IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Resource Consent Applications by Central Plains Water Trust to take and use water and undertake other activities for the construction and operation of the Central Plains Water Enhancement Scheme

EVIDENCE OF PETER FRANCIS CALLANDER

1. INTRODUCTION

1.1. My name is Peter Francis Callander. I hold the qualifications of BSc (Geology) from the University of Auckland and MSc (Earth Sciences) from the University of Waterloo (Canada). Since 1991 I have been employed as a Senior Hydrogeologist with Pattle Delamore Partners Limited, an environmental consulting firm specialising in ground, water and air resources. I am a Director of that firm. Previously I had been employed for 8 years by the Canterbury Regional Council and its predecessor the North Canterbury Catchment Board. During this time I was involved with the Regional Council's groundwater resource investigations and field trials. Between 1989 and 1991 I was in charge of that Council's groundwater section.

1.2. I have been involved with Assessment of Environmental Effects evaluations for a number of large scale irrigation developments including the existing Waimakariri Irrigation Scheme, Southern Valleys Irrigation Scheme (Marlborough), Glenroy Community Irrigation Scheme and proposed schemes in the Wairau Valley and the Ngai Tahu Property Irrigation proposal on the north bank of the Waimakariri River. I have undertaken studies for individual farms that utilise irrigation. These projects have involved assessments of environmental effects on surface water ways and groundwater arising from water abstraction and from a variety of land use activities.

1.3. I have also been involved with providing advice to a variety of groundwater users, including some of the operators of quarries located to the west of urban Christchurch. This advice has been in relation to potential groundwater changes that might arise from the CPW scheme and how those might impact on existing and future quarry operations.

1.4. I confirm that I have read the Environment Court's Code of Conduct for expert witnesses and this evidence is prepared in accordance with that code. I agree to comply with the code's terms. In that regard, I confirm that the statements made in this evidence are within my area of expertise and I confirm that I have not omitted to consider material facts which might alter the opinions stated in this evidence.

1.5. This brief of evidence has been prepared to support the submissions from Isaac Construction Co Ltd, Winstone Aggregates Ltd, Fulton Hogan Canterbury Ltd and Road Metals Ltd regarding the Central Plains Water (CPW) consent applications. It describes the impact of groundwater on the quarry operations and how this might be affected by the proposed CPW activities.

2. GROUNDWATER AND THE QUARRY OPERATIONS

2.1. Figure 1 shows the location of the land zoned for quarrying to the west of urban Christchurch. Isaacs operate a quarry at McLeans Island, Fulton Hogan operate at Pound Road and Winstones, Road Metals and Fulton Hogan all operate in the more westerly quarry area at Miners Road.

2.2. The operation of the quarries at these locations occurs as a Permitted Activity under the Christchurch City Plan. Critical Standard 3.4.5 of that plan limits the depth of excavation that can occur, as specified below:

> *"… No extraction of sands, gravels or other materials shall take place to a depth greater than 1 m above maximum recorded groundwater level.*
>
> *(Maximum recorded groundwater level will be determined upon consultation with the Canterbury Regional Council.)"*

Any mineral extraction activity that does not comply with this critical standard becomes a Non-Complying activity.

2.3. Furthermore, some of the quarry owners backfill their quarry with clean fill material and carry out concrete manufacture. An example of the consent conditions that relate to those activities come from Winstones resource consent for deposition of cleanfill (CRC020238) issued by ECan:

Condition 8) Material shall not be deposited below a level of one metre above the highest recorded groundwater level on site. The base of the pit below any area of fill deposition shall be lined with clay or silt material having a depth of at least 300 millimetres.

Condition 18) Concrete slurry material shall only be deposited within a bunded area that is lined with clay or silt material having a depth of at least 300 millimetres. The bunded area shall be at least 10 metres above the highest recorded groundwater level at the site and shall not be located above any fill material.

2.4. On 28 January 2007, ECan notified Variation 6 to their Proposed Natural Resources Plan, which deals with management of activities within the Christchurch Groundwater Protection Zones. The map of these zones are shown in Figure 2.

2.5. Whilst the main recharge area to the west of urban Christchurch is generally classified as “Christchurch Groundwater Protection Zone 1”, ECan have recognised that there are already some existing land use zonings that allow for activities to occur which that they would prefer not to see in Zone 1. They have identified these as sub-zones. Sub-Zone 1B is the existing quarry zones.

2.6. Policy WQL18 in Variation 6 deals with the control of mineral extraction activities. This policy recognises that quarrying can occur on land authorised for that purpose on 1 August 2007, i.e. the Zone 1B land in Figure 2. However, it also seeks to protect groundwater quality by “avoiding mineral extraction activities in other localities”. Therefore, it is to be expected that ECan will strongly oppose any expansion of existing quarries within the Zone 1 area of Figure 2 outside of the existing areas shown as Zone 1B, and this opposition has already occurred in the context of a recent application by Road Metals.

2.7. Policy WQL18 also seeks to reduce the potential for contaminants entering groundwater by ensuring:

“(a) an effective buffer is maintained between the bottom of the excavation and the top of the highest level of groundwater to avoid any increased risk of contaminants directly or indirectly entering groundwater; …”

2.8. Therefore, it is clear from both the Christchurch City Plan and ECan's NRRP that both authorities view the highest groundwater level as a benchmark which is used to determine the allowable depth of quarrying and their backfilling with hardfill. The use of highest groundwater level as a benchmark for the depth of quarrying activities occurs both in the planning documents and in the individual consents that have been granted to the quarry operators. Therefore, any activities which cause a rise in the highest level of groundwater is of significant concern to the quarry operators.

