



Downtown Carpark Site Development

Groundwater and Settlement Monitoring and Contingency Plan

Prepared for

Precinct Properties New Zealand Limited

Prepared by

Tonkin & Taylor Ltd

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1 Introduction

Precinct Properties New Zealand Limited ("**Precinct**") has engaged Tonkin and Taylor Limited ("**T+T**") to prepare a Groundwater and Settlement Monitoring Contingency Plan ("**GSMCP**") for the proposed basement construction at the Downtown Carpark Site ("**Project**").

This draft GSMCP is applicable for up to four levels of basement construction and assumes a basement excavation generally to RL -10.32 m, though with localised excavation of up to RL -17.02 m to accommodate water tanks and lift pits. This draft GSMCP has been prepared to supplement a Fast-track Approvals Act ("**FTAA**") application for the Project and will be updated as the design for the Project develops. This draft GSMCP should be read in conjunction with the Geotechnical and Groundwater Assessment Report for the Project.

1.1 Project description

The proposed Project Site is located at 2 Lower Hobson Street, at the corner of Lower Hobson Street and Customs Street West within the Auckland City Centre ("**Site**") (legal description Lot 9 DP 60151). The Site to be developed is approximately 6,442 m² in area, with the Site on land reclaimed in stages between 1850 and 1920 by the Auckland Harbour Board.

The Site is relatively level, with the ground surrounding the Site varying from RL 4 m to RL 5 m. A 9-storey (1 below ground level and 8 suspended floors) public carpark building known as the Downtown Carpark currently occupies the Site. The building is surrounded by M Social Hotel immediately to the north, HSBC and Aon Towers to the east, Custom Street West and Lower Hobson Street to the south and west respectively. Figure 1.1 shows the location of the Site. The historical Tepid Baths are located across Lower Hobson Street to the west.

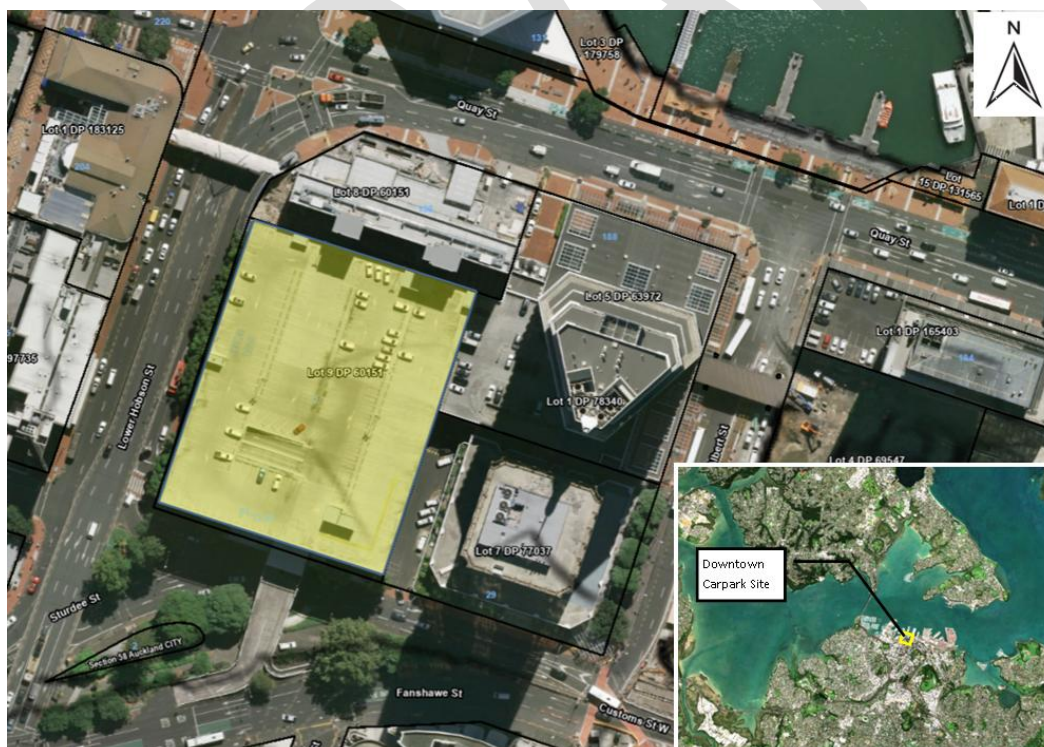


Figure 1.1: Downtown Carpark Development Site.

