action:**	**Date:**	**Time:**	**TSL speed:**	**Length of TSL (m):**
From:	TSL installed				
	TSL remains in place		▨		
To:	TSL removed				

Street/road name (RPs or street numbers):	**TSL action:**	**Date:**	**Time:**	**TSL speed:**	**Length of TSL (m):**
From:	TSL installed				
	TSL remains in place		▨		
To:	TSL removed				

Worksite monitoring

TTM to be monitored and 2 hourly inspections documented below.

Items to be inspected	TTM set-up	2 hourly check	2 hourly check	2 hourly check	2 hourly check	2 hourly check	TTM removal
High-visibility garment worn by all?							
Signs positioned as per TMP?							
Conflicting signs covered?							
Correct delineation as per TMP?							
Lane widths appropriate?							
Appropriate positive TTM used?							
Footpath standards met?							
Cycle lane standards met?							
Traffic flows OK?							
Adequate property access?							
Add others as required							
Time inspection completed:							
Signature:							

Comments:

Time	Adjustment made and reason for change

Appendix H: Written approval of Healthy Waters

15 October 2021

To the Director Regulatory Services

Re: Resource Consent for the proposed collector sewer CC9 (BUN60382589)

Proposed collector sewer CC9 is a key piece of infrastructure that will reduce wet-weather wastewater overflows in the Lynfield catchment, making a significant improvement to the water quality of Te Auaunga. It is one of a suite of wastewater and stormwater upgrades that Watercare and Healthy Waters have developed as part of the Western Isthmus Water Quality Improvement Programme. The planning for this programme is integrated across both organisations to ensure that wastewater and stormwater solutions are complimentary, and deliver best value to Auckland ratepayers.

The proposed alignment and design of CC9 has been developed taking into account any potential risks to Healthy Waters assets, and we are confident that any residual risk is being appropriately managed through detailed design processes and construction methodologies.

CC9 presents a number of opportunities to improve the Te Auaunga watercourse, and to integrate with other Healthy Waters improvement projects. In particular, we have worked to ensure that the design of CC9 facilitates the ultimate removal of several wastewater pipe bridges within Keith Hay Park.

There is a potential opportunity to daylight the watercourse at the Southern end of Keith Hay Park through to Richardson Road, where it is currently piped - a distance of approximately 100 m. This is not a currently intended project, but Healthy Waters is looking to ensure that it could potentially proceed in the future. In this regard we may look to make minor adjustments to the currently proposed alignment, and we request that the consent allow for some flexibility to the alignment of CC9 and the location of manhole structures at this point.

Please accept this letter as confirming Healthy Waters is not an affected person in accordance with section 95E(3)(a) of the RMA.

Yours sincerely

Craig Mcilroy
General Manager Healthy Waters

Written approval of affected persons

PART A (to be completed by applicant)

PART A – APPLICATION

Applicant(s) name: (*please write all names in full*)	Watercare Services Limited	
Address of proposed activity:	660 Richardson Road, Mount Roskill (Keith Hay Park South)	Consent number if known: BUN60382589

Brief description of proposed activity:

Watercare Services Ltd (Watercare) is proposing to undertake construction of a sewer connection (CC9) at Keith Hay Park, Mt Roskill. The proposed works involve the installation of an approximately 810 m long sewer pipeline beneath Keith Hay Park from Watercare's Central Interceptor (CI) Keith Hay shaft construction site to a

Plan references (including title, author and date):

Appendix C: Radius of Influence plans, CC9 Keith Hay Park - groundwater and settlement overview, Tonkin and Taylor, 24 June 2021 noting that alignment is indicative only

Resource consent(s) being sought for (describe area(s) of non-compliance):

As outlined in section 1.3 of the AEE. Of particular relevance to this approval is E7.4.1(A20) and E7.4.1(A28) as these rules relate to effects on Healthy Waters assets

PART B (to be completed by persons and/or organisations providing written approval)

PART B – AFFECTED PERSON(S)

		Tick if Owner	Tick if Occupier
Full name: (*in print*)	Craig Mcilroy, General Manager Healthy Waters	✔	
Full name: (*in print*)			
Full name: (*in print*)			

Address of affected property: 660 Richardson Road, Mount Roskill (Keith Hay Park South) Postcode:

Phone: Mobile:

PART B – AFFECTED PERSON(S) *(continued)*

I have authority to sign on behalf of all the other: (*tick one*)

✔ OWNER(S) ☐ OCCUPIER(S)

of the property. Please provide documentation proving this authority.

Please note: the approval of all the legal owners and the occupiers of the affected property may be necessary.

PART C (to be completed by persons and/or organisations providing written approval)

PART C – DECLARATION

✔ I/We have been given details of the proposal and plans to which I/we are giving written approval.

✔ I/We have signed each page of the plans in respect of this proposal. These need to accompany this form.

✔ I/We understand that by giving my/our written approval, the Council when considering the application cannot take account of any actual or potential effects of the activity on my/our property.

✔ Further, I/we understand that at any time before the determination of the application, I/we may give notice in writing to the Council that this approval is withdrawn.

Note: You should only sign below if you fully understand the proposal. If you require the resource consent process to be explained you can contact the Customer Service Team at the Council who can provide you with information.

Signature(s):		Date:	**15/10/2021**
Signature(s):		Date:	
Signature(s):		Date:	

PRIVACY INFORMATION

The council requires the information you have provided on this form to process your application under the RMA and to collect statistics. The council will hold and store the information, including all associated reports and attachments, on a public register. The details may also be made available to the public on the council's website. These details are collected to inform the general public and community groups about all consents which have been processed or issued through the council. If you would like to request access to, or correction of any details, please contact the council.

Appendix I: CI Groundwater and Settlement Monitoring and Contingency Plan

Groundwater and Settlement Monitoring and Contingency Plan

Keith Hay Park (DSCIN003), 22 Gregory Place, Hillsborough, AucklandWalmsley Park (DSCIN005), 727-761 Sandringham RoadExtension, Mt Roskill, Auckland

Issued for Use

Central Interceptor

Doc No: GAJV-PLN-00142

Version: [2.0]

Watercare
An Auckland Council Organisation

Ghella 5 Generations of Tunnelers
ABERGELDIE COMPLEX INFRASTRUCTURE

From:	Sandra Edwards
To:	Ryan Adam
Subject:	FW: GSMCP Keith Hay Park and Walmsley Park
Date:	Thursday, 3 December 2020 1:54:17 PM
Attachments:	image001.png image004.png

From: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Sent: Thursday, 3 December 2020 1:08 PM
To: Sandra Edwards <sedwards@ga-jv.com>
Cc: XMeier (Xenia) <xenia.meier@water.co.nz>
Subject: RE: GSMCP Keith Hay Park and Walmsley Park

Kia ora Sandra,

As discussed this morning, I can confirm the GSMCP for Keith Hay Park and Walmsley Park are now signed off.

As discussed with Xenia before, I will be sending a list of properties that Council will like to obtain copies of pre-condition surveys as per condition 4.17 (unless properties owner has instructed not to do so).

Many thanks and see you next week.

Kia kaha, stay strong.

Ngā mihi | Kind Regards

Randy Leung | Senior Compliance Monitoring Officer | Licensing & Regulatory Compliance
Auckland Council | **T: +64 (09) 353 9101** | **M: 027 272 0302**
Location: Level 1 | 35 Graham Street | CBD Auckland
Postal: Private Bag 92300 | Wellesley Street | Auckland | 1036
mailto: randy.leung@aucklandcouncil.govt.nz |

From: Sandra Edwards <sedwards@ga-jv.com>
Sent: Friday, 13 November 2020 4:09 PM
To: Randy Leung <Randy.Leung@aucklandcouncil.govt.nz>
Cc: XMeier (Xenia) <xenia.meier@water.co.nz>
Subject: GSMCP Keith Hay Park and Walmsley Park

Good afternoon Randy,

In accordance with Resource Consent Condition 4.6 of the Central Interceptor Resource Consents, please find attached the Groundwater and Settlement Monitoring and Contingency Plan for Keith Hay Park and Walmsley Park in advance of our meeting on Tuesday at 11am.

I will send the information through in a few emails:
This email #1– The Plan Document

Email #2 – Appendix F Drawings
Email #3 – Appendix G Keith Hay Park Temporary Works Detail
Email #4 – Appendix G Walmsley Park Temporary Works Detail

Please let me know if you have issues with any of the attachments/emails.
Ngā mihi | Kind regards,
Sandra

Sandra Edwards
Environmental Manager – Central Interceptor
M +64273663884
Ghella Abergeldie JV

Table of Contents

Appendices

APPENDIX H - Pre-Construction Groundwater Monitoring Data

APPENDIX I - Pre-Construction Ground Surface Monitoring Data

APPENDIX J - Definitions and Abbreviations

Revision History

Review and Approval – Beca Limited

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Prepared by	Hydrogeologist, Beca Limited	Cecilie Rasmussen		11/11/2020
Reviewed by	Technical Director – Hydrogeology, Beca Limited	Sian France		11/11/2020
Approved by	Job Director, Beca Limited	Quintin Blackburn		11/11/2020

Review and Approval – Ghella Abergeldie JV

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Reviewed by	Environmental Manager	Sandra Edwards		20/08/2020
	Senior Project Engineer	Elissa Miller		21/08/2020
	Technical Manger	Gianluca Condini		21/08/2020
	Instrumentation and Monitoring Manager	Peter Yee		21/08/2020
Approved by	Shafts and Microtunneling Construction Manager	Mark Merrie		12/11/2020

Each page of this document bears a document number and revision date. When revisions to the document are issued, the following table will be updated to show the most recent revision level. The revised document will be forwarded to the holders of controlled copies. Recipients are responsible for destroying or marking "superseded" on the previous revision.

Revision Status

VERSION	DATE	STATUS	AMENDMENT DESCRIPTION
0.1	3/03/2020	Draft	Outline plan for GA-JV review ahead of final settlement assessment on services
0.2	5/06/2019	Draft	For GA-JV review with finalised settlement assessment on services
1.0		For Review	For Watercare Review
2.0	11/11/2020	Final Issue	For submission to Auckland Council

Where review and revision are deemed warranted, i.e. such as comments received from the Client, or where necessary to reflect changes in contractual or Project requirements, or as a result of an incident then these revisions shall be reviewed by the respective Project Manager and approved by the Construction Manager.

Distribution (Controlled Copies)

COPY #	ISSUED TO	COMPANY / POSITION	DATE
01	Project File	Ghella Abergeldie Joint Venture - Contractor	
02	Client Rep / Engineer to the Contract	Watercare Services Ltd	

Refer to Section 1.6 for a description of roles and responsibilities

1. Introduction

Watercare Services Limited ('**Watercare'**) has obtained designations and resource consents for the construction and operation of a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them to the Māngere Wastewater Treatment Plant ('**WWTP**').

Referred to as the Central Interceptor Project ('**Central Interceptor'** or '**the Project'**), the proposed works involve a wastewater tunnel that will run between Western Springs and the Māngere WWTP (Figure 1). It includes the construction of the 13 km underground wastewater tunnel, above ground facilities, and two link sewers. Along the route the Central Interceptor will connect to the existing wastewater network, which will divert flows and overflows into the tunnel. Construction of the Project will take approximately 6 years.

The main tunnel will have an internal diameter (ID) of 4.5 metres and will run between 21 m and 107 m below ground, with 10 shafts up to 80 m deep along the main alignment, including three large diameter working shafts, one of which will also serve as the pump station at Mangere WWTP. The two link sewers (referred to as Link Sewers B and C) add a further 4.2 km of smaller diameter tunnels and seven shafts to the project.

Figure 1: Project Location Overview

1.1 Purpose

Construction of the Central Interceptor will require dewatering, sinking of shafts, boring of the main tunnel and link sewers by tunnel boring machine and mining of short sections of connecting adits (i.e. tunnels). These works have the potential to induce ground movements which can adversely impact adjacent buildings, structures and services.

This Groundwater and Settlement Monitoring and Contingency Plan (**'M&CP'**) for the Project has been prepared by Beca Ltd, for the Ghella Abergeldie Joint Venture ('**Ghella Abergeldie JV**' or '**the Contractor**'), and is required to satisfy the resource consent groundwater conditions (numbered 4.1 to 4.34, and in particular condition 4.6 which specifically requires this M&CP). A summary of the relevant groundwater conditions and the proposed means of compliance are presented in Section 1.5.

For the purpose of meeting statutory timeframes, this M&CP has been prepared for the Keith Hay Park (DSCIN003) and Walmsley Park (DSCIN005) construction sites only, and details specifically how groundwater and settlement effects arising from the shafts will be monitored and managed at this location.

1.2 Scope of this M&CP

The M&CP has been prepared in general accordance with the specific condition 4.6 of the resource consent and addresses for each of the relevant Project stages, the following:

- assessment processes and procedures for groundwater monitoring, settlement monitoring and building and utility surveys;
- instrumentation and location of piezometers for groundwater monitoring;
- instrumentation and location of inclinometers, extensometers (where warranted), building and structure movement monitoring marks (where warranted), and survey marks for ground settlement monitoring[1];
- processes for pre-, during and post-construction building and utility condition surveys; and
- proposed trigger levels and contingency actions.

The M&CP addresses shafts, tunnels and other ancillary structures (manholes, chambers etc) which do not meet the Permitted Activity standards of the Auckland Unitary Plan. The following structures have been reviewed by Ghella Abergeldie JV and are considered to meet the Permitted Activity standards and therefore are not included in this M&CP:

- Keith Hay Park:
  - MH84B Bifurcation Chamber
  - MH A84B
  - MH B84B Control Chamber
- Walmsley Park:
  - Bifurcation Chamber

[1] The appended Instrumentation and Monitoring Plan in Appendix G includes for completeness the locations of a broader suite of instruments for construction performance monitoring. These are not required for consenting at Keith Hay Park or Walmsley Park but are provided for information only to allow the reader to understand how the consented monitoring fits into a wider network of monitoring that is proposed.

There are no ancillary structures which do not meet the Permitted Activity Standards.

1.3 Objectives (Condition 4.2)

The management of groundwater and settlement effects for the Project requires integration of a number of components and construction stages, presented graphically in Figure 2 and discussed in detail in Sections 6 to 9.

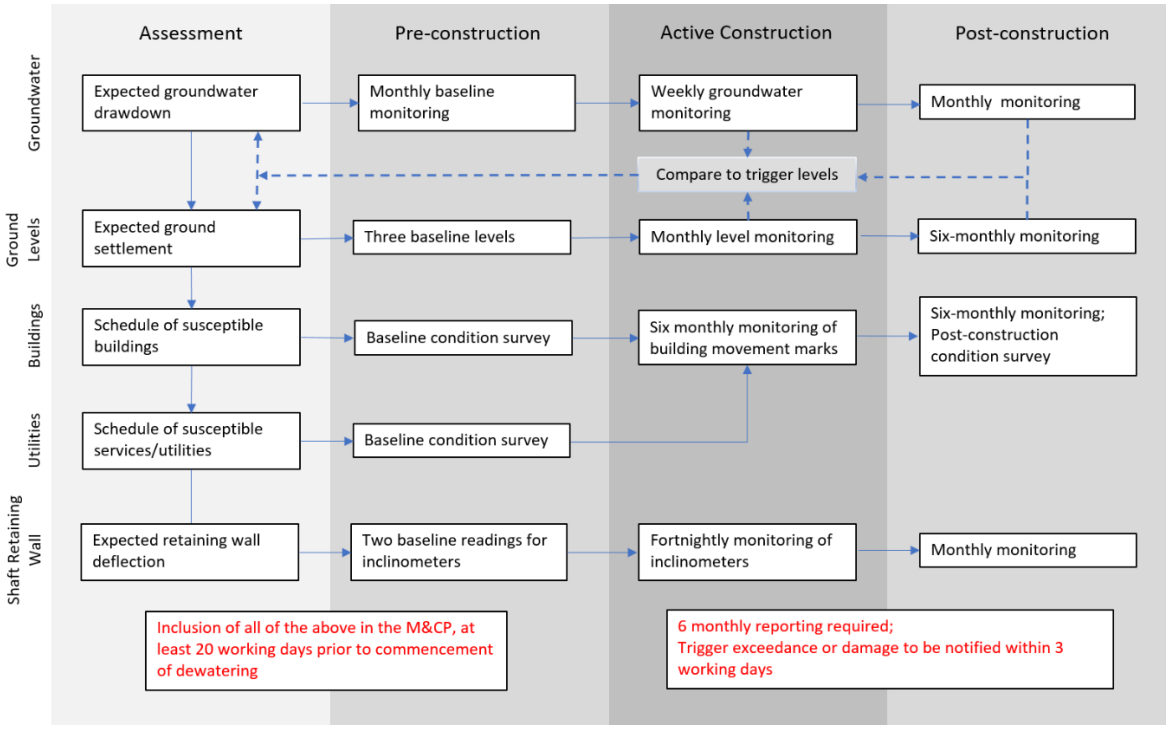


Figure 2: Components of groundwater and settlement monitoring on the Project, as per consent requirements

The broader objectives of the M&CP are:

- To avoid as far as practicable any damage that affects serviceability of structures and services (as per condition 4.2);
- To respond to groundwater and settlement trigger levels by implementing contingency measures and actions; and
- To remedy or mitigate any adverse effects associated with dewatering and excavation activities required for the Project.

1.4 Relationship to other Plans

The M&CP forms part of the set of management plans included in the overarching Construction Management Plan ('**CMP**') (Figure 3).

The M&CP provides details about groundwater and settlement monitoring and contingency actions to meet the requirements of the project's Resource Consent conditions and should be read in conjunction with the CMP and associated sub-plans.

A broader Instrumentation and Monitoring Plan ('**I&M Plan**') has been prepared by the Ghella Abergeldie JV, that will capture the full suite of monitoring requirements. This will include the monitoring described here for consent compliance, as well as monitoring required for construction / performance monitoring,

design verification etc. This does not form part of the CMP but is described here to allow the reader to understand how the consented monitoring fits into a wider network of monitoring that is proposed.

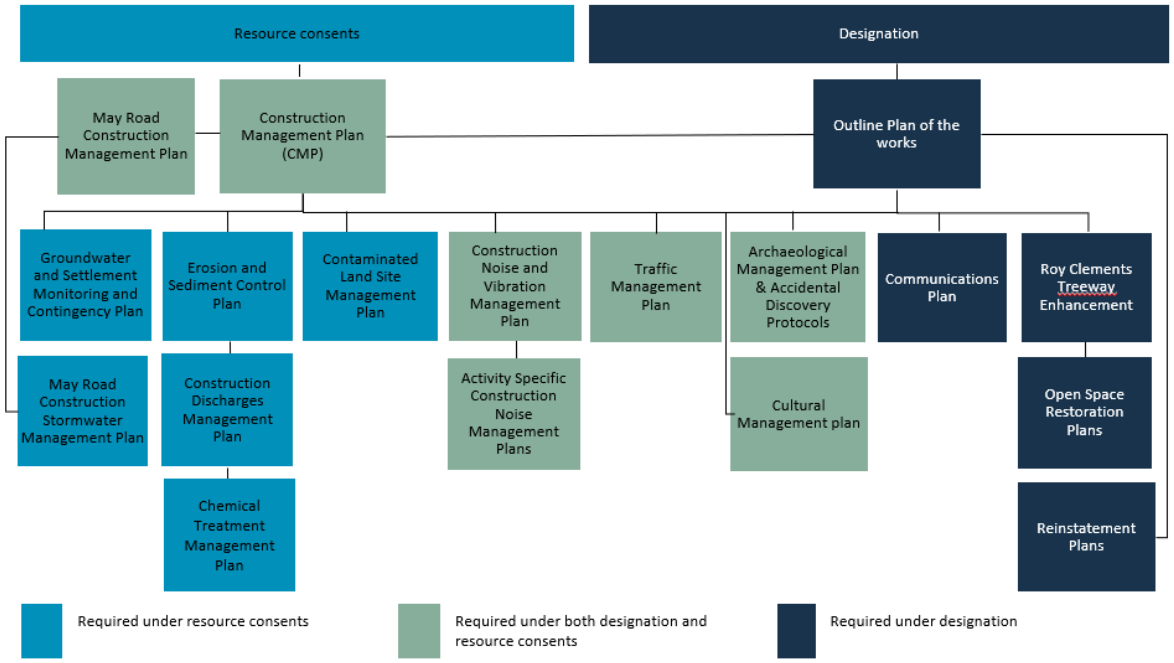


Figure 3: Construction Management Plan Structure

Details of communication are provided in Section 11 and in the Project's Communications Plan (CP).

1.5 Consent Requirements

This M&CP outlines the requirements for monitoring and contingency actions to mitigate potential groundwater and settlement impacts that could be caused by construction of the Keith Hay Park and Walmsley Parks shafts. The M&CP has been prepared prior to commencement of shaft sinking for submission to Auckland Council.

Table 1 provides a summary of requirements with reference to the relevant Resource Consent (RC) conditions (4.1 to 4.34 of consent 40836). NA means not applicable in the tables below.