3. THE EFFECT OF CPW ACTIVITIES ON GROUNDWATER LEVELS

3.1. The CPWT assessment of effects estimates that their proposed activities will cause groundwater levels to rise. This occurs for the following reasons:

- 60,000 ha of irrigated land will cause extra recharge to pass through the soil due to the combined effects of irrigation and rainfall. Across the entire Central Plains area this land based recharge is estimated by CPW to increase from 29 to 33.1 m^3/s – i.e. an extra 4.1 m^3/s of water entering the groundwater system (Appendix P of Julian Weir's evidence);
- the more extensive network of larger water races distributing more water across the plains will contribute increased leakage down into the underlying aquifer. CPW have estimated that this will increase from 0.2 m^3/s to 4 m^3/s, i.e. an extra 3.8 m^2/s of water entering the groundwater system (Appendix P of Julian Weir's evidence);
- there is an expectation that some of the CPW water will be used to replace existing groundwater irrigation abstraction. If that occurs, less groundwater abstraction will lead to higher groundwater levels (paragraph 31 of Cliff Tipler's evidence), although it is reasonable to expect that any groundwater abstractions that are replaced by the CPW supply will be transferred to other locations.

3.2. To some extent, the effects of these increases in groundwater recharge are estimated by CPW to be balanced by a reduction in aquifer recharge from the Waimakariri and Rakaia Rivers which will have smaller seepage losses due to the reduced flow caused by the CPW abstractions. However, these two different changes in recharge patterns (increased recharge beneath the irrigation area and reduced river recharge) occur at different locations across the plains, resulting in differing groundwater level responses based on the relative influence of these factors.

3.3. In order to estimate the magnitude of groundwater level change, CPW have carried out a groundwater modelling exercise. The simulations that are of most interest to the quarry owners are the rise in groundwater levels that is expected to occur at times of naturally high groundwater levels. CPW's simulation of this situation is presented in Figure 3 of my evidence, along with the quarry areas marked on it. The results indicate that a rise of somewhere between 0 and 2 metres will occur.

3.4. In order to obtain a more precise indication of the change in water level predicted by CPW, I have reviewed their modelled simulations for the monitoring wells that occur closest to the quarry areas. The location of these wells are shown in Figure 4.

3.5. Figure 4a shows the simulated rise in water level that is predicted to occur as a result of the CPW activities. The estimated rise in maximum groundwater levels for each of the quarry areas is:

Table 1: CPW Model Predictions of Rise in Highest Groundwater Levels

Quarry Location	**Groundwater Level Monitoring Bore**	**Predicted Rise in Highest Groundwater Levels**
Miners Road (Winstones and Road Metals)	M35/1080	+1.5 m
Pound Road (Fulton Hogan)	M35/1079	+1.0 m
McLeans Island (Isaacs)	M35/0928 M35/1451	No change

3.6. In my review of the Applicant's assessment for the quarry owners, I have also considered the accuracy of the model simulation with measured data. For the four wells located closest to the quarries, the model calibration plots are presented in Figure 4b. These show the following patterns:

Table 2: Accuracy of CPW Model Compared to Measured Groundwater Levels

Quarry Location	**Groundwater Level Monitoring Bore**	**Model Accuracy**
Miners Road (Winstones and Road Metals)	M35/1080	Model estimates are typically 3-4 m too low
Pound Road (Fulton Hogan)	M35/1079	Model estimates are around 4 m too high
McLeans Island (Isaacs)	M35/0928	The lower values of the model estimates match the measured water levels, but the modelled values show too great a fluctuation.

	M35/1451	The higher values of the model estimates match the measured water levels, but the modelled values show too great a fluctuation

3.7. Based on this review of the CPW assessment, I have concluded that the maximum groundwater levels will rise (as indicated by the factors described in paragraph 3.1 of my evidence). Table 1 gives one possible indication of the magnitude of that rise and the relative differences in rise (i.e. highest at Miners Road and least at McLeans Island) seem reasonable given their proximity to both the CPW irrigation area and the Waimakariri River.

3.8. However, there is considerable uncertainty as to the magnitude of the increase predicted by the model, as indicated by the inaccuracy of the model predictions as shown in Figure 4b and Table 2 of this evidence. Irrespective of this inaccuracy, we must conclude that the granting of the CPW consents will cause a rise in groundwater levels in the area of at least some of the existing quarry operations.

3.9. The Applicant's predicted rise in groundwater levels (Table 1) and the level of inaccuracy associated with the model (Table 2) is of great concern to the quarry operators given that the planning rules and consent conditions that control their activities place great significance on the maximum recorded groundwater levels.

4. IMPLICATIONS FOR THE QUARRIES ARISING FROM THE CPW GROUNDWATER LEVEL RISE

4.1. Within the quarry area, many of the pits have already excavated down to their maximum allowable depth and have placed hardfill deposits at the maximum allowable depths. As a result, the rise in the highest water table levels caused by CPW activities could see groundwater enter the working pits, particularly at the Miners Rd and Pound Rd areas.

4.2. This would cause a disruption to the quarrying activities, although the actual period of inundation would be for a limited period of time (perhaps on the order of a few weeks) and only on rare occasions. Figure 5 shows the historical pattern of water levels in well M35/1080 and shows that had the CPW effects been occurring they could have caused breaches of consent conditions on around 8 occasions over the period since 1952. The effect of the breach is to set a new benchmark going forward for the highest recorded groundwater level from which the 1 metre separation must be maintained. Accordingly the rise in highest recorded groundwater levels causes a permanent reduction in the volume of material able to be extracted based on current ECan and CCC rules.