The proposed Project consists of two multi-storey towers, three podium structures and up to four level basement that extends across the full footprint of the Site.

1.2 Definitions

AC	The Auckland Council.
Commencement of dewatering	Excavation below the groundwater table and/or commencing taking any groundwater from the basement excavation excluding the installation of the pile walls.
Completion of excavation	When all bulk excavation below groundwater level has been completed. The permanent retaining walls have been propped with the building floors and all foundation/footing excavations within 10 m of the retaining wall have been completed.
Completion of temporary dewatering	When all the external base slab and basement walls are essentially completed, with permanent drainage systems in place, and the structures internal support mechanisms, including basement floors have been completed.
Completion of construction	When the Certificate of Completion is issued by AC.
Significant damage	When damage is considered to affect serviceability or structural integrity.
Serviceability damage	The degree of damage is minor i.e. when doors and windows start sticking.
Damage	Includes aesthetic, serviceability and significant damage.
Alert Level	Monitoring reaches a level close to, or equal to the design value, which is above the level where potential damage could occur, and requires a review to assess the future trend.
Alarm Level	Monitoring reaches the design value, and/or level close to which damage could occur, and requires immediate action including the cessation of ground dewatering and other construction activities that may have an effect on ground deformation.
The Council	Auckland Council (Team Leader, Water Allocation, NRSI) or nominated AC staff acting on The Team Leader's behalf.
NRSI	Natural Resources and Specialist Input, Auckland Council.
RL	Reduced Level.
Services	Includes for example fibre optic cables, sanitary drainage, gas and water mains, power and telephone, road infrastructure assets such as footpaths, kerbs, catch-pits, pavements and street furniture.

2 Monitoring

2.1 Summary

Monitoring of the excavation works and surroundings shall be undertaken to check that the ground deformations and groundwater conditions are consistent with the design analyses and that the response of neighbouring structures is within adopted design tolerances.

The monitoring requirements include location of monitoring points, frequency of monitoring, action trigger levels, response procedures and reporting requirements are detailed in the following sections. Survey monitoring locations are shown in the Construction Monitoring Instrumentation Plan Figure 1, **Appendix A**.

The proposed construction phase monitoring to assess the effects on ground surrounding the Site and of the services and structures identified above shall include:

- Pre and post-basement construction condition surveys of the potentially affected building and services.
- Regular visual external survey of the surrounding ground, pavement, associated street infrastructure and structures during construction to identify any deterioration of pre-construction baseline conditions.
- Precise levelling survey of markers/pins on the buildings and maintained existing retention structures surrounding the excavation. The marks shall be set as low as practicable on structures on elements in direct connection with the foundation level (i.e. columns or perimeter footings).
- Precise levelling survey of pavement line levels surrounding the Site at ground deformation marks.
- Survey of the retaining wall capping beam at approximately 15 m spacing. The number and spacing of locations may be altered depending on the layout including lateral support spacing and basement access points.
- Retaining wall deformation profile measurement via inclinometers installed within the walls at critical locations, allowing for Site access constraints that limit where measurements may be safely undertaken.
- Groundwater monitoring of piezometer installations to assess any relationship between groundwater drawdown and ground deformation.

Monitoring results will be collated by the project Geotechnical Engineer and compared with the specified trigger levels. These records will be held by the project Geotechnical Engineer and will be available for inspection as required.

2.2 Reporting of monitoring records

2.2.1 General

Survey points will be monitored by the Contractor and results will be provided to a qualified Geotechnical Engineer for their review at the frequency set out in the Consent conditions and the following sections. Survey results should be submitted to the project Geotechnical Engineer within three working days of taking the readings.

Monitoring results will be collated by the project Geotechnical Engineer and compared with the specified trigger levels. These records will be held by the project Geotechnical Engineer and will be available for inspection as required. If results exceed the trigger levels mitigation measures will be implemented and results will be reported to the Consents Manager as described in Section 7 to 8.

2.2.2 Pre-dewatering baseline readings

Building dilapidation and pre-condition surveys will be required prior to commencement of construction.

Baseline readings for ground and building deformation and retaining wall deformation shall be established prior to commencement of excavation.

Baseline readings for groundwater shall be established with weekly readings for at least one month prior to the commencement of dewatering. These baseline readings shall be submitted to the Council for approval prior to the commencement of excavation.