The M&CP is in general accordance with the information supporting the Notices of Requirement (August 2012) and Part D of the supporting documents submitted with the resource consent application.

Table 1 Resource consent conditions relevant to the M&CP (applies to consent 40836 only) and the sections of relevance in this document

Headings	Condition #	Condition	M&CP Section
Groundwater	4.1	This consent shall expire on 28 November 2048 unless it has lapsed, been surrendered or been cancelled at an earlier date pursuant to the RMA.	NA
	4.2	The Consent Holder shall ensure that all excavation, dewatering systems, retaining structures and associated works for the construction of the shafts, tunnels, underground structures and associated works, including all temporary and permanent works, shall be designed, constructed and maintained so as to avoid, as far as practicable, any damage to buildings, structures and services (including road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture).	Refer CMP and Section 4 of this M&CP
	4.3	The Consent Holder shall ensure that all backfilling of temporary shafts is designed and constructed to the required engineering standard, so as to avoid any damage to buildings, structures and services.	NA: Superseded by Central Interceptor Deviation Consent dated 23 March 2018
	4.4	The Consent Holder shall, at least 10 working days prior to the commencement of shaft sinking or tunnelling, advise the Manager, in writing, of the date of the proposed commencement of this work.	Refer CMP and CP for Construction Phases.
	4.5	The Consent Holder shall, at least 10 working days following completion of shaft sinking or tunnelling, advise the Manager, in writing, of the date of completion.	Refer CMP and CP for Construction Phases.
Monitoring and Contingency Plan	4.6	The Consent Holder shall, before commencement of shaft sinking or tunnelling, prepare a Monitoring and Contingency Plan or Plans ("M&CP") addressing groundwater and settlement monitoring for each of the relevant Project stages. The M&CP shall demonstrate how the conditions of this consent will be implemented and shall include the following:	This document
	4.6 (a)	details of the building risk assessment process and building condition surveys required by Conditions 4.10 to 4.18 of this consent;	Section 4, Appendix E
	4.6 (b)	details of the groundwater monitoring programme required by Conditions 4.19– 4.21, 4.23 and 4.25 of this consent;	Section 7
	4.6 (c)	details of the ground surface settlement and building movement monitoring required by Conditions 4.26 – 4.29, 4.31 and 4.34 of this consent;	Section 8
	4.6 (d)	location plan of settlement and building deformation marks and the location of existing and proposed groundwater monitoring bores.	Appendix F, Section 7.1, Section 8.1
	4.6 (e)	details of the shaft retaining wall monitoring programme required by Conditions 4.26 and 4.29 of this consent.	Section 9

Headings	Condition #	Condition	M&CP Section
	4.6 (f)	the groundwater, deformation and settlement Alert and Alarm Levels (Trigger Levels) to be utilised for early warning of settlement with the potential to cause damage to buildings and services and details of the processes used to establish, and if necessary, to review these triggers;	Section 5
	4.6 (g)	details on the procedures for notification of the Manager in the event that Trigger Levels are exceeded;	Sections 10 and 12
	4.6 (h)	options for additional investigations and analyses to determine the potential for groundwater effects or settlement and for damage to structures, including additional groundwater or settlement monitoring and building condition surveys;	Sections 4 and 10
	4.6 (i)	details of the contingency measures to be implemented in the event of trigger levels being exceeded, including details on the practicable methodologies to avoid, remedy, or mitigate surface settlements with the potential to cause damage to buildings; and	Section 10
	4.6 (j)	A methodology to identify trenched sections where there is potential for ground settlement to cause damage to houses or buildings and the measures that will be taken to ensure such damage does not occur.	NA – no trenched sections at Walmsley, minor trenched works at Keith Hay to be progressed as a Permitted Activity
	4.7	The Consent Holder shall submit to the Manager for written approval:	
	4.7 (a)	at least 11 months[2] prior to the Commencement of Dewatering for shaft sinking or tunnelling of any Project stage, those aspects of the M&CP dealing with pre-construction monitoring, including the pre-construction monitoring required under conditions 4.12, 4.13, 4.21 and 4.28; and	Pre-construction M&CP approved by Council 23/11/18
	4.7 (b)	at least 20 working days prior to Commencement of Dewatering for shaft sinking or tunnelling of any Project stage, the M&CP.	This document
	4.8	The Consent Holder shall comply with the M&CP at all times.	This document

[2] Auckland Council waiver dated 12 October 2018, reduced notification period from 14 months to 11 months

Headings	Condition #	Condition	M&CP Section
	4.9	The Consent Holder may amend the M&CP from time to time, as necessary for the Project or any Project stage. Any amendments to the M&CP must be approved by the Manager in writing prior to any such amendment being implemented.	Section 13
Building Condition Surveys	4.10	The Consent Holder shall undertake a risk assessment to identify existing buildings and structures at-risk of damage due to settlement caused by shaft sinking or tunnelling activities. The risk assessment process shall be set out in the M&CP required by Condition 4.6 and shall be based upon the final tunnel alignment and construction methodology, the groundwater and settlement monitoring required under this consent, and groundwater and settlement modelling completed using this data. The risk assessment shall include:	Section 4, Appendix E
	4.10 (a)	identification of the zone of influence where differential settlements of greater (steeper) than 1:1,000 are predicted due to shaft sinking or tunnelling activities;	
	4.10 (b)	identification of the building types in this zone, and their susceptibility to settlement induced damage; and	
	4.10 (c)	identification of the buildings and structures at-risk of damage due to shaft sinking or tunnelling activities.	
	4.11	A schedule of the addresses of existing buildings and structures identified as being potentially at-risk of damage through the building risk assessment process defined in Condition 4.10 shall be included in the M&CP required by Condition 4.6.	Appendix E
Pre-construction condition survey	4.12	The Consent Holder shall consult with owners of existing buildings and structures identified through the building risk assessment process defined in Condition 4.10, and subject to the owner's approval on terms acceptable to the Consent Holder, undertake a detailed pre-construction condition survey of these structures to confirm their existing condition and enable the sensitivity of the existing buildings and structures to any groundwater and ground settlement changes to be accurately determined. The survey shall be completed at least three months prior to the Commencement of Dewatering of any Project stage involving shaft sinking or tunnelling. The intent of the survey is to assist in enabling the magnitude of allowable effects from changes in groundwater pressure and ground settlement movements to be reasonably determined. The survey shall include but not necessarily be limited to the following:	Section 8.2.1
	4.12 (a)	major features of the buildings and site developments, including location, type, construction, age and existing condition;	
	4.12 (b)	type and capacity of foundations;	
	4.12 (c)	existing levels of aesthetic damage;	

Headings	Condition #	Condition	M&CP Section
	4.12 (d)	existing level of structural distress or damage;	
	4.12 (e)	assessment of structural ductility;	
	4.12 (f)	susceptibility of structure to movement of foundations, including consideration of the local geological conditions; and	
	4.12 (g)	susceptibility of scheduled heritage buildings to movement of foundations.	
	4.12	A photographic record of the inspection shall be included. Note: 'Commencement of Dewatering' means excavation below the groundwater table and/or commencing taking any groundwater from a shaft excavation (after construction of the pile walls (if required) and/or dewatering prior to excavation).	
	4.13	Where neighbouring building/property owners indicate, to the satisfaction of the Manager by way of a recommendation from a qualified and experienced vibration consultant, the presence of particularly sensitive structures (examples include old or brittle structures, vibration sensitive equipment, unusually heavy loads or settlement sensitive machinery) the Consent Holder shall undertake a full engineering assessment to determine what, if any, additional avoidance, design, remedial or monitoring works are required in this vicinity. The Manager may require an independent review of that assessment by a Chartered Professional Engineer.	Section 4 Construction Noise and Vibration Management Plan (CNVMP)
	4.14	The building condition surveys required by this consent shall be undertaken by an independent and suitably qualified person.	Sections 4, 8 and 10
Post-construction condition survey	4.15	Unless otherwise agreed in writing with the building owner that such survey is not required, the Consent Holder shall (subject to the owner(s) approval on terms acceptable to the Consent Holder), within six months of the Completion of Dewatering of any Project stage involving shaft sinking or tunnelling, undertake a post-construction survey covering the matters identified in Condition 4.12 for any building located in an area where differential settlement of greater (steeper) than 1:1,000 occurs between two adjacent settlement monitoring points measured in accordance with the M&CP and a pre-construction condition survey was undertaken in accordance with condition 4.12 or condition 4.13. The Consent Holder may, if they are able to provide evidence to show the deformation was not caused by activities related to this consent, seek written approval from the Manager to waive this condition. If, since the pre-construction survey, any building damage is identified, the survey shall determine the likely cause of damage. Note: 'Completion of Dewatering' means when all the permanent shaft lining, base slab and walls are complete and the tunnel lining is complete, and effectively no further groundwater is being taken for the construction of the shaft/tunnel.	Section 8.2.3
	4.16	The Consent Holder shall, at the direction of the Manager, and subject to the owner's approval on terms acceptable to the Consent Holder, undertake an additional survey on any existing building or structure located within the zone of	Section 8.2.3

Headings	Condition #	Condition	M&CP Section
		settlement influence determined under Condition 4.10, or any existing building or structure surveyed in accordance with Condition 4.13, for the purpose of checking for damage and for following up on a report of damage to that building. The requirement for any such survey will cease six months after the Completion of Dewatering of any Project stage involving shaft sinking or tunnelling.	
	4.17	The Consent Holder shall ensure that a copy of the pre, post-construction and any additional building survey reports are forwarded to the respective property owner(s) and the Manager (unless the property owner(s) has instructed the Consent Holder not to do so) within 15 working days of completing the reports.	Section 12.2
Repair of damage	4.18	If the exercise of this consent causes any unforeseen damage to buildings, structures or services not assessed under Conditions 4.15 and 4.16, the Consent Holder shall notify the Manager as soon as practicable, and provide in writing to the Manager a methodology for repair of the damage caused that has been approved by a Chartered Professional Engineer and shall urgently undertake such repairs in accordance with the approved methodology, at its cost, unless written approval for this damage is provided from the owners. Note: Unforeseen damage – means damage to buildings and structures that has occurred outside the area identified as the zone of influence under Condition 4.10 or to buildings or structures that are located within the zone of influence but were not considered to be at-risk at the time of the approval of the M & CP.	Sections 10 and 12.4
Groundwater Monitoring	4.19	The Consent Holder shall install and maintain groundwater monitoring boreholes at the locations described in the M&CP for the period required by the conditions of this consent. Should any of the monitoring bores be damaged and become in-operable or unsuitable for monitoring, then the Manager is to be informed and a new monitoring bore shall be installed at a nearby location in consultation with the Manager.	Sections 7
	4.20	The Consent Holder shall monitor groundwater levels in the groundwater monitoring boreholes and keep records of the water level measurement and corresponding date. All water level data shall be recorded to an accuracy of at least ± 5mm. These records shall be compiled and submitted to the Manager at six monthly intervals.	Sections 7, 12
	4.21	The Consent Holder shall monitor groundwater levels monthly in boreholes identified in the M&CP and keep records for a period of at least 12 months before the Commencement of Dewatering of any Project stage involving shaft sinking or tunnelling. The variability in groundwater levels over this period will be utilised to establish the seasonal groundwater level variability. The Consent Holder shall monitor groundwater levels monthly in any proposed boreholes for a period of at least two months (three readings indicating steady state) before the Commencement of Dewatering of any Project stage involving shaft sinking or dewatering.	Section 7
	4.22	Prior to the Commencement of Dewatering of any Project stage involving shaft sinking or tunnelling, the Consent Holder shall assess the potential groundwater effects resulting from the exercise of this consent. The output of this assessment shall be used to define the expected groundwater level at each borehole and to establish groundwater Trigger Levels for each borehole that minimise the potential for damage to existing buildings or structures. The process	Sections 2.4 and 5

Headings	Condition #	Condition	M&CP Section
		for establishing groundwater Trigger Levels shall be set out in the M&CP and shall be based upon the final tunnel alignment and construction methodology, and any groundwater monitoring required under this consent, and shall be based upon groundwater modelling completed using this data. A factor of natural seasonal variability shall be allowed for in this review based on the survey completed under Condition 4.21.	
	4.23	From Commencement of Dewatering of any Project stage involving shaft sinking or tunnelling, the Consent Holder shall monitor groundwater levels in each borehole at a minimum of monthly intervals and records shall be kept of each monitoring date and the corresponding water level in each borehole. In addition to the above, all boreholes located within 100 metres of active shaft construction sites or within 100 metres of the tunnel excavation face shall be monitored for groundwater level at least once every week. These records shall be compiled and submitted to the Manager at six monthly intervals.	Section 7
	4.24	All monitoring data obtained pursuant to Condition 4.23 shall be compared to the predicted groundwater levels for each borehole. Where Trigger Levels are exceeded the actions as set out in the M&CP shall be undertaken and the Manager shall be notified within three working days, advising of the trigger exceedance, the risk of settlement causing damage to buildings, and details of the actions taken.	Sections 7 and 12
	4.25	The Consent Holder shall continue to monitor groundwater levels in each borehole at monthly intervals for a period of 12 months following Completion of Dewatering of any Project stage involving shaft sinking or tunnelling, or for a lesser period if groundwater levels in any particular borehole show either:	Sections 7 and 13
	4.25 (a)	recovery of the groundwater level to within 2 metres of the pre-construction groundwater level and is above trigger levels; or	
	4.25 (b)	a trend of increasing groundwater level in at least three consecutive monthly measurements and is above trigger levels, in which case monitoring at that borehole may cease.	
	4.25	After 12 months following the Completion of Dewatering of any Project stage involving shaft sinking or tunnelling, monitoring of groundwater levels shall continue at the direction of the Manager if groundwater levels are not recovering from construction effects and there is a risk of adverse effects.	
Settlement Monitoring	4.26	The Consent Holder shall establish and maintain a settlement monitoring network of Ground Settlement Monitoring Marks and Building Movement Marks to detect any deformation (vertical and/or horizontal movements) at the locations described in the M&CP and for the period required by the conditions of this consent. The Ground Settlement Monitoring Marks shall be located generally as follows:	Section 8 and 9
	4.26 (a)	at least one mark within 5 metres of each of the groundwater monitoring boreholes described in Condition 4.19;	

Headings	Condition #	Condition	M&CP Section
	4.26 (b)	at locations along the alignment of the tunnels, and around each of the shafts, such that: (i) the marks are more closely spaced in areas of higher settlement risk, and more widely spaced in areas of low settlement risk, these areas being identified in the risk assessment carried out under Condition 4.10; (ii) the marks are of sufficient number and are located such that they provide a reliable basis for assessing, monitoring and responding to settlement risk during shaft sinking and tunnelling construction work and for confirming compliance with the limits set out in Condition 4.33; and (iii) the marks shall extend out on each side of the tunnel alignment and around each of the shafts by at least 50 metres beyond the zone of influence identified in the risk assessment carried out under Condition 4.10.	Section 8
	4.26	Shaft Retaining Wall Deformation Monitoring: At shaft locations identified in the risk assessment under Condition 4.10 as being in an area of high settlement risk, sufficient inclinometers shall be installed, in accordance with industry best practice, in temporary shaft retaining walls to measure wall deformation. Measurement accuracy shall be to best practice. Building Movement Monitoring Marks Subject to the owner's approval, and on terms acceptable to the Consent Holder, the Building Movement Monitoring Marks shall be located generally on or around buildings or structures identified in the risk assessment process under Condition 4.10 as being at risk of damage due to settlement caused by shaft sinking or tunnelling activities. The final location and number of Building Movement Monitoring Marks shall take into account the number of buildings, building type and size, accessibility to survey the marks and the risk of damage due to ground settlement. Building Movement Monitoring Marks need not be installed on ancillary buildings such as garages.	Section 9
	4.27	In the event of any of the monitoring marks required under Condition 4.26 being destroyed or becoming inoperable, the Consent Holder shall, unless otherwise agreed in writing by the Manager, replace the monitoring marks with new monitoring marks.	Section 8
	4.28	The Consent Holder shall survey and record the elevation of each Ground Settlement Monitoring Mark and record the corresponding date. Ground Settlement Monitoring Marks shall be surveyed at least three times over a 12-month period prior to commencement of any Project stage involving shaft sinking or tunnelling to establish seasonal variability, and the minimum level of these baseline surveys shall be used to establish the pre-construction reference ground level. All surveys are to be completed to an accuracy of at least ± 2mm for level and ± 5mm for plan position, or as otherwise achieved by best practice precise levelling.	Section 5, 8, Appendix I
	4.29	The Consent Holder shall survey and record the readings of each inclinometer as required in condition 4.26 at an average of each 2 metres depth of shaft excavation, and at a minimum frequency of fortnightly intervals from the	Section 9

Headings	Condition #	Condition	M&CP Section
		Commencement of Dewatering of any Project stage involving shaft sinking for a period of one month after the Completion of shaft Excavation, thence monthly until the Completion of Dewatering for any Project stage involving shaft sinking. At least two baseline surveys shall be completed before Commencement of Dewatering.	
	4.30	Prior to the Commencement of Dewatering of any Project stage involving shaft sinking or tunnelling, the Consent Holder shall assess the potential settlement effects resulting from the exercise of this consent. The output of this assessment shall be used to define the expected settlement levels and to establish settlement Trigger Levels (Alert Levels and Alarm Levels) that minimise the potential for damage to existing buildings or structures. The process for establishing settlement Trigger Levels shall be set out in the M&CP and shall be based upon the final tunnel alignment and construction methodology, any groundwater, deformation or settlement monitoring required under this consent, and groundwater and settlement modelling completed using this data. A factor of natural seasonal variability shall be allowed for in this review based on the survey completed under Condition 4.28. Note: 'Alert Level' is the Differential and Total Settlement Limit set at a threshold less than the Alarm Level, at which the Consent Holder shall implement further investigations and analyses as described in the M&CP to determine the cause of settlement and the likelihood of further settlement. 'Alarm Level' is the Differential and Total Settlement Limit set in Condition 4.33, or which has the potential to cause damage to buildings, structures and services, at which the Consent Holder shall immediately stop dewatering the site and cease any activity which has the potential to cause deformation to any building or structure or adopt the alternative contingency measures approved by the Manager.	Sections 2.4, 4 and 5
	4.31	During construction in any Project stage involving shaft sinking or tunnelling, the Consent Holder shall survey the complete settlement network described in Condition 4.26 at six monthly intervals and keep records of each date and the corresponding ground surface and building level. In addition to the above, all Ground Surface Monitoring Marks located within 50 metres of the excavated tunnel and within 100 metres of an excavated shaft or the tunnel excavation face shall be monitored at least once every month. These records shall be compiled and submitted to the Manager at six monthly intervals.	Sections 8 and 12
	4.32	The Consent Holder shall compare all settlement monitoring data obtained during shaft sinking and tunnelling construction work to the pre-construction minimum levels in accordance with the M&CP. Where Trigger Levels are exceeded the appropriate actions as set out in the M&CP shall be undertaken and the Manager shall be notified within three working days, advising of the trigger exceedance, the risk of settlement causing damage to buildings, and details of the actions taken.	Sections 5, 8, 10 and 12
	4.33	The Consent Holder shall use all reasonable endeavours to ensure that the exercise of this consent does not cause:	This Plan

Headings	Condition #	Condition	M&CP Section
	4.33 (a)	greater (i.e. steeper) than 1:1,000 differential settlement (the Differential Settlement Limit) between any two adjacent settlement monitoring points required under this consent; or	
	4.33 (b)	greater than 50mm total settlement (the Total Settlement Limit) at any settlement monitoring point required under this consent.	
	4.34	The Consent Holder shall continue to monitor the Ground Settlement Monitoring Marks at six monthly intervals for 12 months after Completion of Dewatering of any Project stage involving shaft sinking or tunnelling, or for a shorter period if approved by the Manager. At 12 months following the Completion of Dewatering of any Project stage involving shaft sinking or tunnelling, monitoring of ground and settlement marks shall continue at the direction of the Manager if settlement marks have breached trigger levels and there is risk of adverse effects.	Sections 8 and 12

1.6 Roles and Responsibilities

This section presents a summary of the key personnel and responsibilities working on the Project in terms of specific groundwater and settlement matters as defined by the M&CP. Table 2 provides a summary of the roles and responsibilities in order to comply with the M&CP.