4.3. These water level rises could also inundate the hardfill deposits. Whilst these hardfill deposits are currently well controlled, there is the potential for a wider variety of substances to be present in some of the older materials that have been deposited in the quarry areas. The inundation of these wastes by a high water table creates the potential for a slug of contaminants to be mobilised into the water in the quarry pits and into the surrounding groundwater. In my experience, such a slug of contaminants entering the groundwater will be readily dispersed within the gravel aquifers of this area so that I do not consider there is any significant risk of widespread groundwater contamination.

4.4. However, the inundation of waste materials does create a potential health risk for site workers (due to contaminated surface water in their work areas) and an increased (but low) risk of localised contamination at nearby domestic water supply wells. The potential health risk to site workers should be managed by good workplace health and safety measures and in my opinion, the risk of contaminant migration in groundwater is low because tracer tests have indicated that contaminant concentrations are readily attenuated in the gravel strata that occur in this area. However, even though the risk is low, it is important to acknowledge the level of risk is increased due to the CPW activities

4.5. Therefore, in my opinion, the physical problems caused by the CPW scheme are:

- an infrequent and short-term disruption to the quarry activities;
- a potential liability due to an increased risk of localised contamination from inundation of waste materials.

Whilst in practical terms both these effects may be of a relatively minor nature and a low risk, the rise in the maximum groundwater level causes the quarry operators to be in breach of the planning rules and/or the consent conditions that authorise their activities, even though the quarry owners themselves did not cause the breach of rules and conditions.

4.6. It is unclear how ECan and CCC enforcement officers would deal with this situation. However, a similar situation did occur in July 2006 when high water table conditions inundated some of the existing quarry pits that had been excavated too deep. In response to that situation, the affected quarries were required to fill in the deeper parts of the quarry with clean aggregate to restore the buffer between the quarry floor and the highest groundwater level.

4.7. If a similar requirement was to be made in light of the granting of the CPW consent, that would be a considerable cost imposition and loss of aggregate resource through no fault of the quarry operators and caused entirely because of CPW.

4.8. Of even greater significance to these physical disruptions to the existing quarry activities is the potential loss of future aggregate resource. It is unclear how ECan might respond to the rules for quarry operations if CPW are granted consents that are expected to cause a rise in maximum recorded groundwater level. It is important to recognise that ECan's management of groundwater protection is based on the maximum expected groundwater level, irrespective of the fact that it may only occur very infrequently.

4.9. Therefore, recognising that a consent has been granted with the predicted water level rise listed in Table 1 of my evidence, it is conceivable that ECan could seek to limit the maximum depth of quarry operations to allow for that rise (even if it were never to occur in practice). They could seek to have hardfill deposits relocated to a higher level. If they chose to allow a margin for the uncertainties in the Applicant's modelling predictions (as indicated in Table 2), then the imposition and restrictions on the quarry operators could be even more severe.

4.10. I would expect the quarry owners to vigorously oppose any such requirements because, in my opinion, the risk of groundwater contamination from such high water table inundations is relatively low. However, I am also well aware that when it comes to the Christchurch Aquifer Recharge Zone, ECan take a staunch view that any increase in risk, no matter how small, is unacceptable.

4.11. Therefore, the potential implications of granting the CPW consents for the quarry operators are a significant rearrangement of existing quarry activities, a loss of access to future resource within the quarry zones and/or a requirement to challenge the changes that ECan might seek to impose through the consenting and plan hearing processes. All of these potentially significant implications for the quarry operators arise directly from the granting of the CPW applications.

5. THE RESPONSE FROM CPW AND ECan

5.1. The quarry operators have been concerned to make sure that their submission to this Hearing panel is clearly understood, because whilst CPW and ECan have acknowledged receipt of the quarry owners' submissions, in their evidence and reports to date they have made no assessment of the potential effects on the quarry operations. The issue of effects on the quarries is not specifically mentioned in any of the Applicant's evidence or in the ECan Officer's reports as far as I am aware.

5.2. Because of this apparent omission of what seems to be a potentially significant adverse effect on the quarry operations, the quarry operators sought a meeting with CPW representatives. This took place on 16 May 2008 with Messrs Alan Watson and Walter Lewthwaite from the CPW team.

5.3. At that meeting, it was agreed that there was no effective mitigation to limit the groundwater level rise. Unlike shallow near surface groundwater problems, it is not feasible to implement drainage works, because there is nowhere to discharge the water to when you are 9 m below ground level in a pit. Furthermore, the permeability of the gravels and the extent of the pits is so great that pumped dewatering is not feasible.

5.4. The cause of the increase in maximum water levels occurs when the effects of the ongoing extra recharge from the CPW scheme coincides with a season of high natural recharge. There are no management controls that the scheme can implement to stop this contribution to that effect during these times of naturally high water table levels because the extra recharge contribution from CPW activities is already part of the groundwater system by the time any awareness of a pending extreme natural recharge event occurs. Therefore, at our meeting with the CPW representatives it was agreed that if the scheme proceeds, then the quarry owners must expect the sort of rise in maximum water levels as indicated in Table 1 - although the uncertainties in these modelling estimates was also acknowledged.

5.5. We agreed with CPW that the practical implications of the rise in maximum water levels was an infrequent and short-term disruption to quarry activities. However, CPW acknowledged that the much greater potential adverse effect for the quarries arose from the planning rules requiring activities to occur above the highest groundwater level.

5.6. CPW's suggested mitigation was to replace any loss of aggregate that might be caused by more severe restrictions on the quarry depths by extending the quarries laterally to open up new areas. I agree that is one mitigation option. Another option is to allow quarrying to extend below the water table. However, both these options require significant plan change and consenting requirements with no guarantee of success.