2.2.3 Reporting intervals and requirements

During excavation, all monitoring records as detailed in this report shall be compiled and submitted to the Council at **two monthly intervals** from the commencement of excavation until **six months** after the completion of basement construction, when the basement is sealed (or at such time following the completion of basement construction that stable measurements are demonstrated and written approval is granted from the Council).

Each report shall include the following:

- 1 Monitoring records presented in a tabulated format as well as on a timeline plot,
- 2 Comparison of monitoring data with trigger levels and the assumed design models,
- 3 Previous results set out with an explanation of any trends,
- 4 A construction progress summary, and
- 5 Any other information relevant to the reporting period (i.e. exceedance of trigger levels and contingency measures being undertaken).

3 Groundwater monitoring

3.1 Monitoring piezometer details and proposed drawdown trigger levels

Groundwater levels shall be monitored at four locations, as set out in Table 3.1. Two of the proposed monitoring bores (MW01 and MW04) have been installed in August 2025 as part of investigations during preliminary design, with the remaining bores (MW02 and MW03) to be installed subject to accessibility to the locations and more detailed underground service location check.

Measurements shall be accurate to $\pm 100\text{mm}$ for all readings.

Table 3.1: Groundwater drawdown planned locations and drawdown trigger levels

ID	Location	Screen Depth (mRL) ²	Trigger limits below lowest baseline level ¹ (m)	
			Alert Trigger Level 1	Alert Trigger Level 2
MW01	Northeast corner of the Site targeting infilled graving dock	-2 to 1	0.7	1.0
MW02	Southeast corner of the Site	-1 to 3	0.7	1.0
MW03	Southwest corner of the Site	-4 to 3	0.7	1.0
MW04	Northwestern corner – to be confirmed based on access	-2 to 1	0.7	1.0

Note:

1 Baseline readings shall be agreed upon in writing with the Council prior to dewatering.

2 The screen for the monitoring wells are proposed within the reclamation fill and marine sediments. The screen depths will be confirmed following drilling of the boreholes.

See Figure 1 in **Appendix A** for the monitoring well planned locations.

Should any of the monitoring bores be damaged and become inoperable during the basement construction monitoring period, then the Council is to be informed and a new monitoring bore is to be drilled at a nearby location in consultation with the Team Leader.

3.2 Groundwater monitoring intervals

The groundwater level in the piezometers shall be measured at the following intervals:

Prior to dewatering	Weekly in the month prior to commencement of dewatering.
During temporary dewatering	Weekly, until the completion of temporary dewatering, or at such time following the completion of excavation that stable measurements are demonstrated and written approval is granted from The Team Leader (AC) to reduce monitoring frequency.
After completion of dewatering for construction	Monthly for minimum six (6) months or until a consistent pattern of groundwater records are obtained in which no evidence of adverse effects is apparent and groundwater levels are above alert trigger levels.

The monitoring frequency may be changed if approved by the Team Leader Central Monitoring. Any change shall be specified in the GSMCP. In addition, the monitoring period post Completion of Temporary Dewatering may be extended, by the Team Leader, Central Monitoring, Resource Consenting and Compliance, if measured groundwater levels are not consistent with inferred seasonal trends or predicted groundwater movement.

The project Geotechnical Engineer will review the results of this monitoring and compare with the trigger levels detailed in the Consent Conditions. If the alert or alarm levels in Table 4.1 are reached, the actions outlined in Section 7 shall be carried out.

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4 Retaining wall deflection monitoring

4.1 General

The retention system shall be monitored via survey monitoring points installed along the perimeter capping beam at approximately 15 m spacing, and deformation down the retaining wall will be measured via inclinometers installed within the walls at critical locations. The number and spacing of locations may be altered depending on the layout including lateral support spacing and basement access points.

Proposed locations of the survey monitoring points are shown in Figure 1 in **Appendix A**.

Survey measurements shall be accurate to ± 2 mm. A record of the survey results should be submitted to the Geotechnical Engineer within one working day.

4.2 Retaining wall monitoring intervals

Surveys shall be carried out at the following intervals:

Prior to dewatering	At least two baseline surveys to establish baseline readings
During dewatering, until one month after completion of excavation	Weekly (minimum) and at each 2 metres depth of excavation or when changes to the propping system are being carried out
From one month after completion of excavation, until completion of temporary dewatering	Fortnightly until completion of temporary dewatering.

Monitoring frequency may be reduced if stable measurements are demonstrated and written approval is granted from the Council.