Table 2: Groundwater and Settlement M&CP Roles, Responsibilities and Interfaces

Organization	Role	Role Responsibility
Watercare	Consent Holder	Requiring Authority, Consent Holder and Project Manager Overall responsibility for project compliance and performance in relation to environment, quality assurance and incident management
	Watercare Engineer	Engineer to the Contract, as appointed by Watercare
	Principal Engineering Adviser (PEA)	Provides technical assistance to the Engineer on an as-needed basis
Auckland Council	Regulatory Authority	Review and provide approval for works to be undertaken, based on compliance monitoring of M&CP
Ghella Abergeldie Joint Venture	Project Director	Reviewing and reporting on environmental performance Inspection of works to assess compliance with the M&CP including monitoring
	Contractor Construction Staff	Undertake construction and responsible for best practice implementation methods when dewatering Responsible for avoiding and, if necessary, mitigating any potential contaminants that might enter the groundwater system
	Environmental Manager	Inspecting, auditing and checking of environmental management practices and procedures On-site compliance with consent conditions and other requirements and tracking compliance information Reporting to Watercare changes to construction techniques or natural environmental changes which require alterations to existing consents or new resource consents Preparing, reviewing and updating the CMP and relevant sub-plans (including M&CP) Facilitating and overseeing environmental monitoring, including reporting to AC Updating and maintaining the environmental portion of the Project Risk Register Training of all staff including subcontractors
	Instrumentation and Monitoring Manager	Reviewing the monitoring data and correlates the monitoring observations with construction activities Communicating trends and observations to the Project Director and the relevant members of the construction team Responding to Alert and Alarm triggers

Organization	Role	Role Responsibility
		Managing contingency measures and responses in the event that an Alarm level is exceeded
	Stakeholder and Community Manager	Undertake consultation and liaise with utilities and property / building owners throughout the Project and Project phases
Contractor's Temporary Works Designer	Designer (Arup Ltd)	The Design Engineers shall be qualified Chartered Professional Engineers ("CPEng"), or where appropriate a Professional Engineering Geologist ("PEngGeol") Assessment of settlement due to construction works Additional inputs provided by the Contractor's Designer are at the discretion of the contractor and will be provided on an as-requested basis, with assistance from other Technical Specialists as required. This includes: General oversight of monitoring data Response as needed by an Engineer (CPEng) to alert/alarm triggers as requested by the Project Director
	Qualified and experienced vibration consultant	Undertakes vibration assessment of the sensitive receptors Liaise with groundwater and settlement qualified and experienced consultant
Contractor's Hydrogeologist	Beca Ltd	Prepare, review and update of M&CP (with specialist inputs from other Technical Specialists as required e.g. Arup) General oversight of monitoring data with regards to M&CP compliance Preparation of six-monthly reports to Council
Envivo Ltd	Independent and suitably qualified person	Undertake building condition surveys (refer Condition RES4.13)
Utility Owners	Affected parties	Liaison with Consent Holder Request for recommendation from qualified and experienced consultant in case of sensitive utilities services potentially affected
Property and Building Owners	Affected parties	Liaison with Consent Holder Request for recommendation from a qualified and experienced vibration consultant to assess impacts on sensitive structures building / property

1.7 Sources of Data

This section provides information on the key referenced documents used in this M&CP.

Table 3 provides a detailed summary of the referenced documents used to provide information on construction methodology, works programme, settlement and risk assessment for buildings and utilities.

There is no specific assessment of groundwater drawdown effects to reference; as described in Section 2.4, no dewatering is anticipated and as such no assessment of groundwater effects has been undertaken.

Table 3: Key references used in the M&CP

Sections	Document Title	Prepared by	Document ID	Revision	Issued Date
2.2, 3.1, 3.3, 3.4, 4.1, 4.2, 9.0	Keith Hay Park Shaft – Detailed Design Report for Temporary Works	Arup	267571-DSCIN003-GESH-RPT-0001	2.0	21 February 2020
	Walmsley Park Shaft – Detailed Design Report for Temporary Works	Arup	267571-DSCIN005-GESH-RPT-0001	2.0	21 February 2020
4.1., 4.2	Keith Hay Park Shaft Site Damage Assessment Report.	Arup	267571-DSCIN003-UTSH-RPT-0001	2.0	30 March 2020
	Walmsley Park Shaft Site Damage Assessment Report.	Arup	267571-DSCIN005-UTSH-RPT-0001	2.0	30 March 2020
2.3, 6.1, Appendix B	Central Interceptor Main Works Project – Revised Programme Submission. Detailed Programme	GAJV		4.1	30 Jun 2020

2. Environmental Aspects

2.1 Key definitions

The Consent Conditions specifically define 'Commencement of Dewatering' and Completion of Dewatering; however, there are many other key terms that relate to the management of groundwater and settlement effects on this Project. Definitions for these are provided below.

Monitoring Station*	Any ground, building or retaining wall marker, any inclinometer or piezometer required by this consent.
Commencement of Dewatering*	Means excavation below the groundwater table and/or commencing taking any groundwater from a tunnel excavation and/or dewatering prior to excavation). As the project is progressed in stages, and early works will have no influence on later stages of the project, "commencement" should be taken as per the active definitions / distances provided below.
Active Excavation	A monitoring station is defined as being within a zone of "active excavation" where: - Excavation for the advancing tunnel comes within 50 m of, and ending when the final tunnel lining has been installed for 50 m adjacent or beyond the instrument - Excavation for a shaft commences within 50 m of, and ending when the bulk excavation for the shaft has been completed and any temporary retention has been installed.
Active Dewatering	A monitoring station is defined as being within a zone of "active dewatering" where: - Excavation for the advancing tunnel comes within 100 m of, and ending when the final tunnel lining has been installed for 100 m adjacent or beyond the instrument - Excavation for a shaft commences within 100 m of, and ending when no further groundwater is being taken for construction and the shafts permanent lining has been installed.
Completion of Excavation	When bulk excavation of the shaft(s) and / or the tunnelling excavations have been fully completed (including any permanent retention) within 100 m of the monitoring station.
Completion of Dewatering*	Means when all the permanent tunnel lining is complete, and effectively no further groundwater is being taken for the construction of the tunnel.
RL*	Reduced Level
Seasonal Low Groundwater Level*	The annual lowest groundwater level – which typically occurs in summer
Services*	Includes fibre optic cables, sanitary drainage, stormwater drainage, gas and water mains, power and telephone installations (including pylons) and infrastructure, road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture.
Damage*	Includes Aesthetic, Serviceability, Stability, but does not include Negligible Damage. *Note*: A Damage Classification Table is normally included within the conditions of Resource Consent. Such a table was not included in the Project's condition set; however, for reference a copy of the table from Council's standard condition set has been reproduced as Table 4 of this M&CP.

* Indicates that the term is specifically defined in the Conditions. Text in *italics* indicates a recommended additional interpretation. The terms “Active Excavation”, “Active Dewatering” and “Completion of Excavation” are recommended by this document to provide additional interpretation and are consistent with the distances provided in Conditions RES4.23 and RES4.31.

Table 4: Building Damage Classification Adopted by Auckland Council (after Burland (1995) and Mair et al (1996))

Category of Damage	Normal Degree of Severity	Description of Typical Damage	Category of Damage
0	**Negligible**	Hairline cracks.	Aesthetic Damage
1	**Very Slight**	Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection. Typical crack widths up to 1 mm.	
2	**Slight**	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible, some repainting may be required for weather-tightness. Doors and windows may stick slightly. Typically, crack widths up to 5 mm.	
3	**Moderate**	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Brick pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired. Typical crack widths are 5 mm to 15 mm or several greater than 3 mm.	Serviceability Damage
4	**Severe**	Extensive repair involving removal and replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted. Typical crack widths are 15 mm to 25 mm but also depend on the number of cracks.	
5	**Very Severe**	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability. Typical crack widths are greater than 25 mm but depend on the number of cracks.	Stability Damage

2.2 Construction Methodology

The Keith Hay Park shaft (DPCIN003) and the Walmsley Park shaft (DPCIN005) will both be constructed as cascade drop access shafts. Both shafts will be temporarily retained by steel casing to provide soil support during construction. For the long-term arrangement, permanent support will be provided by a Fibre Reinforced Polymer (FRP) liner, and the void between the liner and the excavated face will be grouted.

The methodology specific to the settlement risk assessment (and of relevance to the monitoring programme outlined in this M&CP) is detailed in Section 2.2.1 (below). For a comprehensive construction methodology, please refer to the CMP.

The proposed staging of the works at Keith Hay Park and Walmsley Park respectively, including general sequence and programmed start and completion dates, has been summarised in Table 5 and Section 2.3.

2.2.1 Shaft Construction and Excavation

Keith Hay Park

The following general construction sequence applies to the Keith Hay Park shaft:

1. Establish site and crane pad / piling platform;
2. Excavate locally and construct the reinforced concrete collar beam;
3. Install temporary (sacrificial) steel casing to required temporary casing toe level at~43.50 m RL (~ 1.0 m into competent rock) and excavate within the casing;
4. Excavate through ECBF rock using drilling fluid support (in the wet) to 1.0 m below the main CI tunnel crown level;
5. Clean the excavation hole and carry out CCTV camera inspection of the shaft excavated wall and base of the shaft;
6. Install FRP lining in sections in a top-down sequence to 0.5 m above the main CI tunnel crown, and grout between the lining and excavated face;
7. Grout the 1.5 m void at base of shaft (i.e. between shaft excavation level and toe of FRP lining);
8. Once grouting is completed, reinforced concrete collar is removed and the site will be reinstated;
9. Once the TBM passes (estimated to be April 2023, i.e. several years later), a connection to the shaft will be constructed from the tunnel.

Key elements of the temporary support measures for the Keith Hay Park shaft are shown in Figure 4.

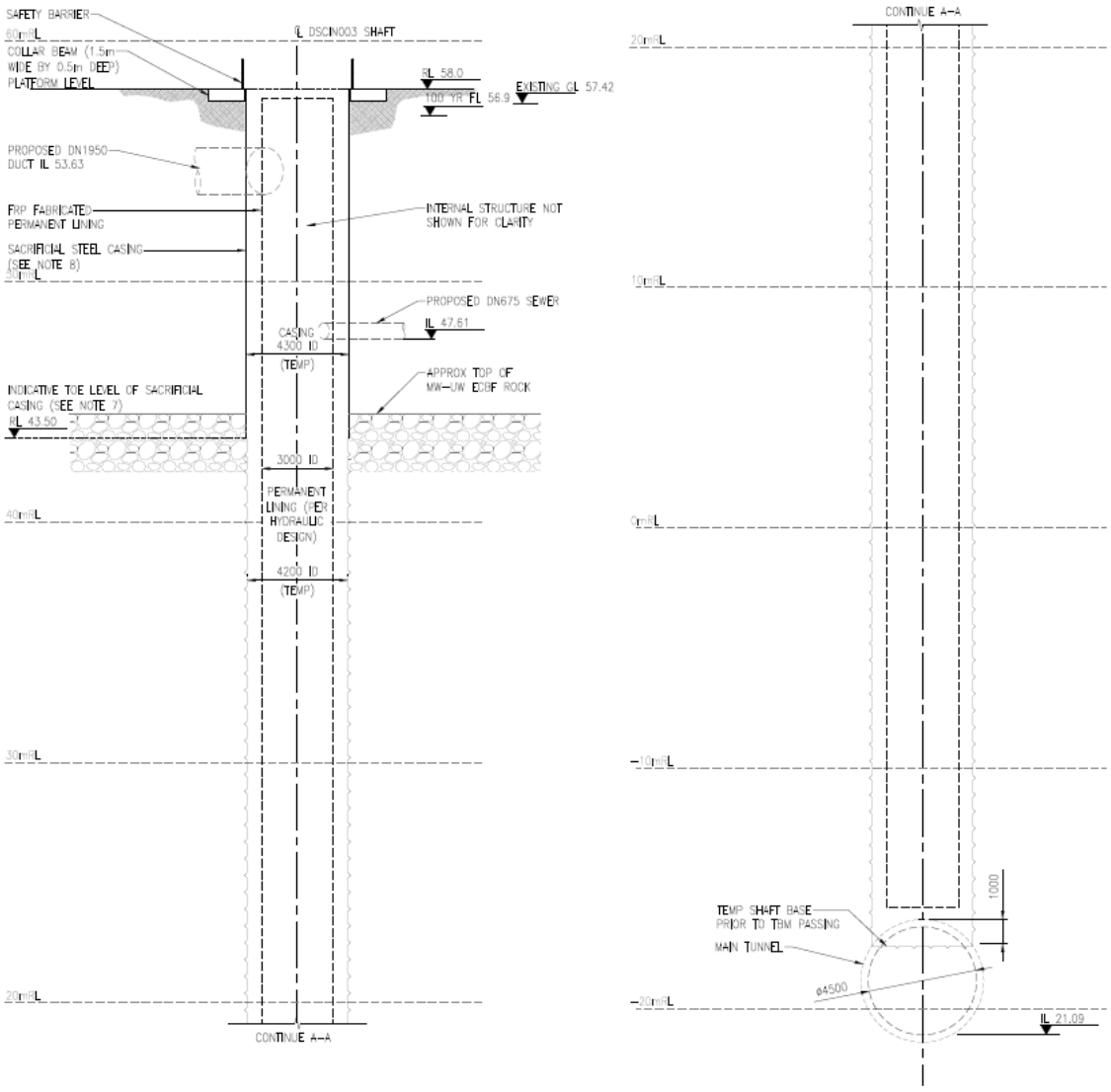


Figure 4: Proposed construction sequence for Keith Hay Park shaft (excerpt from drawing 2011891.312 rev 2).

Walmsley Park

The following general construction sequence applies to the Walmsley Park shaft:

1. Establish site and crane pad / piling platform;
2. Excavate locally and construct the reinforced concrete collar beam;
3. Install an oversize temporary steel casing to the top of basalt layer (~40.0 mRL);
4. Support oversize temporary steel casing with the collar beam at ground level;
5. Excavate through the basalt layer using rock breaker or chisel tooling equipment;
6. Install temporary steel casing (sacrificial) inside the oversize casing (with nominal gap between the two casings) to required temporary casing toe level (~29.0 mRL);
7. Excavate through the soil inside the temporary (sacrificial) steel casing to temporary casing toe level (~29.00 mRL);
8. Remove temporary oversize steel casing;
9. Excavate through ECBF rock using drilling fluid support (in the wet) to the temporary bottom of the shaft, ~1.0 m below the main tunnel lining crown level (~ 14 mRL);
10. Clean the excavation hole and carry out CCTV camera inspection of the shaft excavated wall and base of the shaft;

11. Install FRP lining in sections in a top-down sequence to 0.5 m above main CI tunnel crown, and grout between the lining and excavated ground;
12. Grout the 1.5 m void at base of shaft (i.e. between shaft excavation level and toe of FRP lining);
13. Once grouting is completed, reinforced concrete collar beam is removed and the site will be reinstated;
14. Once the TBM passes (estimated to be June 2024, i.e. several years later), a connection to the shaft will be constructed from the tunnel.

Key elements of the temporary support measures for the Walmsley Park shaft are shown in Figure 5.

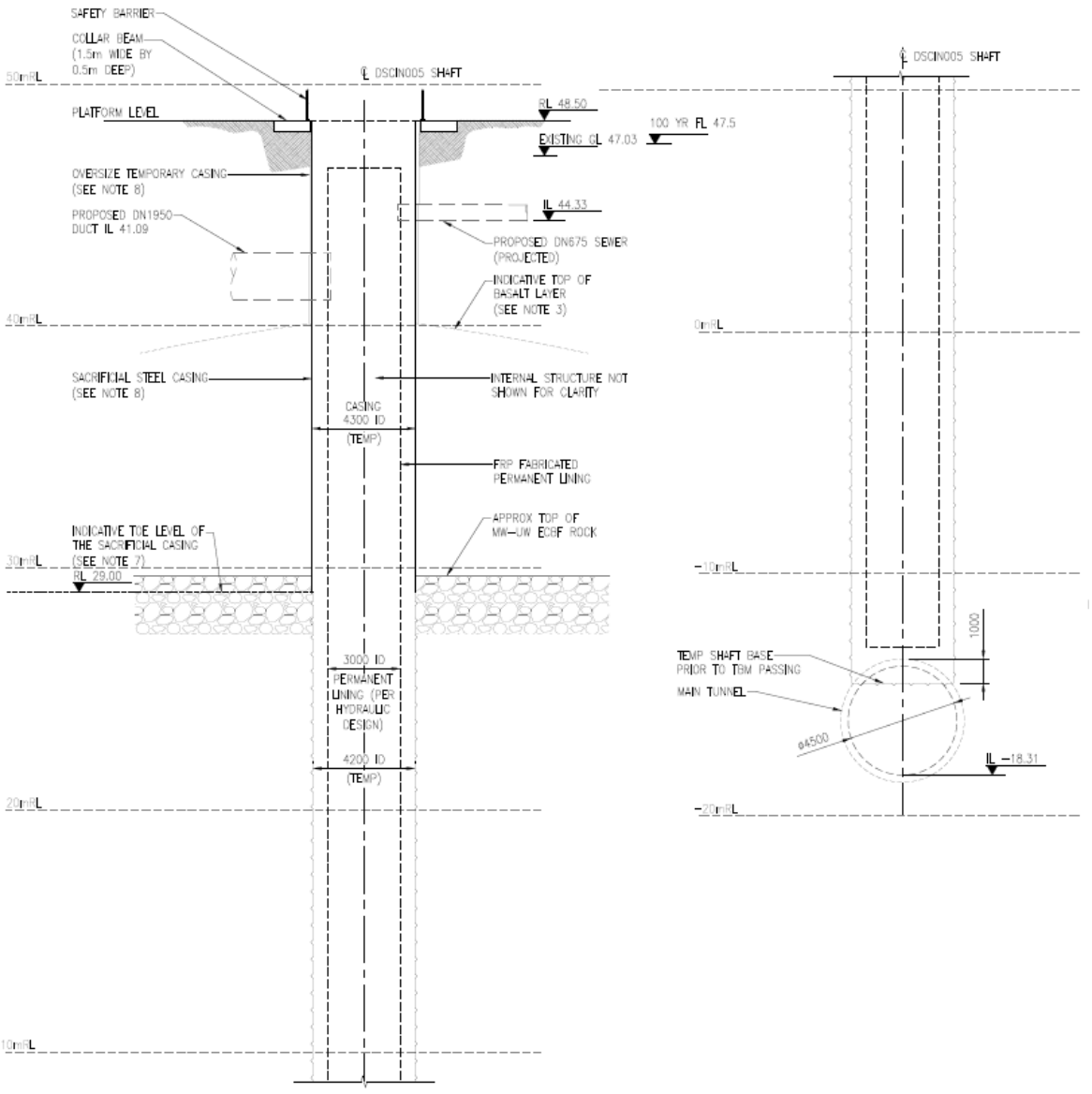


Figure 5: Proposed construction sequence for Walmsley shaft (excerpt from drawing 2011893.312 rev2).

2.2.2 Main Tunnel

Main Tunnel Excavation Methods

The main tunnel will be constructed using a closed-face earth pressure balance ('**EPB**') tunnel boring machine ('**TBM**'), purpose-built for the Central Interceptor project and capable of excavating the tunnel and erecting a gasketed precast concrete segmental lining.

During "closed mode" tunnelling, the earth and groundwater pressures acting on the excavation face are balanced by the pressure of the conditioned soil stored inside the excavation chamber. The pressure of the conditioned soil inside the excavation chamber is controlled by regulating the speed of advance of the TBM and the speed of soil extraction from the screw conveyor.

The use of these operating systems will allow the excavation face pressure to be maintained continuously in order to minimise groundwater inflows to the excavation, and, to reduce / manage resultant ground settlement to an acceptable level (being less than the consented alert trigger levels). During TBM maintenance stops and weekends, an Emergency Bentonite Injection System will be enabled to maintain a constant pressure inside the excavation chamber. Groundwater inflows would therefore be expected to be negligible, though some minor inflows may occur if pressure cannot be maintained for any reason (e.g. drained maintenance stops or drained interventions in competent ground, or TBM break-through). Once lining is installed and grouted, the tunnel will be watertight.

Further details of the tunnel construction and operational effects (drawdown and settlement) will be provided in a later update to this M&CP.

Tunnel/Shaft Connections

The shaft is planned to be connected from within the shaft when the TMB passes. Any dewatering related to the tunnel/shaft connection will be assessed at a later stage when relevant.

2.2.3 Permanent Design

Upon completion, both the Keith Hay Park and the Walmsley Park shaft are required to be effectively watertight. Once permanent lining has been installed, groundwater levels are expected to recover to pre-construction levels and no long-term groundwater effects are anticipated.

2.3 Works Programme

A simplified works programme is provided in Appendix B and key dates for excavation for both sites are provided in Table 5 below.

Please note, that both shafts are planned to be fully constructed "in the wet" i.e. no dewatering is expected at either site. Hence, no 'Commencement of Dewatering' date is set for either site.