5.7. The quarry owners have indicated to me that because of these potentially significant limitations caused to their future activity by CPW that they would require compensation for:

- loss of ability to access future aggregate that under pre-CPW activities is currently available to them;
- any requirements to rearrange pit floors and hardfill deposits;
- costs associated with future consenting and plan change requirements to extend quarries as mitigation for lost resource.

They would also require CPW to provide indemnity for any issues arising from breaches of consent conditions related to maximum groundwater levels or any contamination incidents arising from high groundwater level effects on hardfill.

5.8. The quarry owners have expressed uncertainty as to whether CPW would actually be able to provide the necessary compensation and indemnification. As a result, this appears to be a potential adverse effect that is not readily mitigated.

6. CONCLUSION

6.1. The existing quarry operations west of Christchurch are restricted in the depth to which they can operate by the highest groundwater levels.

6.2. The Applicant's evidence indicates that the CPW activities will raise the highest groundwater levels in the range of no change (in the Isaacs quarry area), up to a 1.5 m increase (in the Winstones, Fulton Hogan and Road Metals quarry areas). There is a large degree of uncertainty associated with these estimates. Despite this uncertainty it seems clear from the Applicants information that the granting of the CPW consents will cause the groundwater levels to rise.

6.3. The evidence that has been prepared to date by CPW and ECan Officers does not appear to have considered the implications of this water table rise on the quarry operations. The implications are:

- an infrequent and short-term disruption to quarry operations in existing pits;
- an increased, but low, risk of localised contamination due to inundation of hardfill deposits;
- non-compliance with planning rules and consent conditions for existing operations that are lawfully established;
- potentially significant restrictions requiring alteration to existing quarry operations;
- loss of access to currently available aggregate resource
- reduced availability of resource in future quarry areas.

6.4. The only feasible mitigation for these effects requires involvement in expensive and difficult hearing processes to change consent planning rules and consent conditions, with no guarantee of success. As a result, the effects of the CPW scheme on the quarry operations appears to be potentially adverse, with no reliable mitigation.