4.3 Retaining wall deflection trigger levels

The results of this monitoring are to be compared with the design assumptions and baseline readings. Trigger levels at which actions are required to be undertaken are summarised in Table 4.1. If the Trigger Levels are reached, the actions outlined in Section 7 shall be carried out.

Table 4.1: Trigger levels for retaining wall deflections

Monitoring ID	Location	Alert trigger level	Alarm trigger level
Survey peg on retaining wall	Top of wall along northern boundary (Design Section 1)	8 mm	10 mm
	Top of wall along western boundary (Design Section 2)	20 mm	25 mm
	Top of wall along southern and south-eastern boundary (Design Section 3)	13 mm	16 mm
Inclinometers (01 to 04)	Inclinometer in the retaining walls	18 mm	20 mm

Note: Inclinometers are proposed to be installed within the Diaphragm wall. Inclinometers are currently not allowed for along the southern and southeastern perimeter where anchored sheet piles are proposed. However, inclinometer over this section will be considered as required.

5 Ground and building deformation monitoring

5.1 General

Ground and building deformation monitoring marks shall be established on the pavements and buildings surrounding the excavation area at the locations shown on Figure 1 in **Appendix A**, subject to permission from neighbouring properties.

Survey measurements shall be accurate to ± 2 mm. A record of the survey results should be maintained on Site and forwarded to the project Geotechnical Engineer within one working day.

5.2 Settlement monitoring intervals

Surveys shall be carried out at the following intervals:

Prior to dewatering	At least two baseline surveys to establish baseline readings
During temporary dewatering	Weekly
Post temporary dewatering	Monthly for six months or until such a time following the completion of temporary dewatering that stable measurements are demonstrated and written approval is granted from the Council

Monitoring frequency may be reduced following the completion of excavation if stable measurements are demonstrated and written approval is granted from the Council.

5.3 Settlement trigger levels

Monitoring data are to be compared with the design assumptions and baseline readings. Alert and Alarm Levels at which actions are required to be undertaken are summarised in Table 5.1. If the alert or alarm levels in Table 4.1 are reached, the actions outlined in Section 7 shall be carried out.

Table 5.1: Ground and building deformation mark trigger levels

Settlement survey mark ID	Location	Total settlement (mm)		Differential settlement	
		Alert level	Alarm level	Alert level	Alarm level
Ground survey pins	Custom Street West	9	12	1V:500H ¹	1V:250H ¹
	Lower Hobson Street	15	18		
	Private accessway between Site and AON/ HSBC tower	9	12		
Building survey pins	M Social	8	12	1:1000 between any two Building deformation marks	1:750 between any two Building deformation marks
	HSBC Tower	8	12		
	AON Tower	8	12		
	Hobson St Flyover	11	14		
	204 Quay Street	7	10		
	Tepid Baths	7	10		
	Watermark Building (85 Custom St West)	7	10		

6 Condition surveys

6.1 Underground service condition surveys

6.1.1 General

Prior to the Commencement of Dewatering, a condition survey of potentially affected stormwater and wastewater Services must be undertaken in consultation with the relevant service provider.

Between six and twelve months after Completion of Dewatering, a detailed condition survey of all previously surveyed Services must be undertaken by an SQEP or SQBS and a written report must be prepared. The report must be reviewed by the SQEP responsible for overseeing the monitoring and then submitted to the Council, within one month of completion of the survey.

The condition survey report must make specific comment on those matters identified in the pre-dewatering condition survey. It must also identify any new Damage that has occurred since the pre-dewatering condition survey was undertaken and provide an assessment of the likely cause of any such Damage.

This condition does not apply to any Service where written evidence is provided to the Council confirming that the owner of that Service does not require a condition survey to be undertaken.

6.2 Building condition surveys

6.2.1 Accessibility

If a structural condition survey requires access to a building or property, then in the event that access is declined by the owner or subject to unreasonable terms, the Council shall be notified as soon as is practicable. A report from a Chartered Professional Engineer shall be provided identifying whether any alternate risk monitoring options are available that do not involve access to the third party property. The report shall clearly state whether the identified alternative monitoring options will be sufficient to monitor any settlement risk to the property/s to which the monitoring relates and whether they will provide sufficient early detection warning to enable contingency measures to be implemented. Written approval from the Council must be obtained before any alternative monitoring option is implemented.