Table 5: Key Construction Dates for Keith Hay Park and Walmsley Park

Site	Element	Scope	Programmed Dates	
			Active Excavation	Active Dewatering
Keith Hay Park	Site Establishment	Establish site and crane pad	No Excavation	No dewatering anticipated for this stage
		Excavate locally to 1 m deep and construct the reinforced concrete collar beam	January 2021	No dewatering anticipated for this stage
	Cascade Drop / Access Shaft (DSCIN003)	Drill into competent rock and then install temporary steel casing to form soil support	January 2021	No dewatering anticipated for this stage
		Drill shaft in rock to required depth	January 2021 to February 2021	No dewatering anticipated for this stage
		Install FRP lining	February to March 2021	No dewatering anticipated for this stage
	Grouting of liner	Once grouting is completed, remove RC collar and reinstate site	No Excavation	No dewatering anticipated for this stage
	Main Tunnel	Construct connection from within the tunnel when the TBM passes	Jan 2023	TBC
Walmsley Park	Site Establishment	Establish site and crane pad	No Excavation	No dewatering anticipated for this stage
		Excavate locally to 1 m deep and construct the reinforced concrete collar beam	February 2021 to March 2021	No dewatering anticipated for this stage
	Cascade Drop / Access Shaft (DSCIN003)	Install temporary oversize steel casing to top of basalt layer and excavate through basalt layer in the wet.	February to March 2021	No dewatering anticipated for this stage
		Install temporary steel casing 1 m into competent rock and excavate within steel casing to the steel casing toe level.		No dewatering anticipated for this stage
		Drill shaft in rock to required depth.		No dewatering anticipated for this stage

Site	Element	Scope	Programmed Dates	
			Active Excavation	Active Dewatering
		Install FRP liner	April 2021	No dewatering anticipated for this stage
	Grouting of liner	Once grouting is completed, remove RC collar and reinstate site	No Excavation	No dewatering anticipated for this stage
	Main Tunnel	Construct connection from within the tunnel when the TBM passes	August 2023	TBC

2.4 Construction Dewatering

The works proposed for both Keith Hay Park (DSCIN003) shaft and Walmsley Park (DSCIN005) shaft will not require construction dewatering, i.e. excavation and construction will be fully "in the wet" with no pumping of any groundwater inflows to excavations below the groundwater table.

Should any stormwater enter the shaft it will be handled as described in the Construction Discharges Management Plan which forms part of the Construction Management Plan (as per condition RES3.2).

3. Effects Assessment

3.1 Existing Situation – Keith Hay Park

This section provides details of the existing situation at the Keith Hay Park construction site in terms of land use, topography, geology and hydrogeology.

The Keith Hay Park shaft is located within 22 Gregory Place, Hillsborough, Auckland. The site is legally described as Lot 27 DP 49583. The property is accessed off Arundel St., adjacent to the entrance to the Keith Hay Park recreation facility carpark.

3.1.1 Land Use and Topography

The Keith Hay Park shaft site is surrounded by a public park (Keith Hay Park) offering recreation opportunities, basketball court, and facilities for the community. The park has been subject to significant historical earthworks with the development of stormwater drainage ditches on the boundaries of the site, and through the central parts of the site.

The site is generally flat and low lying compared to the surrounding area. The site drains from the south-east towards the north-west. The topographic elevation of the site ranges from approximately 55 m RL to 59 m RL, however most of the site is generally between approximately 57 m RL to 58 m RL.

Overland flow paths run along the boundaries of and through Keith Hay Park, which is itself a flood plain.

3.1.2 Utilities

The following subsurface Council services are located within the shaft site boundary:

- 150 mm diameter wastewater pipe and associated manhole that cross through the northern and western boundaries of the site.
- 150 mm diameter wastewater pipe and associated manhole that crosses the access easement from Arundel Street on the southern boundary of the site.
- Two low voltage power cables within the 22 Gregory Place property.

An existing stormwater pipe (1500 mm diameter concrete) runs parallel to the western site boundary, connecting open stormwater channels that run along the eastern boundary of Keith Hay Park. Review of utilities drawings indicates that there are no existing services within the shaft footprint.

There are no park drainage assets in proximity to the shaft location.

3.1.3 Buildings

The nearest privately owned building is located approximately 25 m north-northeast of the shaft.

Major non-residential buildings at Keith Hay Park include Cameron Pool and Leisure Centre located approximately 50 m northwest of the shaft location.

3.1.4 Conceptual Hydrogeological Model

Figure 6 shows mapped surface geology relative to the Keith Hay Park shaft site location.

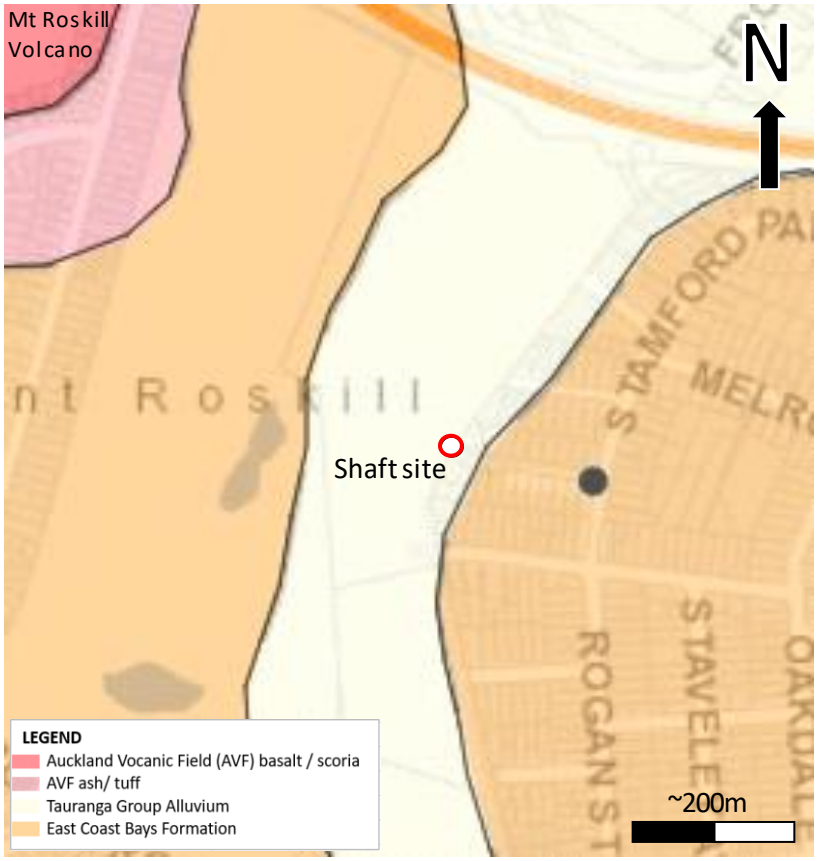


Figure 6: Keith Hay Park site plan including mapped surface geology.

The entire project area is underlain by Waitemata Group, East Coast Bays Formation interbedded sandstones and siltstones (ECBF), in places locally interbedded with volcaniclastic debris flow deposits. Groundwater flow is dominantly defect controlled through fractures and bedding planes, although some lesser flow can also be expected through the matrix of coarser sandstone beds. Rainfall recharge generally occurs slowly from rainfall at the surface percolating down via a series of cascading water levels; however, the main recharge for this unit is from up-gradient flow within the rock mass.

Overall, the Waitemata Group has a relatively low hydraulic conductivity (K_h = ~ 5 x 10^{-7} m/s and K_v = 10^{-8} to 10^{-7} m/s) and low storativity (S = 10^{-3} to 10^{-4}) resulting in typically low yields when dewatered.

The Waitemata Group is overlain by a variable thickness of weathered residual soils and alluvium. The soils are typically fines-dominated and have permeabilities that are similar to the underlying rock (i.e. K_h = 3 to 5 x 10^{-7} m/s and K_v =10^{-8} to 10^{-9} m/s). Groundwater flow is predominantly through pore spaces, and the units exhibit a strong vertical anisotropy due to bedding. The anisotropy generally results in a variable and muted connection with the underlying Waitemata Group; that is, modelling indicates that drawdown in the soils is likely to be smaller and delayed in comparison to that recorded in the Waitemata Group. Although some seasonal variation in groundwater level is observed in the ECBF, residual soils and alluvium there is generally no direct rainfall response observed.

The Keith Hay Park shaft site is located ~500 m south-east of Mt Roskill volcano. The lava flows have erupted primarily into a north-west trending paleo-valley in a direction away from the Keith Hay Park site and hence no basalt layers are expected to be found at site.

3.2 Existing Situation – Walmsley Park

This section provides details of the existing situation at the Walmsley Park construction site in terms of land use, topography, geology and hydrogeology.

The Walmsley Park shaft site is located on the far eastern end of Walmsley Park in Mt Albert, fronting on to the Sandringham Road Extension. Oakley Creek runs through the northern part of the shaft construction site. There a pathway alongside the northern side of the Creek. The park is part of an open space of network that surrounds Oakley Creek and extends from Mt Roskill War Memorial Park in the south east through Alan Wood Reserve to the New North Road in the north west.

3.2.1 Land Use and Topography

The Walmsley construction site is currently a public park offering recreation opportunities for the community. The site has one of the busiest interfaces with the local community; it is located directly across the road from the Wesley Community Centre and youth facility and a carparking area where markets are held every Tuesday and Friday. Just along Sandringham Road Extension is Wesley Intermediate and around the corner from the site is Wesley Kindergarten.

The site is generally flat and low lying compared to the surrounding area and is an identified floodplain being part of the Oakley Creek stormwater catchment system. The site drains from northeast to the southwest. The topographic elevation of the site ranges from approximately 46 m RL to 48 m RL, however most of the site sits around approximately 47 m RL.

3.2.2 Utilities

The following subsurface services are located within the shaft site boundary:

- One existing main wastewater transmission pipe/sewer line (DN525 Branch 9 MT Roskill sewer) including two manholes runs through the shaft site in an east-west direction connecting near the shaft with a local DN 150 wastewater pipe.
- Two medium voltage cables run in a north-south direction close to eastern boundary of the site fronting Sandringham Road Extension.

An existing stormwater stream (Oakley Creek) runs through the site in an east-west direction; the stream has been naturalised (i.e. no concrete base or sides). Review of available utilities drawings indicates that there are no existing services within the shaft footprint.

3.2.3 Buildings

The shaft location on the western side directly borders five neighbouring residential properties (3-11 O'Donnell Avenue and 763 Sandringham Road Extension).

3.2.4 Conceptual Hydrogeological Model

The geology and hydrogeological properties of the soils and rocks beneath the site are as described for Keith Hay Park above. However, the Walmsley Park shaft site is located on the northern side of an apparent paleo-valley located approximately ~1500 m south-east of the Mt Albert volcano and 1300 m north east of Mt Roskill volcano and thin layers of basalt rock (lava flows from Mt Roskill) can be expected close to the surface. Nevertheless, surface geology is mainly comprised of undifferentiated Tauranga Group (recent alluvial deposits). Figure 7 shows mapped surface geology relative to the shaft site location.

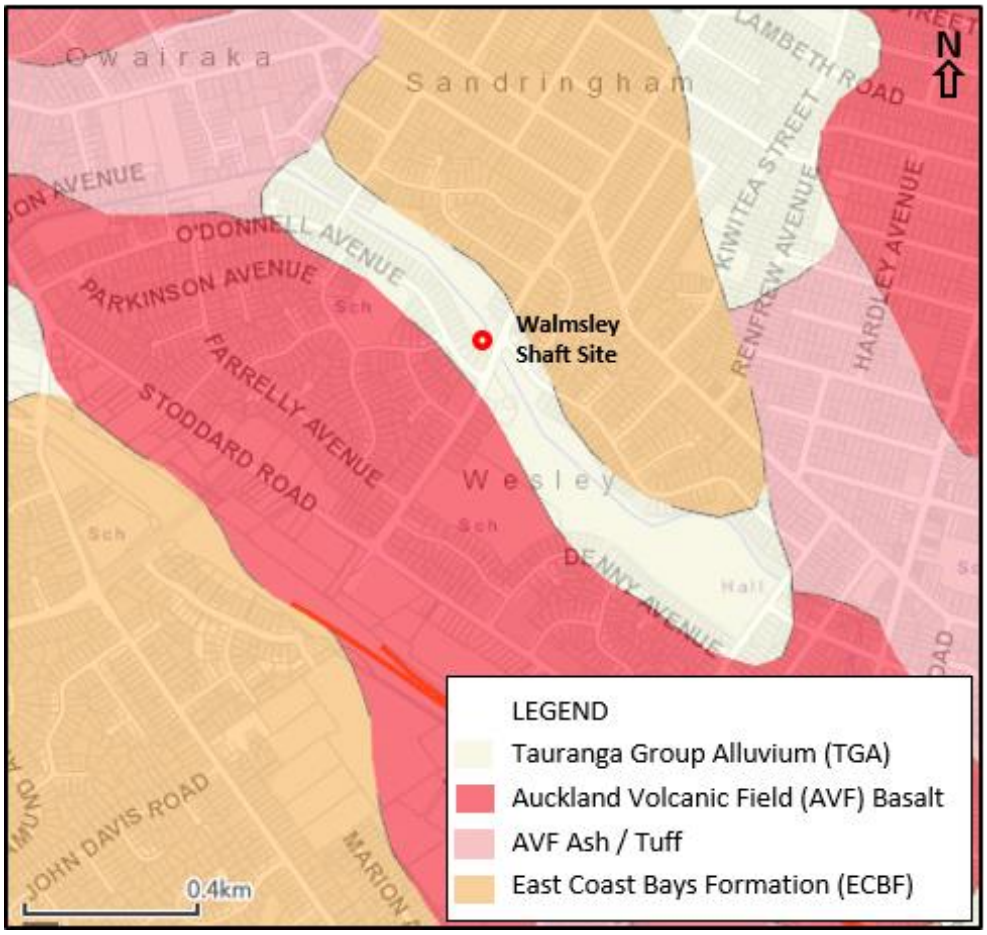


Figure 7: Walmsley Park site plan including mapped surface geology.

3.3 Extent of Groundwater Drawdown and Surface Settlement – Keith Hay Park

3.3.1 Anticipated Groundwater Drawdown

As identified in section 2.4, no dewatering is planned for the shaft and hence no groundwater drawdown is expected.

3.3.2 Cumulative Settlement[3]

Sources of ground surface movement near to the Keith Hay Park shaft site could include:

- Construction of piling platform;
- Excavation and construction of Central Interceptor main tunnel;
- Excavation of shaft and ancillary structures; and

[3] Information in this section provided by Arup, based on the analyses and reporting presented in Arup, 2020a

- Excavation and construction of the shallow connections (air duct and sewer) between the shaft and adjacent chambers.

The above sources of ground movement will occur at different times during the construction period.

Settlement from construction of ancillary structures MH2A, MHA2A, MHB2A, MHC2A, MHD2A is excluded from this assessment as they are located further away from the Keith Hay Park shaft. Mechanical induced settlement from construction of ancillary structures MH84B, MHA84B and MHB84B is included in this assessment to inform the potential cumulative magnitude and extent of settlement prediction around the Keith Hay Park shaft.

The above sources of ground movements following completion of tunnel, shaft and ancillary structure construction (where applicable) have been combined into a drawing, titled "DSCIN003 – Keith Hay Park, Predicted Ground Surface Settlement Contour", drawing no. 2011891.301 prepared by Arup, and dated 19 Feb 2020, Revision 2.

Up to 30 mm total (cumulative) settlement is calculated immediately adjacent to the DSCIN003 shaft. A maximum of 25 mm total settlement is calculated at the western construction site boundary with Keith Hay Park; the maximum calculated settlement to the north and east, where the construction site abuts residential neighbours is <10 mm. Settlement is generally calculated to reduce to < 5 mm between 20 m and 60 m from the shaft.

Based on drawing no. 2011891.301, differential settlement gradients immediately adjacent to the shaft could be as steep as 1/800. Gradients of 1/1000 could occur at the edges of the fill platform.

Less than 10 mm settlement is expected beneath the nearest third-party building (19 Gregory Place).

Consolidation settlement due to excavation is not anticipated for the ancillary structures as the temporary works for these structures are planned to include a tanked retaining wall design. If this is not the case and groundwater lowering could occur due to a non-tanked temporary support design, the assumption of negligible consolidation settlement will be revised.

Settlement from the construction of the shallow connections (DN1950 duct and DN675 sewer) is not included in this assessment. The induced movement due to surcharge loading from plant and machinery is not included in this assessment as this is transitory loading. Ground surface movement associated with seasonal change in groundwater is not included in this assessment as this would occur irrespective of the works.

3.4 Extent of Groundwater Drawdown and Surface Settlement – Walmsley Park

3.4.1 Anticipated Groundwater Drawdown

As identified in section 2.4, no dewatering is planned for the shaft and hence no groundwater drawdown is expected.

3.4.2 Cumulative Settlement[4]

As for Keith Hay Park shaft, sources of ground surface movement near to the Walmsley Park shaft site could include:

- Construction of piling platform;
- Excavation and construction of Central Interceptor main tunnel;
- Excavation of shaft and ancillary structures; and
- Excavation and construction of the shallow connections (air duct and sewer) between the shaft and adjacent chambers.

The above sources of ground movement will occur at different times during the construction period.

Mechanical induced settlement from construction of the ancillary damper chamber and bifurcation chamber MH49A is included in this assessment.

The above sources of ground movements following completion of tunnel, shaft and ancillary structure construction have been combined into a drawing, titled "DSCIN005 – Walmsley Park, Predicted Ground Surface Settlement Contour", drawing no. 2011893.301 Revision 2 prepared by Arup, and dated 21 Feb 2020.

Up to 55 mm total (cumulative) settlement is calculated immediately adjacent to the DSCIN005 shaft. A maximum of 15 mm total settlement is calculated at the western construction site boundary, which abuts neighbouring residences. Settlement is generally calculated to reduce to < 5 mm at approximately 20 m from the shaft.

Based on drawing no. 2011893.301, differential settlement gradients immediately adjacent to the shaft could be as steep as 1/235. Gradients of a similar magnitude could occur at the edges of the fill platform.

Less than 10 mm settlement is expected beneath the nearest buildings (3 O'Donnell Avenue and 9 O'Donnell Avenue).

Consolidation settlement due to excavation is not anticipated for the ancillary structures as the temporary works for these structures are planned to include a tanked retaining wall design. If this is not the case, the assumption of negligible consolidation settlement during ancillary structure construction will be revised.

Settlement from the construction of the shallow connections (DN1950 and DN750 duct and DN675 sewer) is not included in this assessment. The induced movement due to surcharge loading from plant and machinery is also not included as this is transitory loading. Ground surface movement associated with seasonal change in groundwater is not included in this assessment.

[4] Information in this section provided by Arup, based on the analyses and reporting presented in Arup, 2020b

4. Risk Assessment

4.1 Assessment Methodology (Condition 4.10)

A staged approach in accordance with Mair *et al*. (1996) has been adopted for the assessment of potential effects on buildings and structures. A flowchart showing the methodology for the assessment of potential damage is presented in Figure 8.

4.1.1 Building Risk Assessment[5]

A first stage assessment was conducted to identify all structures within a defined "influence zone", this was considered to be the zone within 45 degrees of the tunnel axis or shaft rock level. Any structure within this zone **and** which also lies within the 10 mm settlement contour or where differential settlement exceeds 1:1000 would then be been subject to further assessment (Figure 8).

4.1.2 Utilities Risk Assessment[6]

A first stage approach was conducted to identify existing utilities that are located within the 5 mm combined settlement contour line and/or where the differential settlement exceeds 1:1000. A subsequent risk-based analysis approach was conducted taking into consideration six (6) factors related to failure modes in utilities incl. utility age, material and type, assigning a risk rating for each factor. A logic test then follows (Figure 9) to identify necessary protection/mitigation measures. A detailed description of the method can be found in Arup, 2020c and Arup, 2020d

The assessment of existing utilities is based on available information and no "BeforeUDig" has been carried out to validate the information. The physical location of the affected utilities is to be confirmed by GA-JV prior to construction.

A detailed Stage 2 assessment may be performed to further understand the level of structural damage. A Stage 2 assessment will only be recommended if necessary, i.e. for a critical asset, or if required by the asset owner.

[5] Information in this section provided by Arup, based on the analyses presented in Arup, 2020a and Arup, 2020b.
[6] Information in this section provided by Arup, based on the analyses presented in Arup, 2020c and Arup, 2020d.