Appendix A

Figures

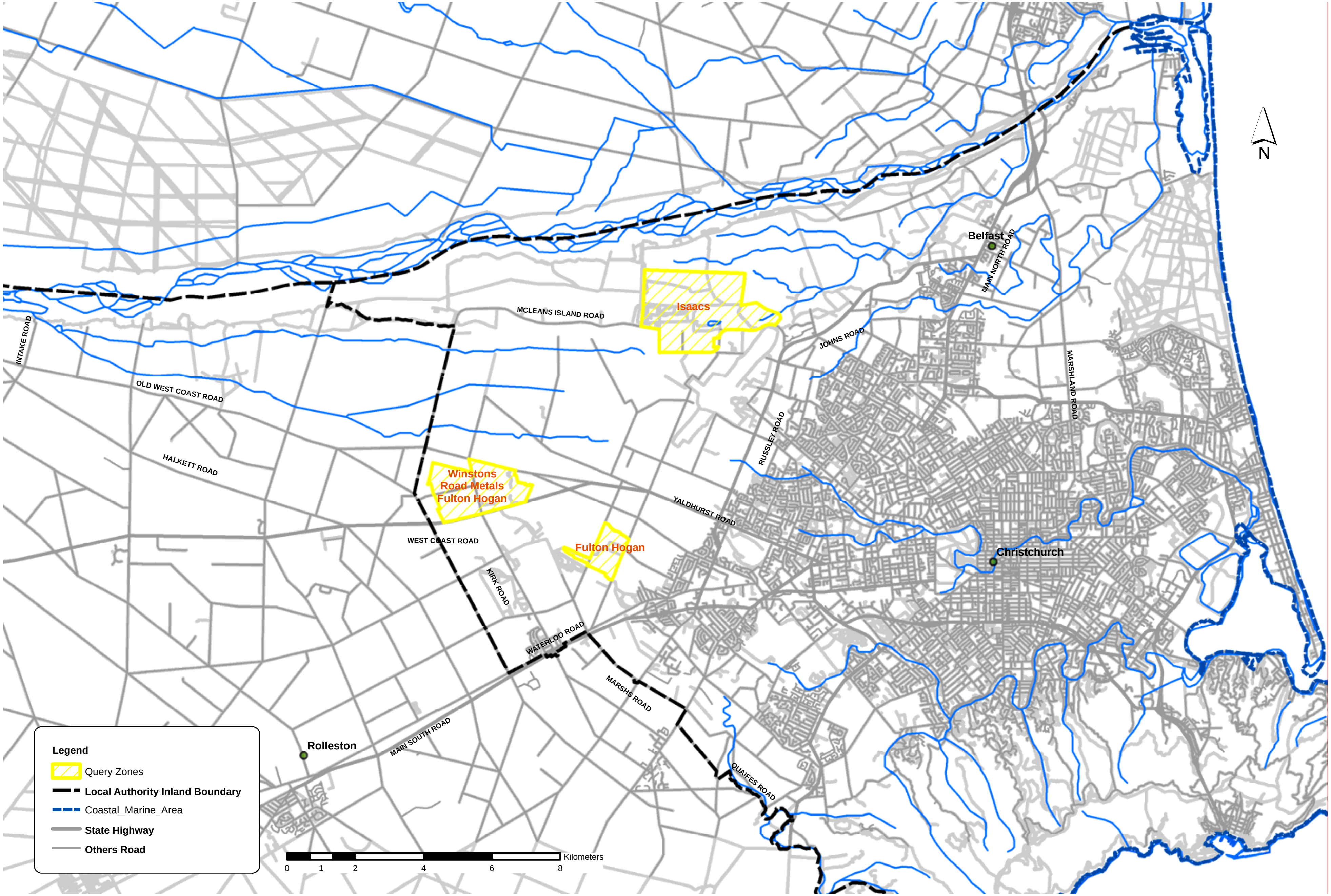

Figure 1 : Location Of Existing Quarry Areas West Of Christchurch

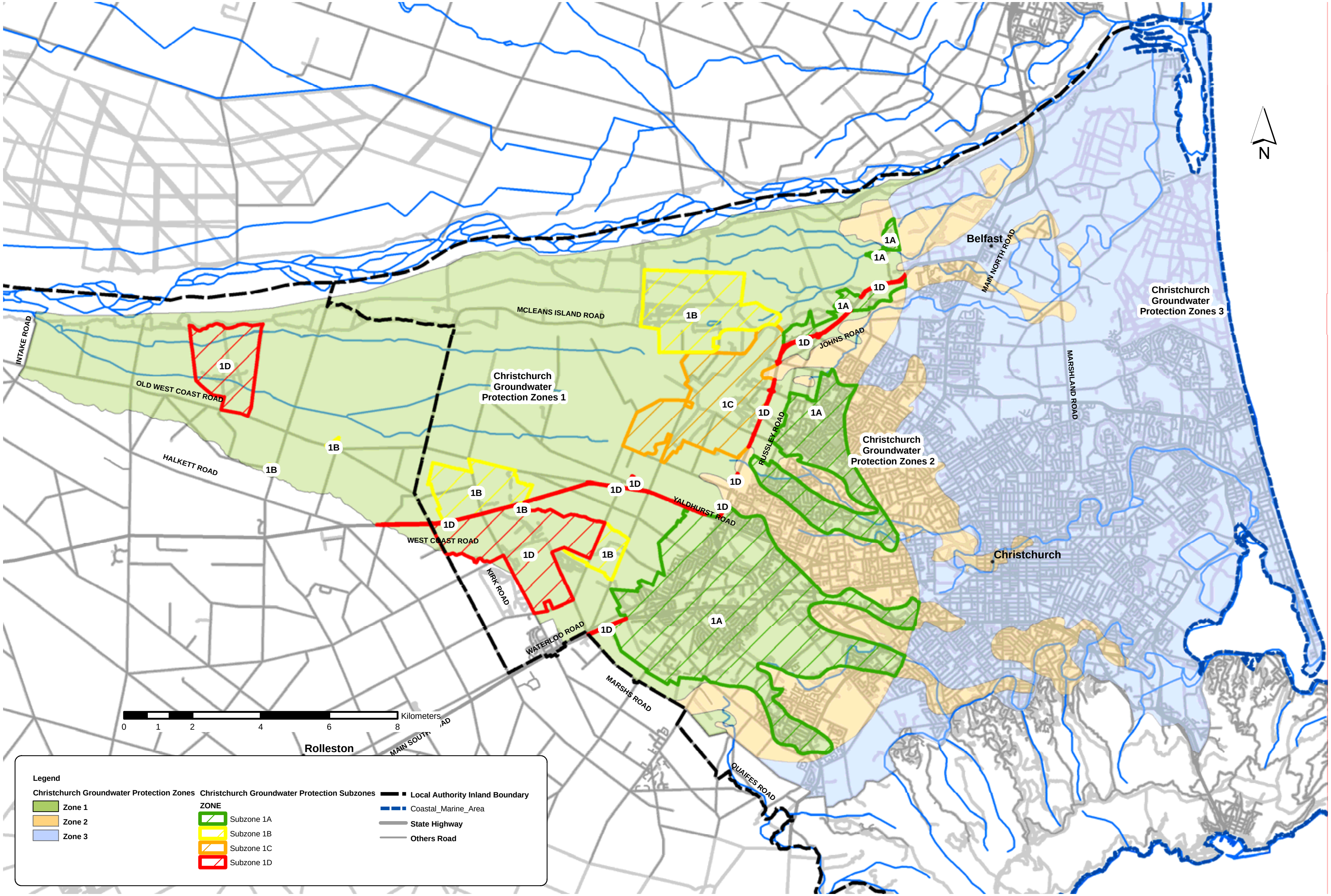

Figure 2 : Christchurch Groundwater Protection Zone Areas Defined In Variation 6 Of NRRP