6.2.2 Recommended building condition survey locations

A visual inspection of the surrounding ground and buildings within 20 m of the project boundary. Survey shall be carried out for the structures in the immediate vicinity of the development, as set out in the following table. For the internal building survey, the survey shall cover the basement levels and the ground floor.

Table 6.1: List of buildings requiring condition surveys

Address	Legal Title	External survey	Internal Survey	Settlement Pins (Yes/No)
M Social (196 Quay St)	Lot 8 DP 60151	✓	✓	Yes
HSBC Tower (188 Quay St)	Lot 5 DP 63972 and Lot 1 DP 7834	✓	✓	Yes
AON Tower (21/29 Custom St West)	Lot 7 DP 77037	✓	✓	Yes
Tepid Baths (100 Custom St West)	Lot 2 DP 184176	✓	✓	Yes
Watermark (85 Custom St West/ 1 Lower Hobson St)	Lot 2 DP 197735	✓	✗	Yes
204 Quay Street	Lot 1 DP 183125	✓	✗	No
Lower Hobson Street flyover	N/A	✓	N/A	Yes

6.2.3 Pre and post-construction condition survey

A pre-construction condition survey of the specified buildings shall be carried out prior to the commencement of dewatering.

The survey report shall confirm the existing condition of the building and enable the sensitivity of the buildings to potential damage caused by groundwater and ground settlement changes to be accurately determined. Major features of the building and Site developments shall be recorded including location, type of construction, age and present conditions including defects.

The survey shall include, but not be limited to, the following:

- 1 A description of the type of foundations.
- 2 A description of existing levels of damage considered to be of an aesthetic or superficial nature.
- 3 A description of existing levels of damage considered affecting the serviceability of the building where visually apparent without recourse to intrusive or destructive investigation.
- 4 An assessment as to whether existing damage may or may not be associated with actual structural damage and an assessment of the susceptibility of the buildings/structures to further movement and damage, to the extent predicted.
- 5 Photographic evidence of existing observable damage.
- 6 Confirmation of the installation of deformation pins as required by this specification.
- 7 A review of proposed Alarm and Alert Levels to confirm they are appropriately set and confirmation that any ground settlement less than the Alarm Level will not cause damage
- 8 An assessment of whether the monitoring frequency is appropriate.
- 9 An assessment of whether the location and density of existing deformation pins is adequate and appropriate for the effective detection of change to building and structure condition.

Between six and twelve months after Completion of Dewatering, a post-construction survey covering the matters detailed above shall be completed the buildings previously surveyed prior to

construction. The survey report shall include a determination of the cause of damage identified (if any) since the pre-construction or previous survey and steps to repair it.

A copy of the pre and post-construction reports shall be forwarded to the Council within 15 working days of completing the reports along with a certificate from the Chartered Surveyor or Chartered Professional Engineer who has certified that the survey has been completed in a professional manner and is an accurate assessment of the condition of the building concerned.

6.2.4 Construction phase inspections

A visual inspection undertaken by the Principal Contractor at weekly intervals shall monitor any deterioration or further cracking of any pre-existing cracks on the following:

- The ground within 10 m of the excavation.
- External facades of the buildings identified for structural condition surveys.

A photographic record of the surveys is to be maintained including the time, date and any observations for each inspection. This record is to be maintained on Site and forwarded to T+T typically monthly but within one day if any deterioration or cracking is observed.

6.2.5 Condition survey intervals

A visual inspection of the surrounding ground and specified buildings shall be carried out at the following intervals:

Prior to dewatering	Pre-construction survey as detailed in Section 6.2.3
From Commencement of Dewatering to Completion of Dewatering	Weekly visual inspections as detailed in Section 6.2.4.
After completion of basement construction	Post-construction survey between six and twelve months of Completion of Dewatering as detailed in Section 6.2.3

7 Alert and alarm trigger level response procedures

7.1 Response procedure if the alert trigger levels are exceeded

If any of the monitoring alert settlement trigger levels are reached then one or more of the contingency options described in Section 8 of this plan should be carried out together with:

- 1 Notify the Project Manager;
- 2 Notify the Council, in writing within one working day of the trigger level being exceeded, with details of any actions being undertaken;
- 3 Survey all monitoring marks within a 20 m radius of the monitoring point, and compare them to settlement trigger levels;
- 4 Review the monitoring data, as-built details and geology and compare against the assumptions made in the design analyses;
- 5 Ensure the data is reviewed, and advice provided, by a SQEP on the need for mitigation measures or other actions necessary to avoid further deformation. Where mitigation measures or other actions are recommended those measures must be implemented.
- 6 Submit a report by a Chartered Professional Engineer to the Council for approval, within 5 working days of trigger level exceedance, which provides analyses of all monitoring data, including wall deflection monitoring, relating to the exceedance of any of the trigger levels and any recommendations for remedial actions and time frames for implementing these actions. If no remedial actions are considered necessary, then justification for this viewpoint is required; and
- 7 All monitoring pins and groundwater levels within 20 m shall be surveyed at two day intervals until such time the written report in (5) has been approved by the Council.