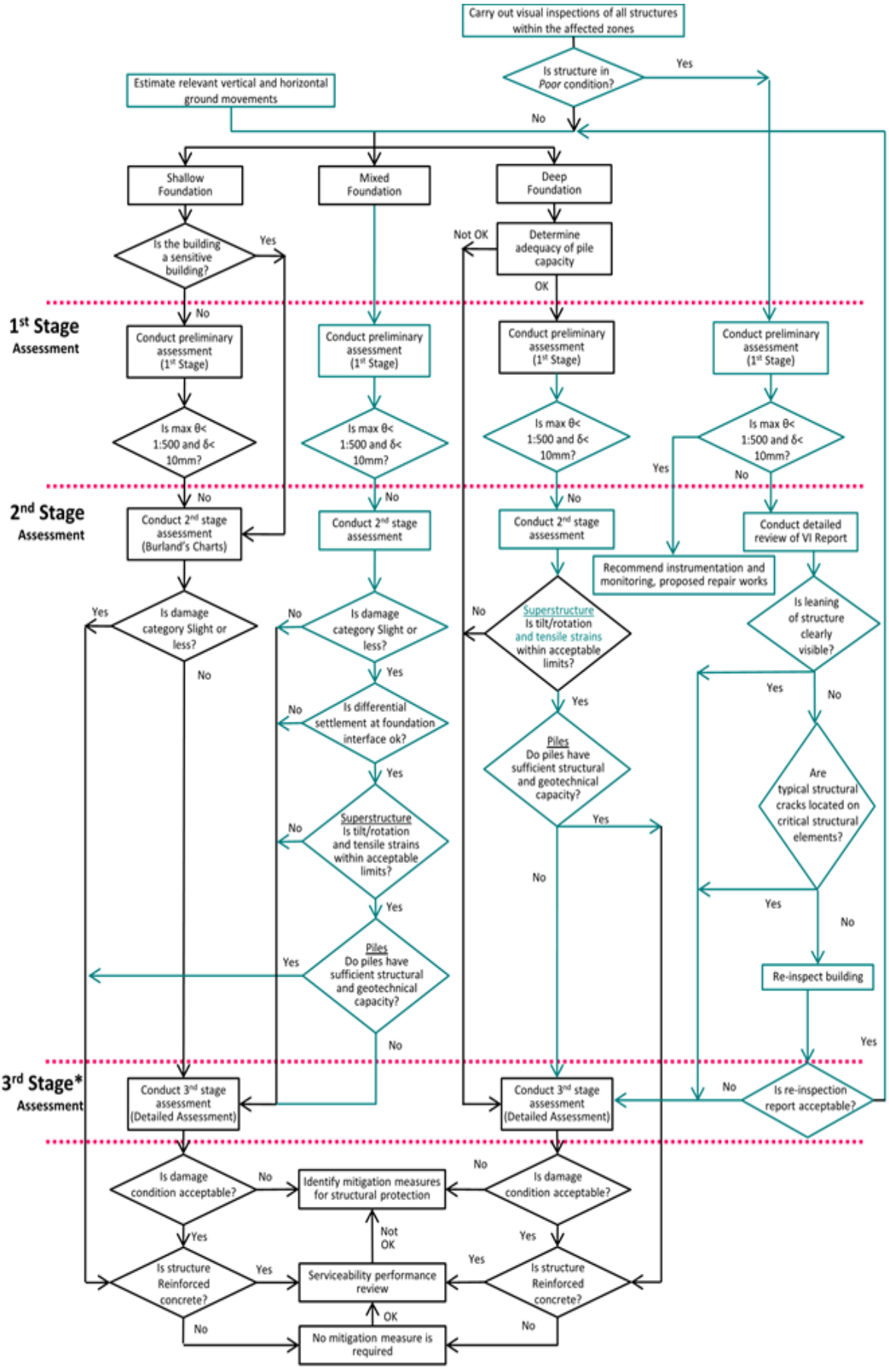


Figure 8: Impact Assessment Methodology (after Mair 1996).

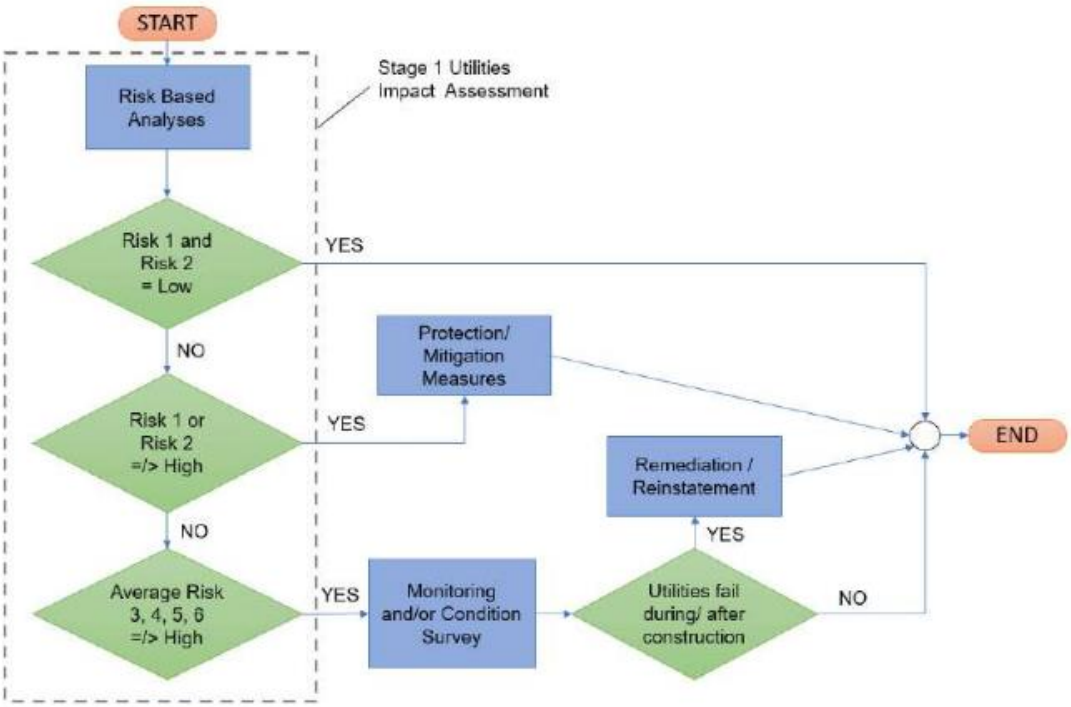


Figure 9: Stage 1 – Risk Based Utilities Impact Assessment – Logic Map (Arup, 2020c).

4.2 Schedules of At-Risk Buildings and Utilities (Condition 4.2, 4.6 (l) and 4.11)

4.2.1 Keith Hay Park[7]

There are no buildings within a zone where settlement of > 10 mm or steeper than 1:1000 is calculated. Hence, there are no third-party owned buildings considered to be "at-risk" using the definition of Condition 4.10.

Table 6 summarizes the sixteen (16) utilities that have been identified through the Stage 1 Assessment to be within the 5 mm contour zone and if protection or diversion is considered warranted to mitigate the risk. In summary fifteen (15) out of sixteen (16) utilities are considered low risk with no further action required. The remaining utility is to be relocated as part of site works.

There are no transmission towers within the expected zone of settlement from the shaft.

Table 6: Utilities at Keith Hay Park within the 5mm or higher settlement zone[8].

Utility Type	Utility ID	Utility Name	Protection or Diversion Works Required?
	1	150mm EW WW Pipe	Pre- and Post-construction survey

[7] Information in this section provided by Arup, based on the analyses presented in Arup, 2020c.
[8] Information in this table is as per Arup, 2020c

Wastewater	2	150mm EW WW Pipe	None required
	3	225mm EW WW Pipe	None required
	4	150mm EW WW Pipe	None required
	5	375mm Concrete WW Trans. Pipe	None required
	6	WW Trans. Inspection MH	None required
	7	WW MH Structure	None required
Stormwater	8	1500mm Concrete SW Pipe	None required
	9	225mm Concrete SW Pipe	WSL tender drawing (2011805.005) suggest temporarily diversion during construction of MHA84B and reinstated upon completion.
	10	225mm Concrete SW Pipe	WSL tender drawing (2011805.005) suggest temporarily diversion during construction of MHA84B and reinstated upon completion.
	11	Concrete SW MH Structure	None required
	12	1500mm Std Outlet	None required
	13	Std. Single Catchpit	None required
Water	14	125mm PE Water Pipe	None required
Power	15	Overhead Power Cable	None required* **
	16	Overhead Power Cable	None required***

*GAJV shall ensure power assets, including UG and OH wires, poles, boxes, substations, are not damaged by construction works. For more information see Arup, 2020c.
** Util. ID 15 is expected to be the existing power connection to park. It is unknown where the overhead wire goes underground. Please note that private duct will not show up in public records, i.e. BeforeUDig.
*** Util. ID 16 is expected to be the power connection to the existing building which will be demolished for the shaft construction.

4.2.2 Walmsley Park[9]

There are no buildings within a zone where settlement of > 10 mm or steeper than 1:1000 is calculated. Hence, there are no third-party owned buildings considered to be “at-risk” using the definition of condition 4.10.

Table 7 summarizes the three (3) utilities that have been identified through the Stage 1 Assessment to be within the 5 mm contour zone and if protection or diversion is considered warranted to mitigate the risk. In summary all three (3) utilities located within the 5mm contour zone are to have protection or mitigation measures in place before construction starts.

There are no transmission towers within the expected zone of settlement from the shaft.

[9] Information in this section provided by Arup, based on the analyses presented in Arup, 2020d.

Table 7: Utilities at Walmsley Park within the 5mm or higher settlement zone.

Utility Type	Utility ID	Utility Name	Protection or Diversion Works Required?
Wastewater	1	525mm RC WW Trans Pipe	Protection Works
	2	150mm EW WW Pipe	Protection Works
	3	525 Concrete WW Trans. Structure	Protection Works

4.3 Pre-construction Building Condition Survey (Condition 4.12, 4.13 and 4.17)

4.3.1 Keith Hay Park

There are no third-party owned buildings which require a pre-construction building condition survey.

4.3.2 Walmsley Park

There are no third-party owned buildings which require a pre-construction building condition survey

4.4 Post-construction Condition Surveys (Conditions 4.15 - 4.17)

4.4.1 Keith Hay Park

There are no third-party owned buildings which require a pre-construction building condition survey, and hence no buildings are specifically required to have a post-construction survey.

4.4.2 Walmsley Park

There are no third-party owned buildings which require a pre-construction building condition survey, and hence no buildings are specifically required to have a post-construction survey

5. Trigger Limits

5.1 Groundwater Drawdown Trigger Levels (Condition 4.22)

The groundwater trigger levels applicable for the Project are set out in Appendix D. The location of all groundwater monitoring instruments is shown in Appendix F. The process for establishing groundwater trigger levels is based upon:

- identifying piezometers located within the expected zone of drawdown from the final tunnel alignment and shaft locations, and with respect to the proposed construction methodology;
- the results of baseline groundwater monitoring required under condition 4.21 – refer to Sections 7.1 to 7.5 of the M&CP;
- a factor of natural seasonal variability is allowed for in the identification of trigger levels based on monitoring undertaken during pre-construction, completed under condition 4.21. Where a natural, pre-construction baseline has not been captured in the data available, this has been clearly noted and a nominal baseline and interim trigger level presented.

The consent conditions do not specifically identify if groundwater drawdown is subject to “alert” and “alarm”, or “alert 1” and “alert 2” type trigger levels. We have adopted alert 1 and alert 2 type triggers as per current practice for groundwater drawdown triggers. We note that these are the compliance triggers however, an internal lower interim trigger will also be used within the project; whilst this would not trigger specific reporting to Council it would serve as an early notification of drawdown approaching that calculated.

As no drawdown is expected at the site, trigger levels have been defined as described below. This is consistent with the approach at May Road and Mangere, in the locations where drawdown was expected to be < 0.5 m:

- Where drawdown is < 0.5 m, drawdown would not generally be expected to have an adverse impact and baseline monitoring has shown that water levels can naturally fluctuate by more than 0.5 m due to natural influences. Standardised trigger levels are proposed in these locations:
  - Interim Trigger Level is set at 0.4 m drawdown below the pre-dewatering Baseline (seasonal low groundwater) Level;
  - Alert Trigger Level 1 is set at 0.5 m drawdown below the pre-dewatering Baseline (seasonal low groundwater) Level; and
  - Alert Trigger Level 2 is set at 0.6 m drawdown below the pre-dewatering Baseline (seasonal low groundwater) Level.

Exceedance of a groundwater alert level would first trigger review of monitoring data and potentially an increased frequency of monitoring. If the exceedance was confirmed in this way, contingency actions to be implemented will be selected from those set out in Section 10.

5.2 Settlement Trigger Levels (Condition 4.30 and 4.33)[10]

The Alert and Alarm settlement trigger levels applicable for the Project are set out in Appendix D. The location of all ground, building or utility movement marks is shown in Appendix F. The process for establishing settlement trigger levels is based upon:

- identifying the expected zone of settlement with respect to the final tunnel alignment, shaft locations and construction methodology;
- the general requirements to:
  - avoid greater (steeper) than 1:1000 differential settlement between any two adjacent monitoring stations, or greater than 50 mm total settlement at any settlement monitoring station (as per condition 4.33); and
  - avoid as far as practical more than 'negligible' damage to buildings, structures, utilities or other assets (as per condition 4.2 and the consent definitions)
- the settlement assessment presented in Sections 2.4 and 4.

Condition 4.33 requires that the project does not cause greater (steeper) differential settlements than 1:1000 or greater than 50 mm total settlement. As per the note associated with condition 4.30 this can be set as the Alarm Trigger Level where it can be demonstrated that this level of settlement will not cause damage.

Based on the settlement calculated by Arup, the JV propose the following approach to setting of trigger levels:

- Total ground settlement alarm trigger level for all **ground markers on the shaft array** to be set based on the maximum calculated settlement immediately adjacent to the shafts i.e.
  - Alert trigger level set at 100 % of calculated maximum settlement to the shaft; and
  - Alarm trigger level set at 120 % of calculated maximum settlement at the shaft.

We note that the above are the proposed compliance triggers. An internal, lower interim trigger level will also be used within the project, set at 80 % of calculated maximum settlement. Whilst this would not trigger specific reporting to Council, it would serve as an early notification of settlement approaching that calculated to prompt further review and analysis ahead of any consent exceedances occurring.

The approach to trigger levels is the same as that adopted for previous shafts sites

As set out in Section 4 of this M&CP, there are no buildings considered to be "at risk" from the works associated with either the Keith Hay Park or Walmsley Park shafts. Accordingly, there are no buildings proposed for monitoring at either site and hence there are no total or differential building settlement trigger levels.

5.3 Shaft Retaining Wall Trigger Levels

As set out in Section 9, retaining wall monitoring is proposed as part of the broader instrumentation and monitoring requirements for the project. However, as neither the Keith Hay Park nor Walmsley Park shafts are considered to be "high risk" in terms of potential for settlement at nearby buildings, specific retaining

[10] Trigger levels in this section are based on the recommendations contained in Arup, 2020a and Arup, 2020b

wall monitoring is not required at these locations for compliance with consent conditions. Accordingly, no shaft retaining wall trigger levels are proposed.

6. General Monitoring Requirements

This section introduces a monitoring programme for the measurement of groundwater levels and ground settlement, before, during and after the construction period. The location of all monitoring stations is shown on the drawing in Appendix F.

Trigger levels are presented in Section 5 and Appendix D.

Where instruments have not yet been installed these are clearly distinguished in the relevant appendices, which will be updated prior to active excavation or dewatering occurring within the vicinity of these instruments.

6.1 Construction Stages

There are three main construction stages, each with specific monitoring (and reporting) requirements as described in Table 8. Reporting requirements are addressed in Section 12.

Table 8: Groundwater and Settlement Monitoring Requirements for each Construction Stage

	Stage	Expected Dates	Description
Keith Hay (DSCIN003)	**Pre-Construction (Baseline)**	Ongoing	This monitoring phase will provide baseline data against which effects resulting from the construction works can be assessed. Data required by the Consent for this stage of works is presented in this document.
	During Excavation	January 2021 to February 2021, January 2023	Monitoring during the construction phase will be used to verify the design analyses, by comparing the actual measurements with those estimated. The monitoring data will be used to reassess the building damage classifications at critical locations. If these reassessments indicate that the damage classifications have increased significantly then additional analyses, increased monitoring or other actions may be required. Mitigation options, discussed in Section 10 of this M&CP, may also be required to be implemented.
	After Excavation	February 2021 to February 2023 onwards	Where specified in the Consent, monitoring will occur until the various stages of works are completed (excavation and construction) and shall continue until stable measurements are demonstrated and written approval is provided by AC to cease monitoring.
Walmsley (DSCIN005)	**Pre-Construction (Baseline)**	Ongoing	This monitoring phase will provide baseline data against which effects resulting from the construction works can be assessed. Data required by the Consent for this stage of works is presented in this document.
	During Excavation	February 2021 to April 2021, August 2023	Monitoring during the construction phase will be used to verify the design analyses, by comparing the actual measurements with those estimated. The monitoring data will be used to reassess the building damage classifications at critical locations. If these reassessments indicate that the damage classifications have increased significantly then additional analyses, increased monitoring or other actions may be required. Mitigation options, discussed in Section 10 of this M&CP, may also be required to be implemented.

After Excavation	April 2021 to July 2023, September 2023 onwards	Where specified in the Consent, monitoring will occur until the various stages of works are completed (excavation and construction) and shall continue until stable measurements are demonstrated and written approval is provided by AC to cease monitoring.

6.2 Data Management (Condition 4.20, 4.23 and 4.31)

Survey results, positions and instrumentation readings should be presented in reports appropriate for the type of survey undertaken. An online electronic database of all installations and survey results will be prepared and maintained by the JV, this includes all as-built installation locations. This database is accessible to the wider project team in real time via web browser.

A telemetry system is being used with the piezometers, extensometers and tiltmeters (where specified) to ensure near real time deformation readings can be made. This system is linked to alerts via email if trigger levels are reached.

All data collected as required by conditions of the Consent from commencement of dewatering to completion of monitoring will be compiled, compared with the relevant trigger levels and submitted to Auckland Council at six monthly intervals (as per condition 4.20, 4.23 and 4.31).

6.3 Data Review Reporting (Condition 4.24 and 4.32)

All groundwater level and survey level monitoring data collected will be compared to predicted trigger levels and where exceeded, Council shall be notified within 3 working days, and, the actions set out in Section 10 and 12 of this M&CP (where appropriate) shall be undertaken.

All data collected as required by conditions of the consent from Commencement of Dewatering to completion of all monitoring will be compiled, compared with the relevant trigger levels and submitted to Auckland Council at the six-monthly intervals specified in conditions 4.20, 4.23 and 4.31. These reports will include an update on construction progress, an assessment of any trends evident in the data and confirmation if any exceedances occurred through the monitoring period.

As a result of the large volume of data, it will not be practical to provide tabulated records of all monitoring data with each report; however, plots of groundwater level or survey movement vs. time will be provided for relevant monitoring instruments, and tabulated records can be viewed on request (if between the six-monthly intervals described above).

7. Groundwater Monitoring

Groundwater monitoring requirements are outlined in consent conditions 4.19 to 4.25. The purpose of monitoring groundwater levels in boreholes is to:

- Establish seasonal groundwater variability pre-construction;
- Determine potential groundwater effects resulting from dewatering (where applicable) and construction and define groundwater trigger levels for each borehole that limit the potential for damage to existing buildings or structures; and
- Identify where trigger levels are exceeded during or post-construction.

7.1 Groundwater Monitoring Locations (Condition 4.19)

7.1.1 Keith Hay Park

Three (3) piezometers, two standpipes and one vibrating wire piezometer, have been established for the purpose of monitoring at the Keith Hay Park site. One (1) piezometer has already been decommissioned and it is expected that the remaining two piezometers will eventually be damaged / inaccessible during site works.

Given that no dewatering is proposed at this site it is considered that a single new piezometer (DSCIN003PZ01), located between the shaft and the nearest residential building, will be sufficient to monitor groundwater levels. Monitoring of the existing piezometers will be maintained for as long as practical and we expect there will be a minimum 3-month period where all piezometers can be monitored simultaneously to allow for correlation to the longer-term records.

Groundwater monitoring locations for the proposed works at Keith Hay Park are shown in Appendix F and listed in Appendix C.

7.1.2 Walmsley Park

One (1) existing piezometer (vibrating wire piezometer) has been established for the purpose of monitoring at the Walmsley Park site. Three (3) additional piezometers (DSCIN005PZ01-03) are planned to be installed for construction and post-construction monitoring. One of these new piezometers is intended to replace the existing piezometer which is in the shaft footprint. We expect there will be a minimum 3-month period where all piezometers can be monitored simultaneously to allow for correlation to the longer-term records.

Groundwater monitoring locations for the proposed works at Walmsley Park are shown in Appendix F and listed in Appendix C.

7.2 Groundwater Monitoring Accuracy (Condition 4.20)

All water level data shall be recorded to an accuracy of +/- 5 mm.

7.3 Monitoring Frequency (Condition 4.21, 4.23 and 4.25)

Groundwater levels will be monitored at the frequencies described in Table 9. Monitoring may be from a combination of manual readings, automated data loggers and / or telemetered sites where appropriate; however, in all cases the frequencies will be at the minimum noted in Table 9.

As a result of the large volume of data, it will not be practical to provide tabulated records of groundwater levels with each report; however, plots of groundwater level vs. time for each piezometer will be provided and tabulated records can be viewed on request.

Groundwater levels will be plotted against time, key construction milestones, and against alert trigger levels to allow direct comparison.

Table 9: Groundwater Monitoring Schedule[11]

Relevant Condition	Project Stage	Groundwater Monitoring Frequency
4.21	For a period of at least 12 months prior to commencement of dewatering	Minimum monthly and a reading no greater than one week prior to commencement of dewatering.
4.23	From commencement of dewatering	Boreholes < 100 m from active shaft construction or tunnel excavation face: Minimum weekly Otherwise: Minimum monthly
4.25	12 months following completion of dewatering or lesser period as specified in 4.25.	Minimum monthly
4.25	After 12 months following completion where specifically required	Minimum monthly

7.3.1 Pre-Construction Monitoring

Condition 4.21 requires monthly monitoring for a period of at least 12 months prior to commencement of dewatering, with a reading no greater than 1 week prior to commencement of dewatering. Any monitoring stations installed within the 12-month period must have at least three measurements, over a minimum 2-month period prior to commencement of dewatering.