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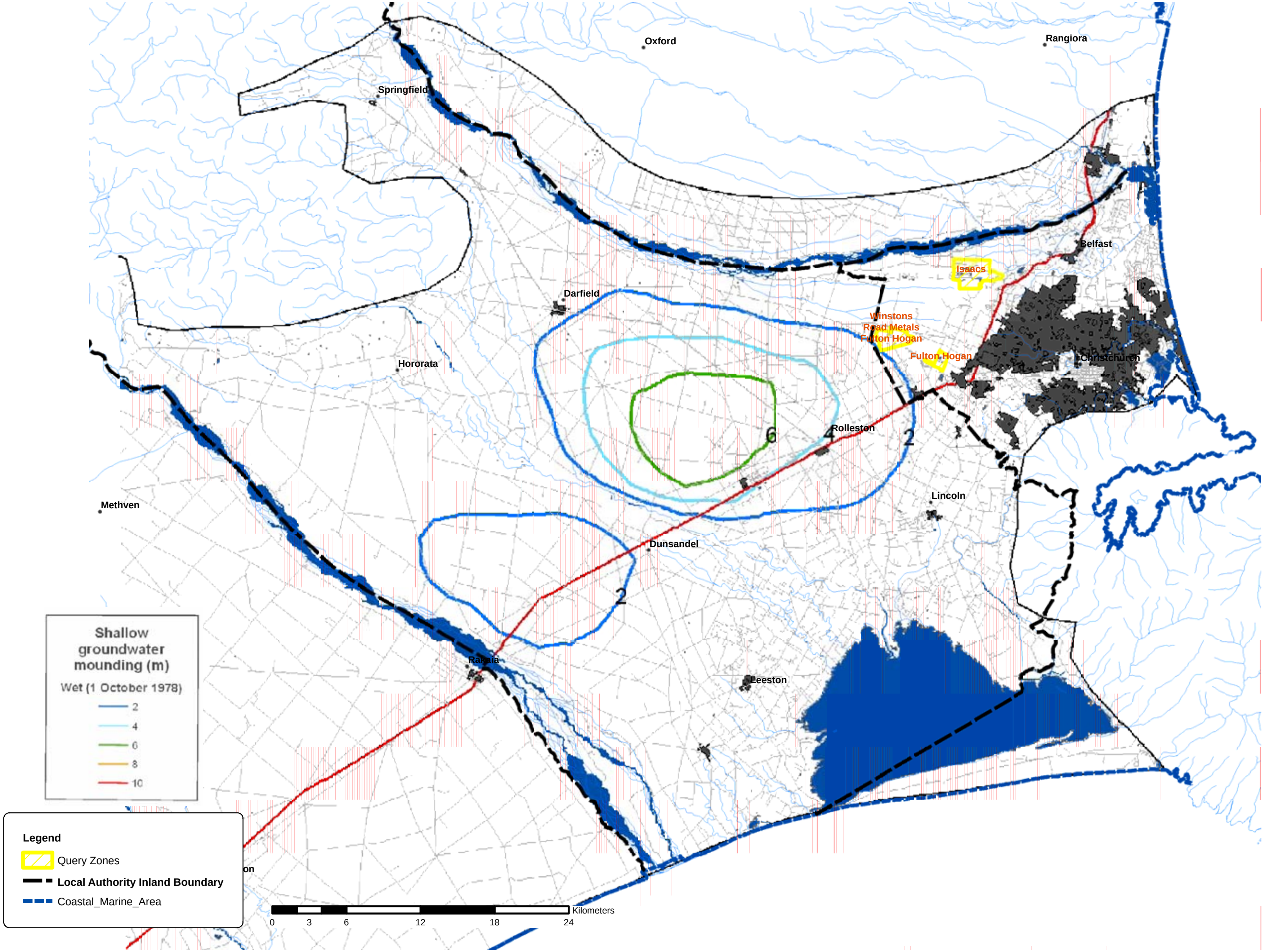


Figure 3: Applicants Predicted Rise In Highest Groundwater Levels Caused By CPW Activities

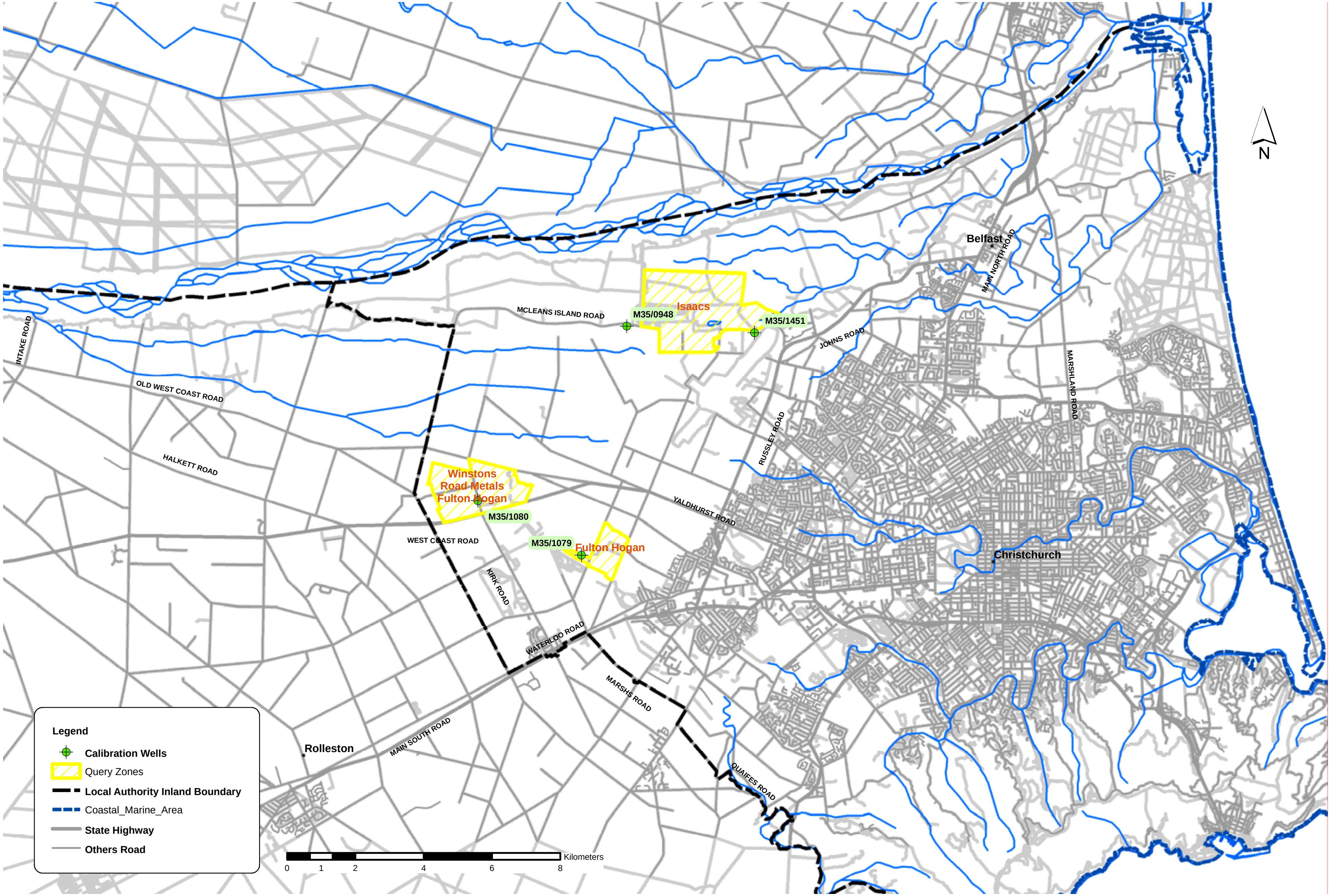


Figure 4: Location Of Applicants Model Calibration Bores In Close Proximity To Quarrys