If considered necessary:

- 1 Increase monitoring frequency; or
- 2 Develop a detailed contingency plan and submit to the Council.

7.2 Response procedure if the alarm trigger levels are exceeded

If any of the monitoring alarm settlement trigger levels are reached then the following shall be carried out in addition to the actions outlined in the previous section:

- 1 Cease further lowering of the water table or any other activity which has the potential to cause further deformations, unless halting the activity is considered by a SQEP to be likely to be more harmful (in terms of effects on the environment) than continuing to carry out the activity;
- 2 Undertake a condition survey (this could comprise either a detailed condition survey or an external visual inspection at the discretion of the SQEP responsible for overseeing the monitoring) by a SQEP or suitably qualified building surveyor (SQBS) of any building or structure located adjacent to any Monitoring Station where the Alarm Level has been exceeded.
- 3 Submit a written report by a Chartered Professional Engineer to the Council for approval, within one week of alarm trigger Level exceedance, which provides analyses of all monitoring data and any recommendations for remedial action; and
- 4 Once approved by the Council the recommendations shall be implemented.

- 5 Not resume construction activities (or any associated activities), halted in accordance with paragraph (1) above, until any mitigation measures (recommended in accordance with paragraphs (3) above) have been implemented to the satisfaction of a SQEP.

Dewatering and/or construction may be resumed once the Council provides written notice to the Consent Holder that the Council is satisfied that damage to buildings, structures and services is unlikely with or without any approved additional mitigation measures to be undertaken or that the Council is satisfied that owners of potentially affected buildings, structures and services have given written approval for dewatering and/or construction to continue.

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8 Contingency options

8.1 General

If any of the monitoring trigger levels are exceeded the general response will be as detailed in Section 7. Specific actions will be selected depending on the exact nature of the problem. Possible contingency actions are detailed in the following sections.

8.2 Retaining wall deflection contingency measures

In the event of retaining wall deflections exceeding the monitoring trigger levels, a review of the retaining design model shall be carried out to assess the potential increased load in the wall, anchors and existing props, and potential increase in mechanical ground deformations.

If required, the following actions may be taken:

- 1 Reduce load on the wall by allowing water to drain from behind the wall. This would be temporary while one of the other mitigation measures is undertaken;
- 2 Place a temporary berm of soil in front of the wall; and
- 3 Install additional props and/ or anchors.

8.3 Groundwater drawdown contingency measures

8.3.1 Groundwater recharge during construction

One option to lessen the effect of groundwater dewatering during the excavation in a local area is to inject further water into the ground through shallow injection wells or a trench.

The shallow well injection system will likely consist of the following:

- 1 2 m to 6 m deep, 150 mm diameter wells spaced at approximately 10 m centres (depending on degree of drawdown); and
- 2 A water supply manifold connected to a header tank with float valve and flow meter.

The location of the wells will be dependent on where the groundwater has been drawn down. Following the implementation of the injection wells the groundwater levels will be monitored closely.

8.3.2 Options to reduce temporary and permanent drawdown

In the event of groundwater drawdown exceeding the monitoring trigger levels, one or more of the following actions may be taken:

- 1 Grout anchor points, wall connections or other areas of excessive seepage,
- 2 Shallow reinjection wells to inject potable water into the ground to mitigate the change in groundwater level (groundwater recharge),
- 3 Construct a grout curtain to reduce inflow,
- 4 Install an impermeable wall inside the diaphragm/ sheet pile wall, designed to resist hydraulic pressure,
- 5 Locally tank floor to extend the drainage path,
- 6 Convert to a tanked basement.