At both the Keith Hay Park and Walmsley Park project sites there are existing piezometers with long term records (>12 months), which can be used to establish baseline low levels. As described above, these piezometers will be maintained for as long as possible but are expected to become damaged /inaccessible at some stage.

One (1) new vibrating wire piezometer at Keith Hay Park and three (3) new vibrating wire piezometers at Walmsley Park are planned to be installed prior to shaft excavation. Following installation baseline monitoring will be undertaken over the next few months to establish baseline levels and trigger levels ahead of works commencing on site. These will be reviewed continuously until such time as dewatering starts or a natural seasonal low level can be established, at which time permission may be sought to update the baseline and trigger levels.

[11] Commencement of dewatering are here to be understood as commencement of excavation as no dewatering are planned at neither the Keith Hay nor Walmsley Park construction site.

7.3.2 Active Construction Monitoring

Groundwater levels will be monitored at the frequencies described in Table 9. Monitoring may be from a combination of manual readings, automated data loggers and / or telemetered sites where appropriate; however, in all cases the frequencies will be at the minimum noted in Table 9.

Where the piezometer is within 100 m of the shaft or active tunnel face the groundwater level will be recorded at a minimum weekly frequency.

Subject to the results of monitoring confirming that full drawdown has been achieved (and is recovering), that drawdown has stabilised or that drawdown has not occurred, permission may be sought from Council to reduce the frequency of the monitoring for subsequent stages of the Project.

7.3.3 Post-Construction Monitoring

Monitoring will continue on a monthly basis for a period of 12 months after completion of the dewatering[12].

Written approval from Auckland Council to cease monitoring for a particular piezometer may be sought within this period if the monitoring shows:

- Recovery of the groundwater level to within 2 metres of the pre-construction groundwater level and above the trigger level; or
- A trend of increasing groundwater level in at least three consecutive monthly measurements and groundwater level is above trigger levels.

[12] Completion of dewatering here defined as the end of the shaft excavation works as no dewatering is planned.

8. Settlement Monitoring

A network of settlement monitoring stations, to detect vertical and/or horizontal movements that occur as a result of works proposed at Keith Hay Park and Walmsley Park respectively, has been established as per consent conditions 4.26 to 4.34.

The settlement monitoring network at Keith Hay Park includes:

- Ground surface monitoring marks (9 installed, 14 proposed).

The settlement monitoring network at Walmsley Park includes:

- Ground surface monitoring marks (6 installed, 17 proposed); and
- Utility movement monitoring marks (22 proposed along the Mt Roskill sewer line DN225 Branch 9 and the connection DN150 sewer line).

8.1 Location of Monitoring Stations (Condition 4.26 and 4.27)

A network of Ground Settlement Monitoring Marks has been established at both the Keith Hay Park and the Walmsley Park sites to detect any deformation (vertical and/or horizontal movements).

The Ground Settlement Monitoring Marks have been located generally as follows:

a) at least one mark within 5 m of each of the groundwater monitoring boreholes described in Condition 4.19;

b) at locations along the alignment of the tunnels, and around each of the shafts, such that:

   i. the marks are more closely spaced in areas of higher settlement risk, and more widely spaced in areas of low settlement risk, these areas being identified in the risk assessment carried out under Condition 4.10;

   ii. the marks are of sufficient number and are located such that they provide a reliable basis for assessing, monitoring and responding to settlement risk during shaft sinking and tunnelling construction work and for confirming compliance with the limits set out in Condition 4.33; and

   iii. the marks shall extend out on each side of the tunnel alignment and around each of the shafts by at least 50 m beyond the zone of influence identified in the risk assessment carried out under Condition 4.10.

With regards to b) iii, survey monitoring has generally been limited to areas where settlement of > 10 mm is calculated to occur. This reflects that the risk assessment has not identified any buildings expected to be "at risk". However, the markers required by a) are generally located beyond the zone of influence and hence are considered sufficient to meet the general intent of this Condition, providing for monitoring in areas where settlement is not expected.

In the event that any markers are damaged or destroyed, the monitoring marks will be replaced with new monitoring marks, unless otherwise agreed in writing with Council (as per Condition 4.27).

The location of all monitoring marks and installations required for consenting are provided in Appendix F.

To meet the requirements of the above, settlement arrays aligned normal to the shaft perimeter are proposed. These arrays are a requirement of the project's specifications but in this case can serve both compliance and construction monitoring purposes. Survey marks are spaced nominally at 0 m, 2 m, 5 m, 10 m, 25 m, 50 m and 75 m from the shaft perimeter. The locations of these monitoring arrays are also shown on the plans in Appendix F.

8.2 Monitoring Frequency (Conditions 4.28, 4.31 and 4.34)

The frequency of ground settlement monitoring is outlined in Table 10.

Table 10: Ground Surface, Building and Utility Monitoring Frequency[13]

Relevant Condition	Project Stage	Settlement Monitoring Frequency as Specified in the Consent Conditions
4.28	For a period of at least 12 months prior to commencement of dewatering	At least three times in 12 months, sufficient to establish seasonal variability and a reading no greater than one week prior to commencement of dewatering.
4.31	During construction	Survey Marks located < 50 m from excavated tunnel and < 100 m from excavated shaft or the tunnel excavation face: minimum monthly. Entire network: Minimum 6 monthly
4.34	12 months following completion of dewatering or lesser period as specified in 4.34	Minimum 6 monthly
4.34	After 12 months following completion where required	As required

8.2.1 Pre-Construction Surveys and Monitoring

Pre-construction monitoring has been undertaken for a small number of ground surface monitoring marks that were installed by Watercare to establish baseline ground surface movements associated with seasonal variations in soil moisture content and associated shrink/swell behaviour unrelated to construction of the project. The monitoring has been undertaken using a deep level monitoring pin as a datum and several shallow monitoring points near each shaft site over a minimum period of 12 months. Data will be presented in Appendix I.

Three readings over 12 months is not practical for the shaft array marks, which can only be installed after site establishment; however, the data from the longer-term marks described above is considered sufficient to assess background seasonal variation on the site.

8.2.2 Active Construction Phase

The settlement monitoring network will be surveyed as per Table 10. Results will be compared with pre-construction minimum levels established in the M&CP and evaluated against the trigger levels.

8.2.3 Post-Construction Surveys and Monitoring

Ground surface monitoring marks will be surveyed as per Table 10.

Post-construction surveys will include similar investigations to the pre-construction surveys and be undertaken on any building located in areas at-risk of settlement (as identified in Section 4 and Appendix E,

[13] Commencement of dewatering is here to be understood as commencement of excavation as no dewatering is planned at either the Keith Hay or Walmsley Park construction sites.

for Keith Hay and Walmsley there are no buildings requiring specific survey) and / or where pre-construction condition surveys were undertaken. The surveys will be undertaken within six months of completion of dewatering and additional surveys can also be carried out where and when required for the purpose of checking for damage and following up on a report of damage (as required by Conditions 4.15 to 4.17).

The post-completion survey is to be provided in writing to the property owner(s) and Auckland Council within 15 working days of completing the survey and shall include a determination of the cause of damage identified (if any) since the pre-construction survey, and a description of the steps taken to repair any damage (as required by Condition 4.18).

9. Shaft Retaining Wall Monitoring Programme

As set out in sections 4 and 5 of this M&CP, there are no buildings considered to be “at risk” from the shaft works at either the Keith Hay Park or the Walmsley Park site. This is largely due to the proposed construction methodology (in the wet) and using a drilled casing and small shaft diameter. As such retaining wall monitoring (as per condition 4.26) is not strictly necessary for either site and hence is not included in this M&CP.

Regardless, as part of wider project instrumentation and monitoring requirements, a shaft retaining wall monitoring programme will be implemented for all new retaining structures. For the Keith Hay and Walmsley sites, this will comprise four prisms located at north, south, east and west positions around the perimeter at the top of the steel casing. Whilst not required for this M&CP the anticipated location of this monitoring is shown on the plans in Appendix F.

10. Response, Mitigation and Contingency

10.1 Response to Alerts

10.1.1 Groundwater Alerts

Groundwater trigger levels (Alerts) are described in Section 5. If the groundwater Alert level 2 is exceeded, the following response will occur:

- The Contractor will notify Auckland Council and Watercare within three (3) working days and will advise of the trigger exceedance, the risk of drawdown inducing settlement that could cause damage to buildings, and details of the actions taken.
- If initial review suggests that there may be a risk of settlement, then the frequency of groundwater level monitoring for the affected area may be increased to three-times weekly until such time as a more robust assessment of risk has been undertaken.
- The building and ground settlement information will be reviewed to identify any potential risk of damage to building and utilities (Section 4).
- If potential for settlement is identified then the Instrumentation Manager, in liaison with the Design Engineer and Contractor, is to consider if an increased frequency of survey monitoring is warranted.

10.1.2 Settlement Alerts

Settlement Alert Trigger Levels are defined in Condition 4.30 of the resource consent as: the Differential and Total Settlement Limit set at a threshold less than the Alarm Level, at which the Consent Holder shall implement further investigations and analyses as described in the M&CP to determine the cause of settlement and the likelihood of further settlement.

Settlement alert trigger levels are defined in Section 5 and Appendix D.

In the event that settlement exceeds an identified Alert trigger level during construction works, the following will occur:

- The Contractor will notify Auckland Council and Watercare within three (3) working days.
- A repeat survey of ground (and where required building) survey monitoring will be undertaken to confirm the exceedance and the extent of area affected.
- The Contractor will:
  - Reassess the works constructed up to that time to identify if the higher movement can be attributed to construction activities; and, if confirmed as attributable to construction will
  - Recommend measures to restrain further increases in movement and possible ensuing effects to existing structures.
- If the exceedance is attributable to construction and the review described above indicates that alarm level will be reached or exceeded, then a written report will be provided to Auckland Council and Watercare, which provides analyses of all monitoring data, relating to the exceedance of the trigger levels and any actions taken. If the movement is not attributable to construction, then the movement would be addressed in the 6-monthly report.

10.2 Response to Alarms

'Alarm Level' is defined in Condition 4.30 of the resource consent as: the Differential and Total Settlement Limit set in Condition 4.33, or which has the potential to cause damage to buildings, structures and services, at which the Consent Holder shall immediately stop dewatering the site and cease any activity which has

the potential to cause deformation to any building or structure or adopt the alternative contingency measures approved by the Manager.

Settlement alarm trigger levels are provided in Section 5 and Appendix D.

In the event that settlement exceeds the identified Alarm trigger levels during construction works, the actions described above for an Alert level exceedance will be undertaken along with the following measures:

- The Contractor will notify Auckland Council and Watercare within three (3) working days.
- Any work likely to result in further settlement will be stopped immediately;
- If required, additional instrumentation will be installed to monitor potentially affected buildings or structures in the affected area, with greater detail prior to work being resumed.
- The Contractor's Design Consultant will prepare and submit a written report to Auckland Council within seven (7) working days of alarm level exceedance. This report will provide:
  - Analyses of all monitoring data relating to the exceedance of the trigger levels;
  - Assessment of risk of any further settlement and building damage;
  - Recommendations for remedial actions required in order to complete construction so as to avoid damage that will affect building serviceability; and
  - The actions that will be or have already been taken to address the triggered alarm level.

10.3 Response to Building Damage (Condition 4.18)

10.3.1 General

Unforeseen damage is defined in the note below consent Condition 4.18 as: damage to buildings and structures that has occurred outside the area identified as the zone of influence under Condition 4.10 or to buildings or structures that are located within the zone of influence but were not considered to be at-risk at the time of the approval of the M&CP.

In the event that unforeseen damage to buildings, structures and/or services is reported during the construction works or determined from a building condition survey or inspection the following will occur:

- The Contractor will notify Auckland Council and Watercare as soon as practicable;
- The reported damage will be compared with the pre-construction building condition survey to determine if the damage is:
  - Pre-existing and unchanged,
  - New, or
  - Pre-existing, but exacerbated.
- The construction history in the vicinity of the building will be reviewed, along with the recorded settlement history, to determine if the damage can be reasonably attributed to the construction works;
- If the damage cannot be reasonably attributed to the construction works, the Contractor will present a report setting out the basis for this assessment;
- If the damage can be reasonably attributed to the construction works the Contractor will prepare a methodology for repair of the damage (approved by a CPEng) caused, including timeframes;
- Repairs will be undertaken urgently, in accordance with the approved methodology, unless written approval for not repairing the damage is provided. The timing and nature of the repairs will depend on the owner's requirements, stage of construction and degree of damage.

10.4 Mitigation Options

10.4.1 Design Validation

The first mitigation measure for the effects of settlement is to ensure that temporary ground support works are constructed in accordance with the design, and that the ground conditions encountered are consistent with the design assumptions.

During construction of the temporary works the design assumptions with regard to ground conditions will be validated by observation of materials encountered as the excavation proceeds.

The construction of the temporary works will be subject to quality control procedures and design validation records, certifying that the temporary works have been constructed in accordance with the design, will be issued progressively prior to loading each layer of ground support.

10.4.2 Mitigation of Effects

In the event that differential settlement or total settlement exceeds the identified Alert or Alarm trigger level during construction works, or ground conditions differ significantly from the design assumptions then the mitigation options include:

- Additional specific structural and geotechnical calculations;
- Reducing the spacing of soldier piles (where applicable);
- Installation of additional anchors or struts and walers;
- Adjustment of the vertical spacing of these structural elements;
- Preloading struts to reduce ground movement;
- Applying thicker shotcrete arches between the soldier piles, or increasing the vertical extent of the shotcrete arches;
- Installation of additional instrumentation; and
- Further structural assessment of an affected building.

10.5 Contingency Measures

The Contractor will develop a range of contingency measures with which to respond to the events more likely to result in trigger levels being exceeded. These proactive mitigation measures are proposed to include:

- Pressurisation of the TBM;
- Watertight shafts;
- Shaft support measures while excavating in soils;
- Building protection measures; and
- The provision of stand-by temporary works methods and materials such as compensation grouting or other components that may be added to the ground support system to increase its strength or stiffness or reverse adverse ground movements.

In the event the most appropriate contingency measure will be implemented to mitigate the actual or anticipated adverse effects of the triggering event.

10.5.1 Pressurisation of the TBM

The requirement for an Earth Pressure Balance ('**EPB**') TBM with annular grouting of the segmental lining through the TBM tail shield will minimise mechanical settlements related to tunnelling. Operation of the

TBM in closed-mode or partial-mode will control dewatering around the tunnel, thus limiting or eliminating risk of consolidation settlements due to dewatering.

10.5.2 Watertight Shafts

Where watertight or very low permeability shaft support systems are specified (e.g. MPS D-walls and shaft support systems in soil such as secant piles, sheet piles, steel casings or caissons), dewatering of soils will be limited and resulting consolidation settlements reduced.

10.5.3 Shaft Support Measures While Excavating in Soils

Section 2.2 outlines the proposed construction methodology, whereby excavation in soils will be carried out within the temporary works structures (secant pile walls) which are expected to be essentially impermeable until the excavation reaches the ECBF and thereafter seepage is assumed from the rock. This process is followed to control invert heave and lateral shaft wall movements in weak soils, which in turn will limit shaft mechanical settlements.

10.5.4 Building Protection Measures

Possible methods for building protection include underpinning, permeation grouting, compaction grouting, and compensation grouting. Building and utility protection methods will be selected by the JV.

10.6 Training

Training relevant to the implementation of this groundwater and settlement M&CP is as follows:

- Contractor staff are trained for any specific construction operation (dewatering / shaft excavation) procedures and mitigation actions which could potentially contribute to groundwater drawdown; and
- Monitoring staff are trained for groundwater monitoring, settlement monitoring and reading of other geotechnical instruments.

Refer to details of roles and responsibilities in Section 3.

11. Communications

11.1 General

General communication measures are detailed in the Communications Plan. The Communication Plan also sets out the specific communication measures in relation to groundwater and settlement condition surveys and building movement markers.

11.2 Groundwater and Settlement Related Complaints

Procedures for responding to complaints about construction activities, including groundwater and settlement related complaints, are set out in the Communications Plan.

12. Reporting

12.1 Commencement of Work (Condition 4.4)

The Consent Holder shall, at least 10 working days prior to the commencement of shaft sinking or tunnelling, advise the Manager, in writing, of the date of the proposed commencement of this work (Condition 4.4).

12.2 Reporting of Building Condition Surveys (Condition 4.17)

A copy of all pre-construction, post-construction or any additional Building Condition Surveys, and interim visual inspections, will be forwarded to the respective property owner(s) within 15 working days of receipt of the final reports.

As discussed with Council, on previous projects landowners have expressed concerns at condition surveys being sent directly to Council, and in some instances, access for such surveys has been denied for this reason. Accordingly, and as agreed with Council, copies of the surveys will not be automatically sent to Council.

Copies will be held on file and can be made available to Council if specifically requested, and with the landowner's approval.

12.3 Reporting and Review of Monitoring Results (Condition 4.20, 4.23 and 4.31)

The results of all groundwater monitoring will be reported at six-monthly intervals to Auckland Council, and full compilations of collected data will be supplied every six months (Condition 4.20, 4.23 and 4.31).

The results of groundwater level, ground and building settlement will be compared to the expected effects of construction in order to reassess risk throughout the construction period.

Reporting will confirm if exceedances of Alert or Alarm trigger levels occurred during the monitoring period and will provide details of any remedial actions undertaken.

12.4 Reporting of Damage (Condition 4.18)

If the exercise of this consent causes any unforeseen damage to buildings, structures or services not assessed under Conditions 4.15 and 4.16, the Consent Holder shall notify the Manager as soon as practicable, and provide in writing to the Manager a methodology for repair of the damage caused that has been approved by a Chartered Professional Engineer and shall undertake such repairs in accordance with the approved methodology, as soon as practicable, at its cost, unless written approval for this damage is provided from the owners (Condition 4.18).

12.5 Completion of Construction (Condition 4.5)

Auckland Council will be advised in writing, within 10 working days of the Completion of Construction (Condition 4.5).

13. Review of this Plan

The M&CP may be updated by the Consent Holder, with the necessary approval from Auckland Council, throughout the course of the Project to reflect any changes to conditions and material changes associated with changes to construction techniques or the natural environment as per Condition 4.9.

Trigger levels may need to be reviewed from time to time, as indicated in Condition 4.6 (f) of the resource consent. In particular, it is anticipated that review of the trigger levels will be required to confirm they are appropriately set to provide early warning of settlement with the potential to cause damage to buildings and services. These trigger levels may be revised with more/less stringent levels if recommended by further assessment, or to acknowledge change of conditions at the site.

An annual management review will also be undertaken of the Project CMP, including the M&CP and other sub-plans. The management review procedure is described in further detail within the Project CMP.

Reasons for making changes to the Plan will be documented. A copy of the original Plan document and subsequent versions will be kept for the Project records and marked as obsolete. Each new/updated version of the Plan documentation will be issued with a version number and date to prevent obsolete Plan documentation being used.

Auckland Council approval will be required for any amendments to the M&CP, prior to any such amendment being implemented.

14. References

Arup, 2020a: Keith Hay Park Shaft Detailed Design Report for Temporary Works. Document reference 267571-DSCIN003-GESH-RPT-0001 (Revision 2, dated 21 February 2020).

Arup, 2020b: Walmsley Park Shaft Detailed Design Report for Temporary Works. Document reference 267571-DSCIN005-GESH-RPT-0001 (Revision 2, dated 21 February 2020).

Arup, 2020c: Keith Hay Park Shaft Site Damage Assessment Report. Document reference 267571-DSCIN003-UTSH-RPT-0001 (Revision 2, dated 30 March 2020).

Arup, 2020d: Walmsley Park Shaft Site Damage Assessment Report: Document reference 267571-DSCIN005-UTSH-RPT-0001 (Revision 2, dated 30 March 2020).

Auckland Council, 2013: Central Interceptor Main Works, Resource Consent Conditions. Document reference STD00538.01953

Burland J.B. (1995). Assessment of risk of damage to buildings due to tunnelling and excavation, Invited Special Lecture: 1st International Conference of Earthquake Geotechnical Engineering, IS Tokyo, 1995.

Mair, R.J., Taylor, R.N. and Burland, J.B. (1996). Prediction of ground movements and assessment of risk of building damage due to bored tunnelling. In *International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground*. London" City University, April 1996, p 713-718.