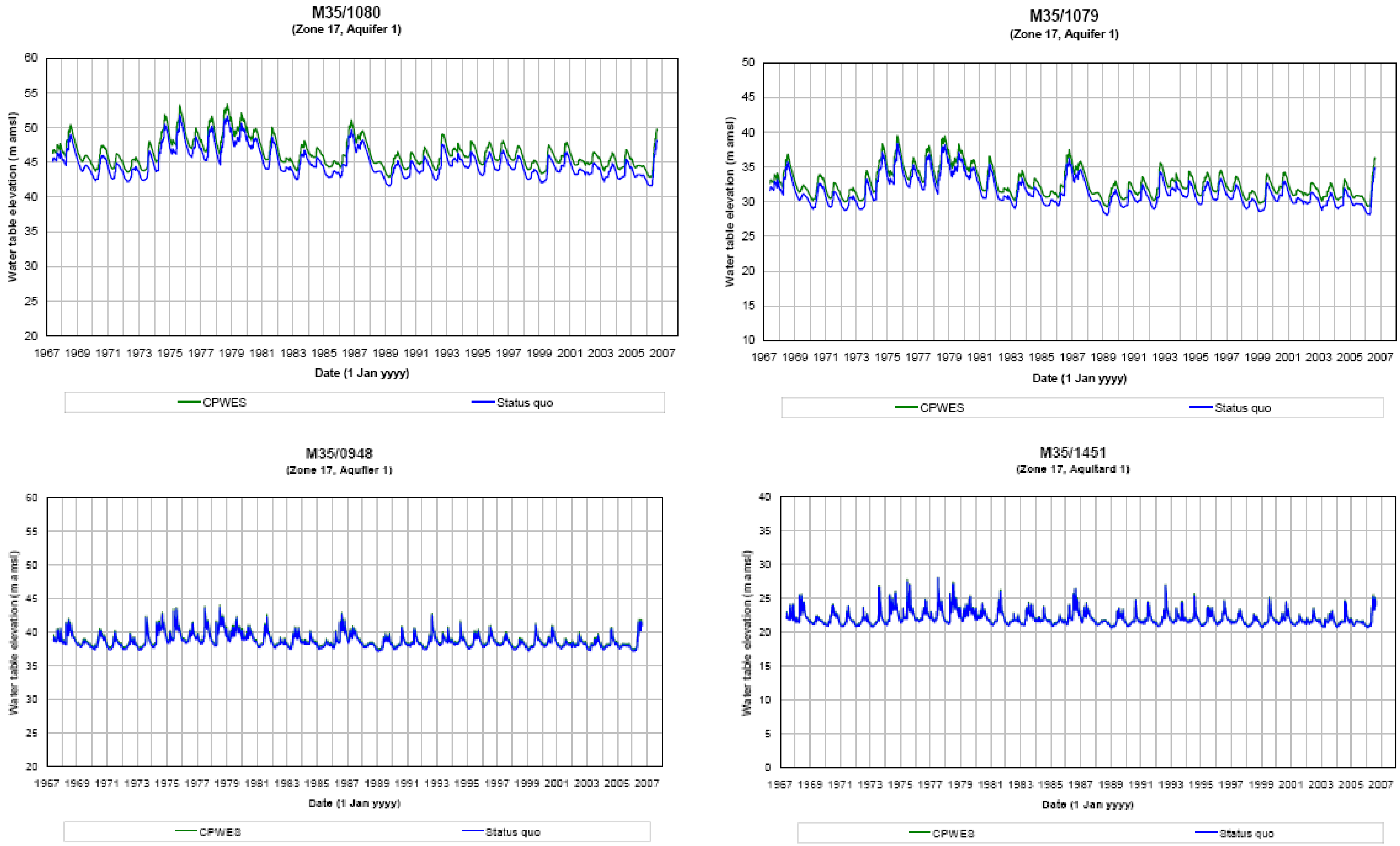
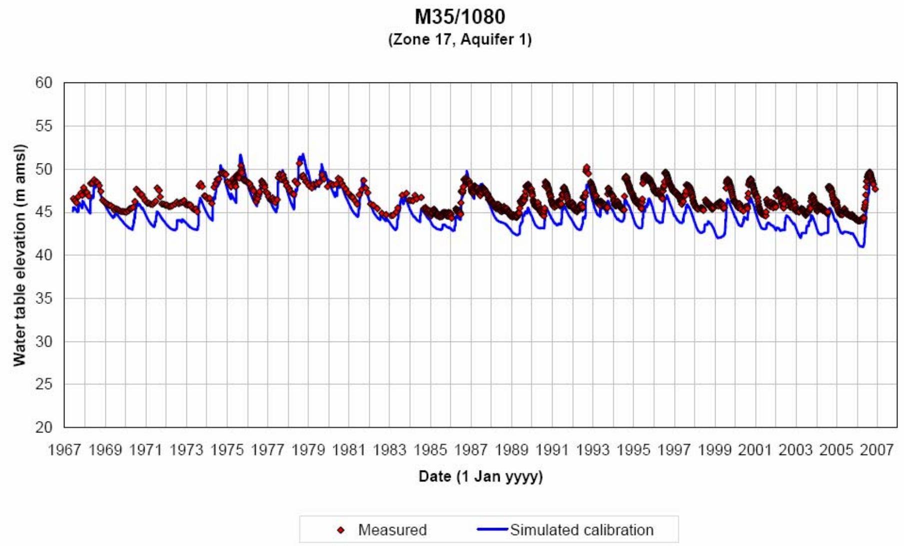
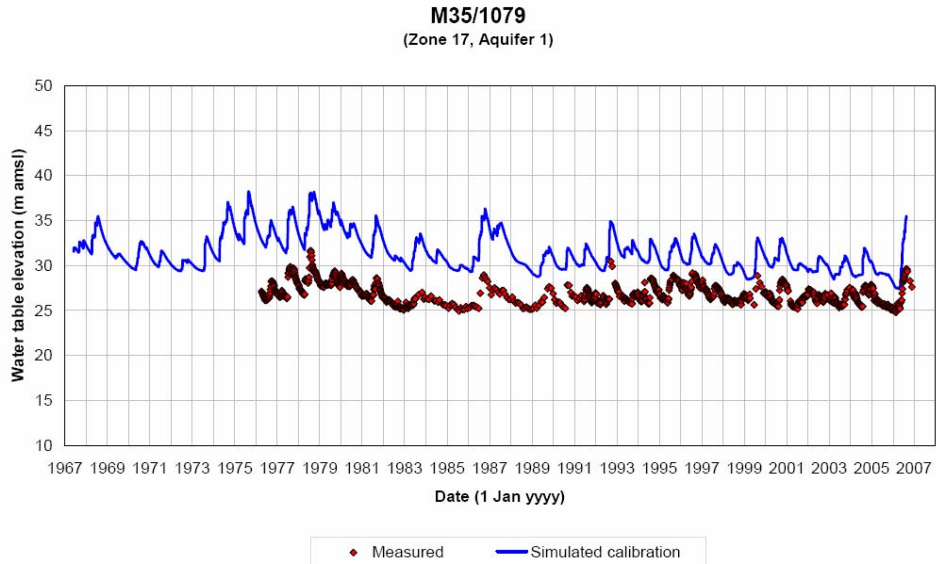
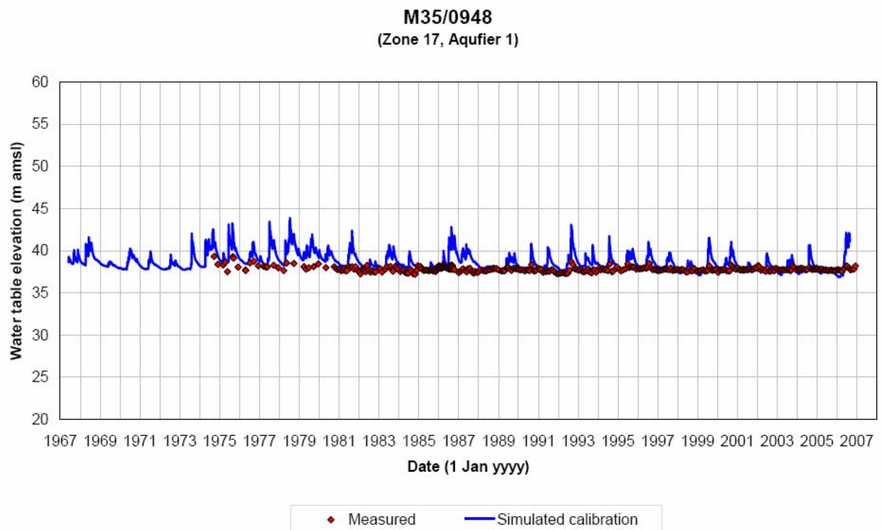