8.4 Ground and building deformation contingency measures

In the event of ground or building deformation exceeding the monitoring trigger levels, one or more of the following actions shall be taken:

- 1 Check public safety is maintained;
- 2 Review the potential causes for ground or building deformations;
- 3 Discuss the situation with the property/service owner that may be affected;
- 4 Monitor the rate of settlement (assuming that other steps have been undertaken to address the cause);
- 5 Undertake remedial works including foundation strengthening; and
- 6 Accept and reinstate resultant damage.

9 Applicability

This report has been prepared for the exclusive use of our client Precinct Properties New Zealand Limited, 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 FTAA application, and that the consenting authority will use this report for the purpose of assessing that application.

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

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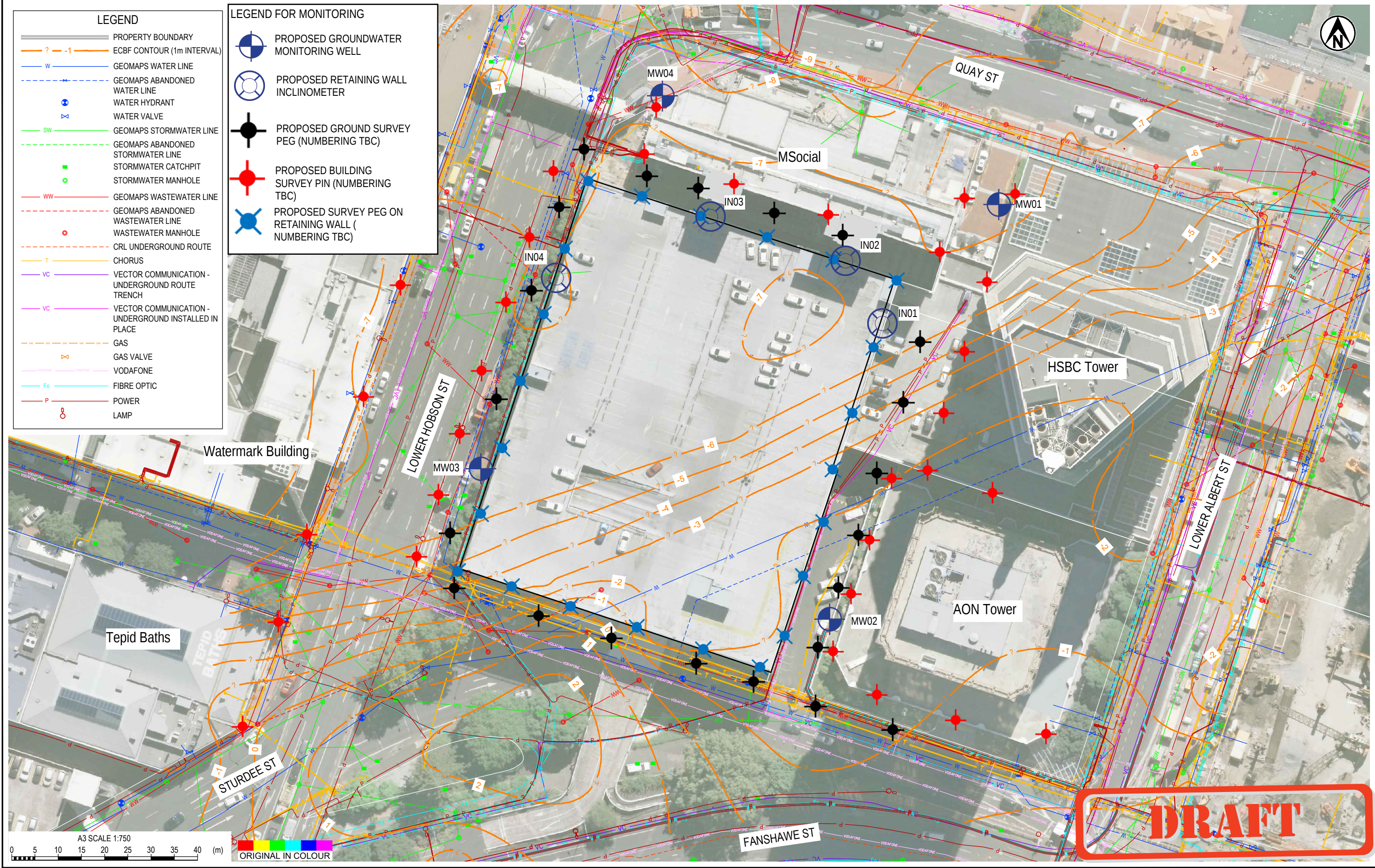
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Appendix A Construction Monitoring and Instrumentation plan

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