APPENDIX A - COMMUNICATION RECORDS

Please refer to the Project Communication Plan

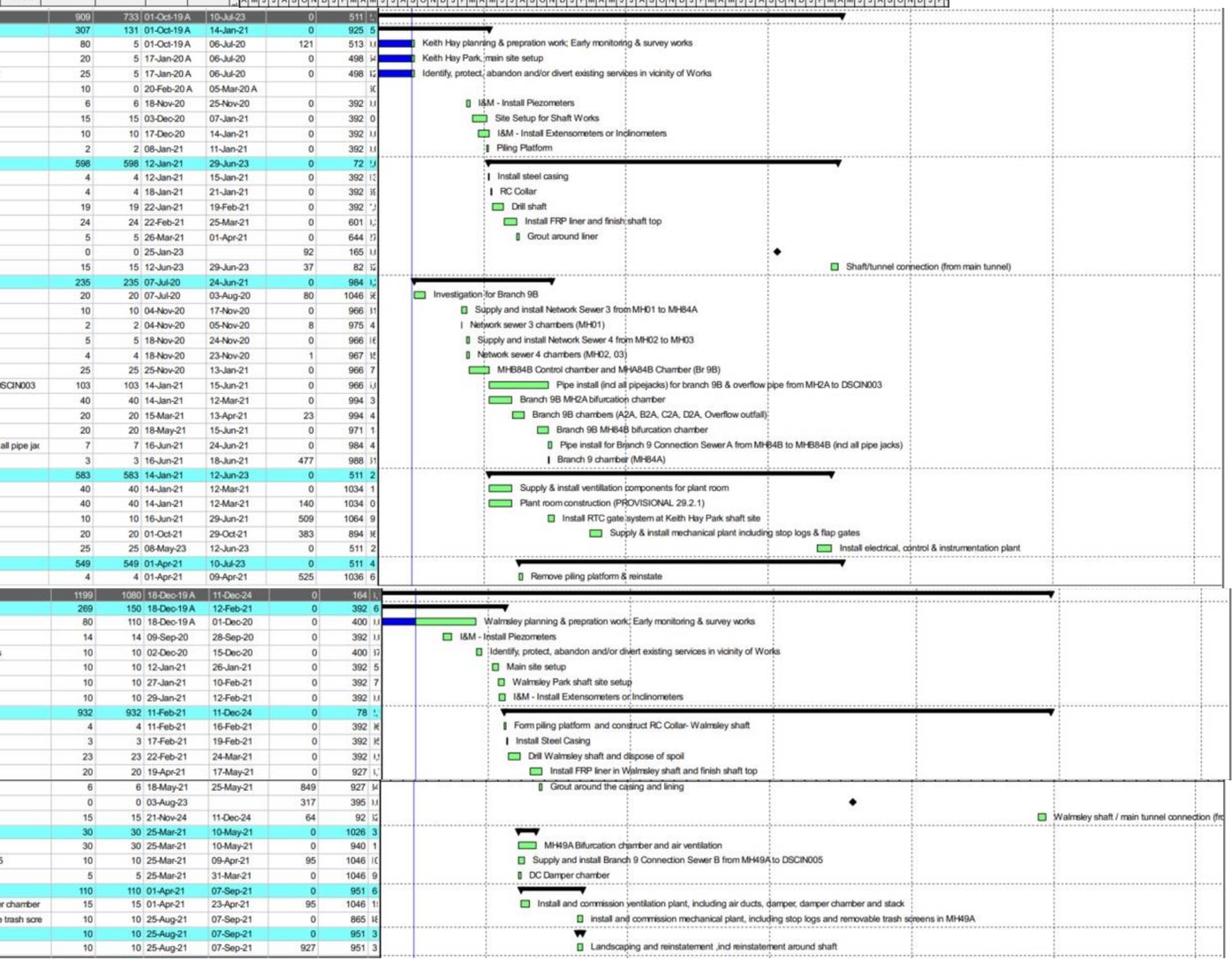
APPENDIX B - CONSTRUCTION WORKS PROGRAMME

Project: WSL: CENTRAL INTERCEPTOR MAIN WORKS PROJECT - Rev 4.
Working File

Central Interceptor Main Works Project - Revised Programme Submission; Rev.4.1
Detailed Programme

Data Date (Date Progressed to): 30-Jun-20
Print Date: 22-Jul-20

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Free Float	Total Float
WSL-CI-R4.1-1.2.1.3.2 Keith Hay Park (DSCIN003)		909	733	01-Oct-19 A	10-Jul-23	0	511
WSL-CI-R4.1-1.2.1.3.2.1 Site Establishment		307	131	01-Oct-19 A	14-Jan-21	0	925
CI-S7-DSCIN3-S-9451	Keith Hay planning & prepration work; Early monitoring & survey works	80	5	01-Oct-19 A	06-Jul-20	121	513
CI-S7-DSCIN3-S-0100	Keith Hay Park, main site setup	20	5	17-Jan-20 A	06-Jul-20	0	498
CI-S7-DSCIN3-S-440	Identify, protect, abandon and/or divert existing services in vicinity of Works	25	5	17-Jan-20 A	06-Jul-20	0	498
CI-S7-DSCIN3-S-1020	Demolish existing house (22 Gregory Place)	10	0	20-Feb-20 A	05-Mar-20 A		
CI-S7-DSCIN3-S-140	I&M - Install Piezometers	6	6	18-Nov-20	25-Nov-20	0	392
CI-S2-DSCIN2-S-360	Site Setup for Shaft Works	15	15	03-Dec-20	07-Jan-21	0	392
CI-S7-DSCIN3-S-150	I&M - Install Extensometers or Inclinometers	10	10	17-Dec-20	14-Jan-21	0	392
CI-S2-DSCIN3-S-0120	Piling Platform	2	2	08-Jan-21	11-Jan-21	0	392
WSL-CI-R4.1-1.2.1.3.2.2 Shaft Works		598	598	12-Jan-21	29-Jun-23	0	72
CI-S2-DSCIN3-S-900	Install steel casing	4	4	12-Jan-21	15-Jan-21	0	392
CI-S2-DSCIN3-S-910	RC Collar	4	4	18-Jan-21	21-Jan-21	0	392
CI-S2-DSCIN3-S-0130	Drill shaft	19	19	22-Jan-21	19-Feb-21	0	392
CI-S2-DSCIN3-S-0140	Install FRP liner and finish shaft top	24	24	22-Feb-21	25-Mar-21	0	601
CI-S2-DSCIN3-S-0150	Grout around liner	5	5	26-Mar-21	01-Apr-21	0	644
CI-S2-DSCIN3-S-0230	TBM arrival at shaft	0	0	25-Jan-23		92	165
CI-S2-DSCIN3-S-0240	Shaft/tunnel connection (from main tunnel)	15	15	12-Jun-23	29-Jun-23	37	82
WSL-CI-R4.1-1.2.1.3.2.3 Sewer Connections		235	235	07-Jul-20	24-Jun-21	0	984
CI-S7-DSCIN3-S-960	Investigation for Branch 9B	20	20	07-Jul-20	03-Aug-20	80	1046
CI-S7-DSCIN3-S-0110	Supply and install Network Sewer 3 from MH01 to MH84A	10	10	04-Nov-20	17-Nov-20	0	966
CI-S7-DSCIN3-S-1000	Network sewer 3 chambers (MH01)	2	2	04-Nov-20	05-Nov-20	8	975
CI-S7-DSCIN3-S-970	Supply and install Network Sewer 4 from MH02 to MH03	5	5	18-Nov-20	24-Nov-20	0	966
CI-S7-DSCIN3-S-1010	Network sewer 4 chambers (MH02, 03)	4	4	18-Nov-20	23-Nov-20	1	967
CI-S7-DSCIN3-S-0150	MHB84B Control chamber and MHA84B Chamber (Br 9B)	25	25	25-Nov-20	13-Jan-21	0	966
CI-S7-DSCIN3-S-0170	Pipe install (incl all pipejacks) for branch 9B & overflow pipe from MH2A to DSCIN003	103	103	14-Jan-21	15-Jun-21	0	966
CI-S7-DSCIN3-S-930	Branch 9B MH2A bifurcation chamber	40	40	14-Jan-21	12-Mar-21	0	994
CI-S7-DSCIN3-S-980	Branch 9B chambers (A2A, B2A, C2A, D2A, Overflow outfall)	20	20	15-Mar-21	13-Apr-21	23	994
CI-S7-DSCIN3-S-940	Branch 9B MH84B bifurcation chamber	20	20	18-May-21	15-Jun-21	0	971
CI-S7-DSCIN3-S-950	Pipe install for Branch 9 Connection Sewer A from MH84B to MHB84B (incl all pipe jac	7	7	16-Jun-21	24-Jun-21	0	984
CI-S7-DSCIN3-S-990	Branch 9 chamber (MH84A)	3	3	16-Jun-21	18-Jun-21	477	988
WSL-CI-R4.1-1.2.1.3.2.4 Mechanical,Electrical and Ventilation Works		583	583	14-Jan-21	12-Jun-23	0	511
CI-S7-DSCIN3-S-0180	Supply & install ventillation components for plant room	40	40	14-Jan-21	12-Mar-21	0	1034
CI-S7-DSCIN3-S-0200	Plant room construction (PROVISIONAL 29.2.1)	40	40	14-Jan-21	12-Mar-21	140	1034
CI-S29-RTCSys-1000	Install RTC gate system at Keith Hay Park shaft site	10	10	16-Jun-21	29-Jun-21	509	1064
CI-S7-DSCIN3-S-0210	Supply & install mechanical plant including stop logs & flap gates	20	20	01-Oct-21	29-Oct-21	383	894
CI-S7-DSCIN3-S-0190	Install electrical, control & instrumentation plant	25	25	08-May-23	12-Jun-23	0	511
WSL-CI-R4.1-1.2.1.3.2.5 Site Re-establishment		549	549	01-Apr-21	10-Jul-23	0	511
CI-S2-DSCIN3-S-920	Remove piling platform & reinstate	4	4	01-Apr-21	09-Apr-21	525	1036
WSL-CI-R4.1-1.2.2.2.2 Walmsley Park (DSCIN005)		1199	1080	18-Dec-19 A	11-Dec-24	0	164
WSL-CI-R4.1-1.2.2.2.2.1 Site Establishment		269	150	18-Dec-19 A	12-Feb-21	0	392
CI-S3-DSCIN5-N-9461	Walmsley planning & prepration work; Early monitoring & survey works	80	110	18-Dec-19 A	01-Dec-20	0	400
CI-S3-DSCIN5-N-140	I&M - Install Piezometers	14	14	09-Sep-20	28-Sep-20	0	392
CI-S3-DSCIN5-N-180	Identify, protect, abandon and/or divert existing services in vicinity of Works	10	10	02-Dec-20	15-Dec-20	0	400
CI-S3-DSCIN5-N-0100	Main site setup	10	10	12-Jan-21	26-Jan-21	0	392
CI-S3-DSCIN5-N-350	Walmsley Park shaft site setup	10	10	27-Jan-21	10-Feb-21	0	392
CI-S3-DSCIN5-N-150	I&M - Install Extensometers or Inclinometers	10	10	29-Jan-21	12-Feb-21	0	392
WSL-CI-R4.1-1.2.2.2.2.2 Shaft Works		932	932	11-Feb-21	11-Dec-24	0	78
CI-S3-DSCIN5-N-0110	Form piling platform and construct RC Collar- Walmsley shaft	4	4	11-Feb-21	16-Feb-21	0	392
CI-S3-DSCIN5-N-0230	Install Steel Casing	3	3	17-Feb-21	19-Feb-21	0	392
CI-S3-DSCIN5-N-0120	Drill Walmsley shaft and dispose of spoil	23	23	22-Feb-21	24-Mar-21	0	392
CI-S3-DSCIN5-N-0130	Install FRP liner in Walmsley shaft and finish shaft top	20	20	19-Apr-21	17-May-21	0	927
CI-S3-DSCIN5-N-0240	Grout around the casing and lining	6	6	18-May-21	25-May-21	849	927
CI-S3-DSCIN5-N-0160	TBM arrival at Walmsley shaft	0	0	03-Aug-23		317	395
CI-S3-DSCIN5-N-0170	Walmsley shaft / main tunnel connection (from main tunnel)	15	15	21-Nov-24	11-Dec-24	64	92
WSL-CI-R4.1-1.2.2.2.2.3 Sewer Connections		30	30	25-Mar-21	10-May-21	0	1026
CI-S3-DSCIN5-N-0140	MH49A Bifurcation chamber and air ventilation	30	30	25-Mar-21	10-May-21	0	940
CI-S9-DSCIN5-N-430	Supply and install Branch 9 Connection Sewer B from MH49A to DSCIN005	10	10	25-Mar-21	09-Apr-21	95	1046
CI-S9-DSCIN5-N-440	DC Damper chamber	5	5	25-Mar-21	31-Mar-21	0	1046
WSL-CI-R4.1-1.2.2.2.2.4 Mechanical,Electrical and Ventilation Works		110	110	01-Apr-21	07-Sep-21	0	951
CI-S3-DSCIN5-N-190	Install and commission ventilation plant, including air ducts, damper, damper chamber	15	15	01-Apr-21	23-Apr-21	95	1046
CI-S3-DSCIN5-N-200	install and commission mechanical plant, including stop logs and removable trash scre	10	10	25-Aug-21	07-Sep-21	0	865
WSL-CI-R4.1-1.2.2.2.2.5 Site Re-establishment		10	10	25-Aug-21	07-Sep-21	0	951
CI-S3-DSCIN5-N-0150	Landscaping and reinstatement ,incl reinstatement around shaft	10	10	25-Aug-21	07-Sep-21	927	951



APPENDIX C - GROUNDWATER MONITORING PIEZOMETERS

Site	Piezo ID	Currently monitor (yes/no)	Easting (NZTM)	Northing (NZTM)	Elevation Collar (mRL)	Piezometer Type	Sensor No.	Sensor Depth [VW] or Screen Interval (Standpipe) (mbgl)	Geology Unit
Keith Hay Park	BH250*	Yes	1755311	5912777	57.96	VW - Data logger	1	5.0	ECBF (HW)
							2	9.0	ECBF (MW-UW)
							3	74.0	ECBF (MW-UW)
	BH249*	Yes	1755293	5912817	56.30	Standpipe	1	1.2-4.2	TG
							2	8.0-14.0	TG/ECBF (MW)
	DSCIN003PZ01	No, to be installed				VW - Data logger	1	80	ECBF (MW-UW)
							2	5	TG

Site	Piezo ID	Currently monitor (yes/no)	Easting (NZTM)	Northing (NZTM)	Elevation Collar (mRL)	Piezometer Type	Sensor No.	Sensor Depth [VW] or Screen Interval (Standpipe) (m bgl)	Geology Unit
Walmsley	BH233	Yes	1754223	5914827	47.65	VW - Data logger	1	11.0	TG
	DSCIN005PZ01	No, to be installed				VW - Data logger	1	57	ECBF (MW-UW)
							2	17	TG
	*DSCIN005PZ02***	*No, to be installed*				*VW - Data logger*	*1*	*57*	*ECBF (MW-UW)*
							2	*11*	*TG*
	DSCIN005PZ03	No, to be installed				VW - Data logger	1	57	ECBF (MW-UW)
							2	17	TG

* Due to the location of the piezometer, being within the main working footprint, it is expected that they will be damaged and not replaced. Given the lack of dewatering it is considered that DSCIN003PZ01, located between the shaft and nearest buildings, will be sufficient to provide monitoring at this location

** Will only be required if can't protect / maintain access to BH233

APPENDIX D - TRIGGER LEVELS

Trigger Levels Keith Hay Park

Category	Monitoring Station Type	Station ID	Baseline Groundwater Level (mRL)	Calculated Drawdown (m)	Interim (80 %) Trigger Level	Alert 1 (100 %) Trigger Level	Alert 2 (120 %) Trigger Level
Groundwater	Vibrating Wire Piezometer	BH250 (74 m bgl)	53.61	NA	0.4 m	0.5 m	0.6 m
		BH250 (9 m bgl)	55.97	NA	0.4 m	0.5 m	0.6 m
		BH250 (5 m bgl)	53.95	NA	0.4 m	0.5 m	0.6 m
		DSCIN003PZ01_1	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN003PZ01_2	TBD	NA	0.4 m	0.5 m	0.6 m
	Standpipe	BH249 (8-14 m bgl)	54.77	NA	0.4 m	0.5 m	0.6 m
		BH249 (1.2-4.2 m bgl)	55.77	NA	0.4 m	0.5 m	0.6 m

Category	Monitoring Station Type	Station ID	Baseline (mRL)	Calculated Movement (mm)	Alert Trigger Level	Alarm Trigger Level
Ground Surface	Pins and markers	North Array (all markers)	TBD	30*	24	30
		West Array (all markers)	TBD	30*	24	30

TBD – indicates recently installed instrument, baseline monitoring still to be undertaken. Final baseline level to be confirmed at final submission to Council

* Maximum calculated movement immediately adjacent the shaft

Walmsley Park Trigger Levels

Category	Monitoring Station Type	Station ID	Baseline Groundwater Level (mRL)	Calculated Drawdown (m)	Interim (80 %) Trigger Level	Alert 1 (100 %) Trigger Level	Alert 2 (120 %) Trigger Level
Groundwater	Vibrating Wire Piezometer	BH233 (11 m bgl)	45.70	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ01_1	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ01_2	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ02_1	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ02_2	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ03_1	TBD	NA	0.4 m	0.5 m	0.6 m
		DSCIN005PZ03_2	TBD	NA	0.4 m	0.5 m	0.6 m

Category	Monitoring Station Type	Station ID	Baseline (mRL)	Calculated Movement (mm)	Alert Trigger Level	Alarm Trigger Level
Ground Surface	Pins and markers	West Array (all markers)	TBD	40	32	40
		North Array (all markers)	TBD	55	44	55
		East Array (all markers)	TBD	55	44	55

TBD – indicates recently installed instrument, baseline monitoring still to be undertaken. Final baseline level to be confirmed at final submission to Council

* Maximum calculated movement immediately adjacent the shaft

APPENDIX E - SCHEDULE OF AT RISK BUILDINGS AND STRUCTURES

ID	Owner	Address	Survey Status	Expected Total Settlement (mm)	Expected Differential Settlement	Specific Survey Monitoring Required?

No "at risk" buildings or structures for Keith Hay Park and Walmsley Park

APPENDIX F - DRAWINGS

Site	Drawing Number	Plan Name	Revision	Date
Keith Hay Park	2011891.301	DPCIN003 – KEITH HAY PARK– PREDICTED GROUND SURFACE SETTLEMENT CONTOUR *prepared by Arup*	B	**16/06/2020**
	2013333.513	DSCIN003 – KEITH HAY PARK TEMPORARY WORKS. INSTRUMENTATION AND MONITORING PLAN *prepared by JV*	2	**20/08/2020**
Walmsley Park	2011893.301	DPCIN005 – WALMSLEY PARK– PREDICTED GROUND SURFACE SETTLEMENT CONTOUR *prepared by Arup*	B	**16/06/2020**
	2013335.509	DSCIN005 – WALMSLEY PARK TEMPORARY WORKS. INSTRUMENTATION AND MONITORING PLAN *prepared by JV*	2	**20/08/2020**

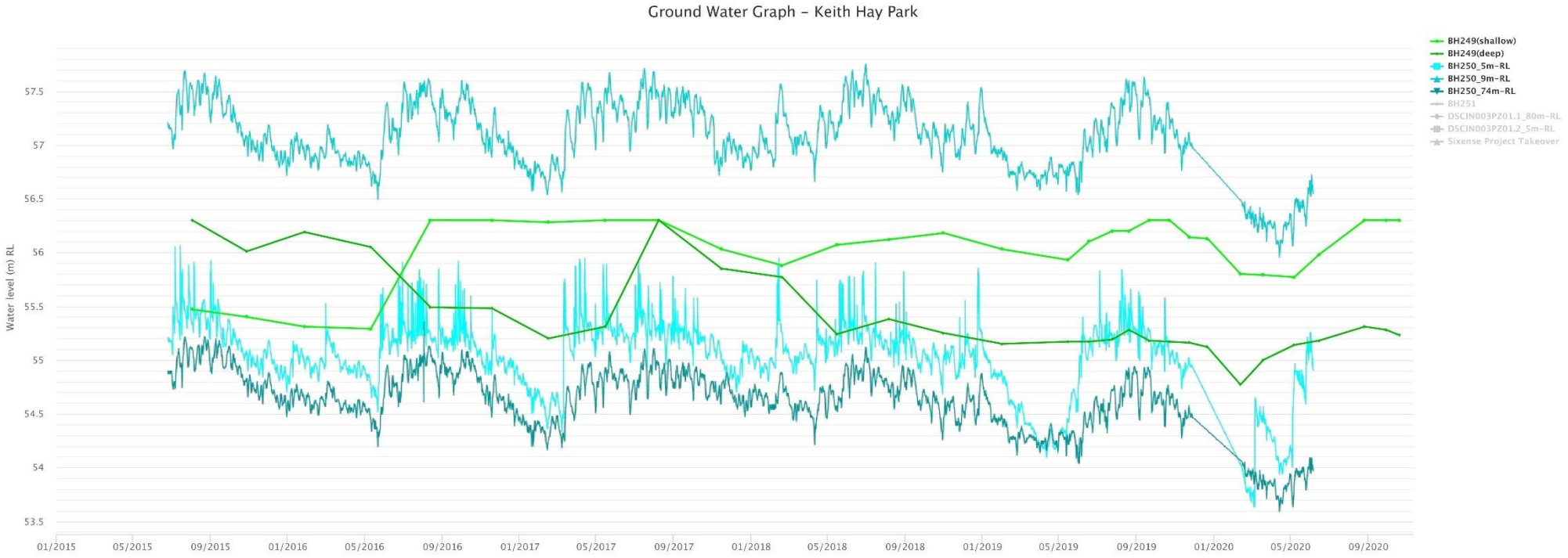
APPENDIX G - SETTLEMENT RISK ASSESSMENT

Refer to:

GAJV-RPT-00072 Keith Hay Park Shaft – Temporary Works Detailed Design Report

GAJV-RPT-00073 Walmsley Park – Temporary Works Detailed Design Report

APPENDIX H - PRE-CONSTRUCTION GROUNDWATER MONITORING DATA


Ground Water Graph – Keith Hay Park
Water level (m) RL
57.5
57
56.5
56
55.5
55
54.5
54
53.5
01/2015
05/2015
09/2015
01/2016
05/2016
09/2016
01/2017
05/2017
09/2017
01/2018
05/2018
09/2018
01/2019
05/2019
09/2019
01/2020
05/2020
09/2020
BH249(shallow)
BH249(deep)
BH250_5m-RL
BH250_9m-RL
BH250_74m-RL
BH251
DSCIN003PZ01.1_80m-RL
DSCIN003PZ01.2_5m-RL
Sixense Project Takeover


Ground Water Graph – Walmsley Park
Water level (m) RL
47
46.8
46.6
46.4
46.2
46
45.8
45.6
01/2015
05/2015
09/2015
01/2016
05/2016
09/2016
01/2017
05/2017
09/2017
01/2018
05/2018
09/2018
01/2019
05/2019
09/2019
01/2020
05/2020
09/2020
BH231
BH232
BH233_11m-RL
Sixense Project Takeover

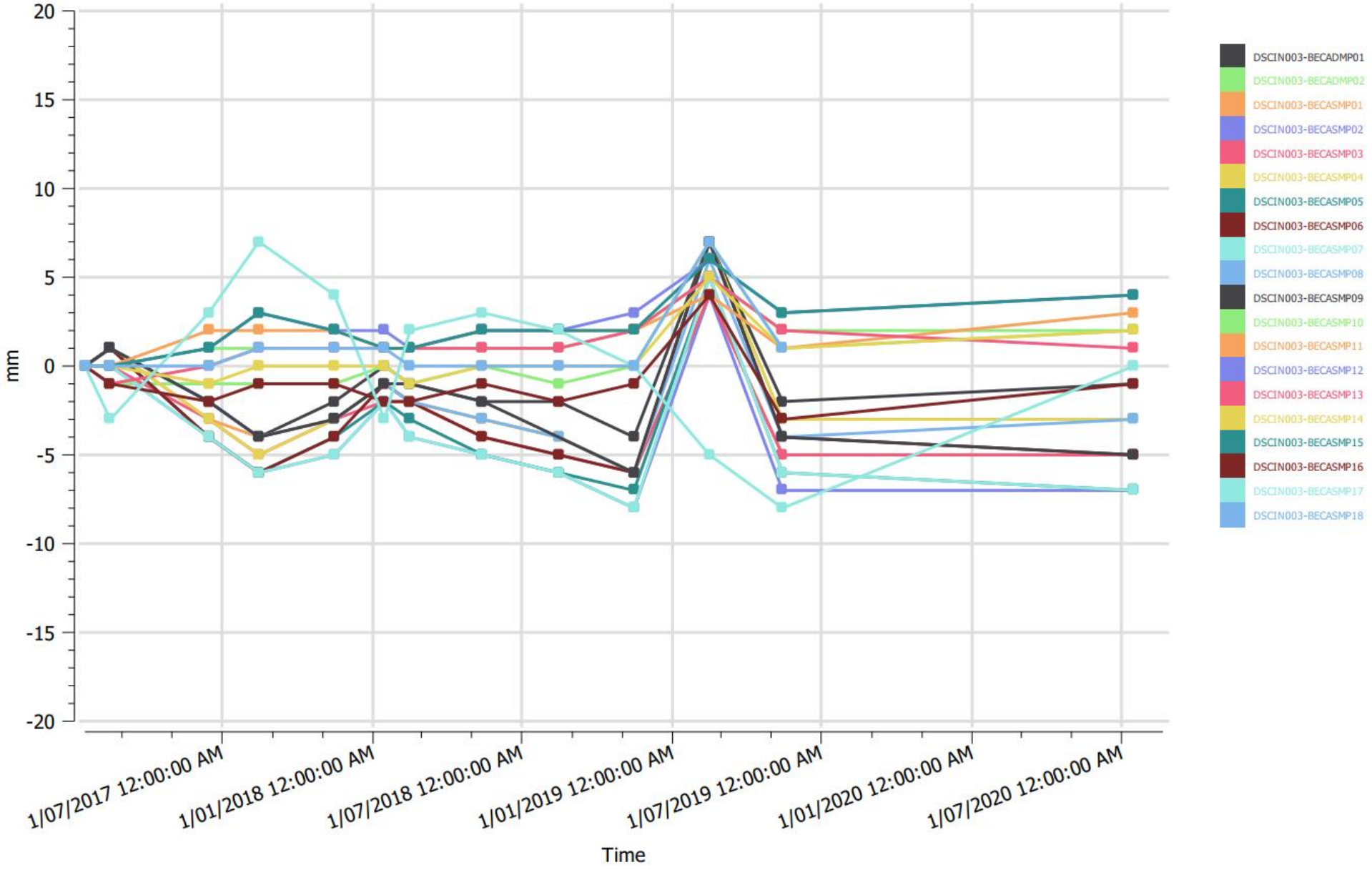
APPENDIX I - PRE-CONSTRUCTION GROUND SURFACE MONITORING DATA

Keith Hay Park – Seasonal SMP Data

Keith Hay Park - Seasonal SMP data

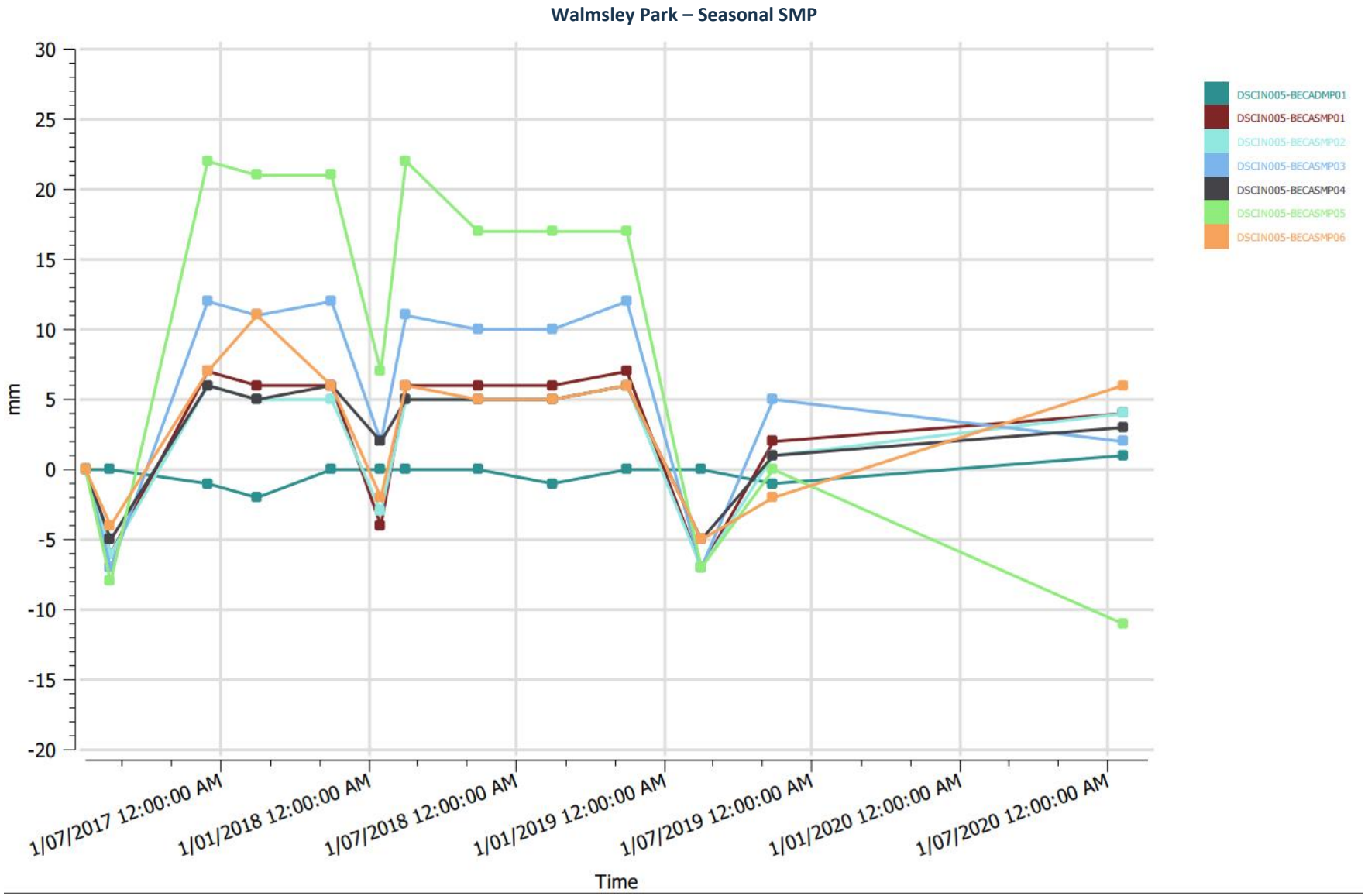
Data	Time	Total	Data	Time	Total	Data	Time	Total	Data	Time	Total
	15/01/2017	0		15/01/2017	0		15/01/2017	0		15/01/2017	0
	15/02/2017	1		15/02/2017	1		15/02/2017	1		15/02/2017	-3
	15/06/2017	-2		15/06/2017	-3		15/06/2017	-2		15/06/2017	3
	15/08/2017	-4		15/08/2017	-5		15/08/2017	-4		15/08/2017	7
	15/11/2017	-2		15/11/2017	-3		15/11/2017	-3		15/11/2017	4
	15/01/2018	0		15/01/2018	-1		15/01/2018	-1		15/01/2018	-3
DSCIN003-BECADMP01_mm	15/02/2018	-1	Sum of DSCIN003-BECASMP04_mm	15/02/2018	-2	DSCIN003-BECASMP09_mm	15/02/2018	-1	Sum of DSCIN003-BECASMP17_mm	15/02/2018	2
	15/05/2018	-2		15/05/2018	-3		15/05/2018	-2		15/05/2018	3
	15/08/2018	-2		15/08/2018	-4		15/08/2018			15/08/2018	2
	15/11/2018	-4		15/11/2018	-6		15/11/2018	-6		15/11/2018	0
	15/02/2019	7		15/02/2019	7		15/02/2019	7		15/02/2019	-5
	15/05/2019	-2		15/05/2019	-3					15/05/2019	-8
	16/07/2020	-1		16/07/2020	-3					16/07/2020	0
	15/01/2017	0		15/01/2017	0		15/01/2017	0		15/01/2017	0
	15/02/2017	-1		15/02/2017	1		15/02/2017	0		15/02/2017	-1
	15/06/2017	-1		15/06/2017	-4		15/06/2017	1		15/06/2017	-2
	15/08/2017	-1		15/08/2017	-6		15/08/2017	1		15/08/2017	-1
	15/11/2017	-1		15/11/2017	-4		15/11/2017	1		15/11/2017	-1
	15/01/2018	0		15/01/2018	-2		15/01/2018	1		15/01/2018	-2
DSCIN003-BECADMP02_mm	15/02/2018	-1	Sum of DSCIN003-BECASMP05_mm	15/02/2018	-3	DSCIN003-BECASMP10_mm	15/02/2018	1	Sum of DSCIN003-BECASMP16_mm	15/02/2018	-2
	15/05/2018	0		15/05/2018	-5		15/05/2018	1		15/05/2018	-1
	15/08/2018	-1		15/08/2018	-6		15/08/2018	1		15/08/2018	-2
	15/11/2018	0		15/11/2018	-7		15/11/2018	2		15/11/2018	-1
	15/02/2019	7		15/02/2019	5		15/02/2019	5		15/02/2019	4
	15/05/2019	1		15/05/2019	-6		15/05/2019	2		15/05/2019	-3
	16/07/2020	2		16/07/2020	-7		16/07/2020	2		16/07/2020	-1
	15/01/2017	0		15/01/2017	0		15/01/2017	0		15/01/2017	0
	15/02/2017	1		15/02/2017	1		15/02/2017	0		15/02/2017	0
	15/06/2017	-3		15/06/2017	-4		15/06/2017	2		15/06/2017	1
	15/08/2017	-4		15/08/2017	-6		15/08/2017	2		15/08/2017	3
	15/11/2017	-3		15/11/2017	-4		15/11/2017	2		15/11/2017	2
	15/01/2018	-1		15/01/2018	-1		15/01/2018	1		15/01/2018	1
DSCIN003-BECASMP01_mm	15/02/2018	-2	Sum of DSCIN003-BECASMP06_mm	15/02/2018	-2	DSCIN003-BECASMP11_mm	15/02/2018	1	Sum of DSCIN003-BECASMP15_mm	15/02/2018	1
	15/05/2018	-3		15/05/2018	-4		15/05/2018	2		15/05/2018	2
	15/08/2018	-4		15/08/2018	-5		15/08/2018	2		15/08/2018	2
	15/11/2018	-6		15/11/2018	-6		15/11/2018	2		15/11/2018	2
	15/02/2019	4		15/02/2019	7		15/02/2019	4		15/02/2019	6
	15/05/2019	-5		15/05/2019	-4		15/05/2019	1		15/05/2019	3
	16/07/2020	-5		16/07/2020	-5		16/07/2020	3		16/07/2020	4
	15/01/2017	0		15/01/2017	0		15/01/2017	0		15/01/2017	0
	15/02/2017	0		15/02/2017	0		15/02/2017	0		15/02/2017	0
	15/06/2017	-4		15/06/2017	-4		15/06/2017	1		15/06/2017	-1
	15/08/2017	-6		15/08/2017	-6		15/08/2017	3		15/08/2017	0
	15/11/2017	-5		15/11/2017	-5		15/11/2017	2		15/11/2017	0
	15/01/2018	-2		15/01/2018	-2		15/01/2018	2		15/01/2018	0
DSCIN003-BECASMP02_mm	15/02/2018	-4	Sum of DSCIN003-BECASMP07_mm	15/02/2018	-4	DSCIN003-BECASMP12_mm	15/02/2018	1	Sum of DSCIN003-BECASMP14_mm	15/02/2018	-1
	15/05/2018	-5		15/05/2018	-5		15/05/2018	2		15/05/2018	0
	15/08/2018	-6		15/08/2018	-6		15/08/2018	2		15/08/2018	0
	15/11/2018	-8		15/11/2018	-8		15/11/2018	3		15/11/2018	0
	15/02/2019	4		15/02/2019	5		15/02/2019	6		15/02/2019	5
	15/05/2019	-7		15/05/2019	-6		15/05/2019	3		15/05/2019	1
	16/07/2020	-7		16/07/2020	-7		16/07/2020	4		16/07/2020	2
	15/01/2017	0		15/01/2017	0		15/01/2017	0		15/01/2017	0
	15/02/2017	0		15/02/2017	1		15/02/2017	0		15/02/2017	-1
	15/06/2017	-3		15/06/2017	-2		15/06/2017	0		15/06/2017	0
	15/08/2017	-5		15/08/2017	-4		15/08/2017	1		15/08/2017	1
	15/11/2017	-3		15/11/2017	-3		15/11/2017	1		15/11/2017	1
	15/01/2018	-2		15/01/2018	-1		15/01/2018	1		15/01/2018	1
Sum of DSCIN003-BECASMP03_mm	15/02/2018	-2	Sum of DSCIN003-BECASMP08_mm	15/02/2018	-2	Sum of DSCIN003-BECASMP18_mm	15/02/2018	0	Sum of DSCIN003-BECASMP13_mm	15/02/2018	1
	15/05/2018	-4		15/05/2018	-3		15/05/2018	0		15/05/2018	1
	15/08/2018	-5		15/08/2018	-4		15/08/2018	0		15/08/2018	1
	15/11/2018	-6		15/11/2018	-6		15/11/2018	0		15/11/2018	2
	15/02/2019	4		15/02/2019	6		15/02/2019	7		15/02/2019	5
	15/05/2019	-5		15/05/2019	-4		15/05/2019	1			
	16/07/2020	-5		16/07/2020	-3		16/07/2020				

Keith Hay Park – Seasonal SMP



Walmsley Park – Seasonal SMP Data

Years (Time)	Months (Time)	Average of DSCIN005-BECADMP01_mm	Average of DSCIN005-BECASMP01_mm	Sum of DSCIN005-BECASMP04_mm	Average of DSCIN005-BECASMP02_mm	Average of DSCIN005-BECASMP03_mm	Average of DSCIN005-BECASMP05_mm	Average of DSCIN005-BECASMP06_mm
2017	Jan	0	0	0	0	0	0	0
	Feb	0	-6	-5	-6	-7	-8	-4
	Jun	-1	7	6	6	12	22	7
	Aug	-2	6	5	5	11	21	11
	Nov	0	6	6	5	12	21	6
2017 Total		-0.6	2.6	12	2	5.6	11.2	4
2018	Jan	0	-4	2	-3	2	7	-2
	Feb	0	6	5	5	11	22	6
	May	0	6	5	5	10	17	5
	Aug	-1	6	5	5	10	17	5
	Nov	0	7	6	6	12	17	6
2018 Total		-0.2	4.2	23	3.6	9	16	4
2019	Feb	0	-7	-5	-7	-7	-7	-5
	May	-1	2	1	1	5	0	-2
2019 Total		-0.5	-2.5	-4	-3	-1	-3.5	-3.5
2020	Jul	1	4	3	4	2	-11	6
2020 Total		1	4	3	4	2	-11	6


Walmsley Park – Seasonal SMP
30
25
20
15
10
5
0
-5
-10
-15
-20
mm
1/07/2017 12:00:00 AM
1/01/2018 12:00:00 AM
1/07/2018 12:00:00 AM
1/01/2019 12:00:00 AM
1/07/2019 12:00:00 AM
1/01/2020 12:00:00 AM
1/07/2020 12:00:00 AM
Time
DSCIN005-BECADMP01
DSCIN005-BECASMP01
DSCIN005-BECASMP02
DSCIN005-BECASMP03
DSCIN005-BECASMP04
DSCIN005-BECASMP05
DSCIN005-BECASMP06

APPENDIX J - DEFINITIONS AND ABBREVIATIONS

Abbreviation	Detail
AS	Access Shaft
AVF	Auckland Volcanic Field
AVFB	Auckland Volcanic Field Basalts
BRTS	Bamford Rock Testing Services
CAI	Cerchar Abrasivity Index
CI	Central Interceptor
CMP	Construction Management Plan
CP	Communications Plan
CPT	Cone Penetration Test
CS	Construction Shaft
ECBF	East Coast Bays Formation
EPB	Earth Pressure Balance
Fmn	Formation
FPV	Fixed Price Variation
GBR	Geotechnical Baseline Report
GFR	Geotechnical Factual Report
GP	Geopolymer
GIR	Geotechnical Interpretive Report
GIS	Geographic Information System
GRP	Glass Reinforced Polymer
HW	Highly Weathered
ID	Internal Diameter
IJS	Intermediate Jacking Station
LEL	Lower Explosive Limit
LPI	Liquefaction Potential
LSB	Link Sewer B
M&CP	Groundwater and Settlement Monitoring and Contingency Plan
MBIE	Ministry of Business Innovation & Employment

Abbreviation	Detail
MPBX	Multi-point borehole extensometers
MTBM	Microtunnel Boring Machine
MW	Moderately Weathered
MPS	Mangere Pumping Station
MT	Main Tunnel
NZGS	New Zealand Geotechnical Society
OPC	Ordinary Portland Cement
PEA	Principal Engineering Advisor
PSD	Particle Size Distribution
PVC	Parnell Volcaniclastic Conglomerate
RQD	Rock Quality Designation
RS	Residual Soil
RW	Residually Weathered (Soil)
SLS	Serviceability Limit State
SMP	Surface Monitoring Pin
SW	Slightly Weathered
TG	Tauranga Group Alluvium
UCS	Unconfined Compressive Strength
ULS	Ultimate Limit State
UU	Unconfined Uniaxial
UW	Unweathered
VOC	Volatile Organic Compound
WS	Working Shaft
WWTP	Wastewater Treatment Plant
XRD	X-Ray Diffraction