Figure 4a: Applicant's Simulated Change In Groundwater Level Due To CPW Activities Near Existing Quarries







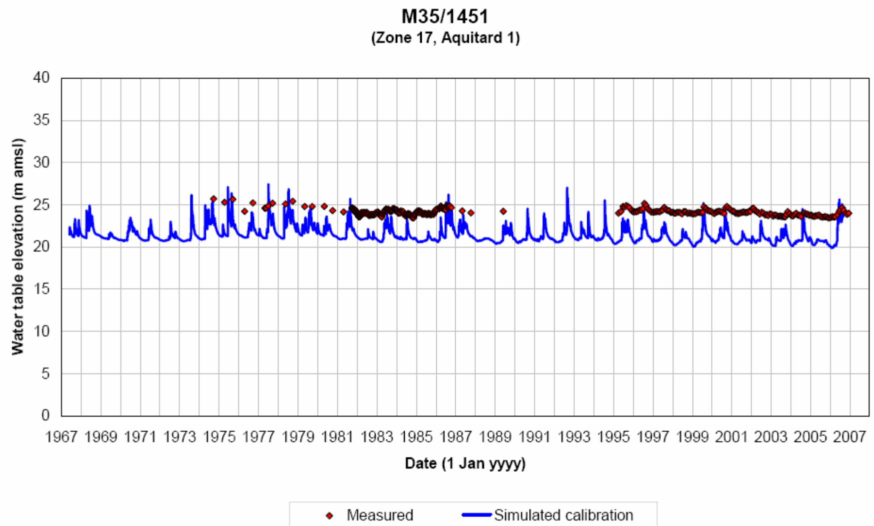


Figure 4b: Applicant's Model Calibration Plots Near Existing Quarries

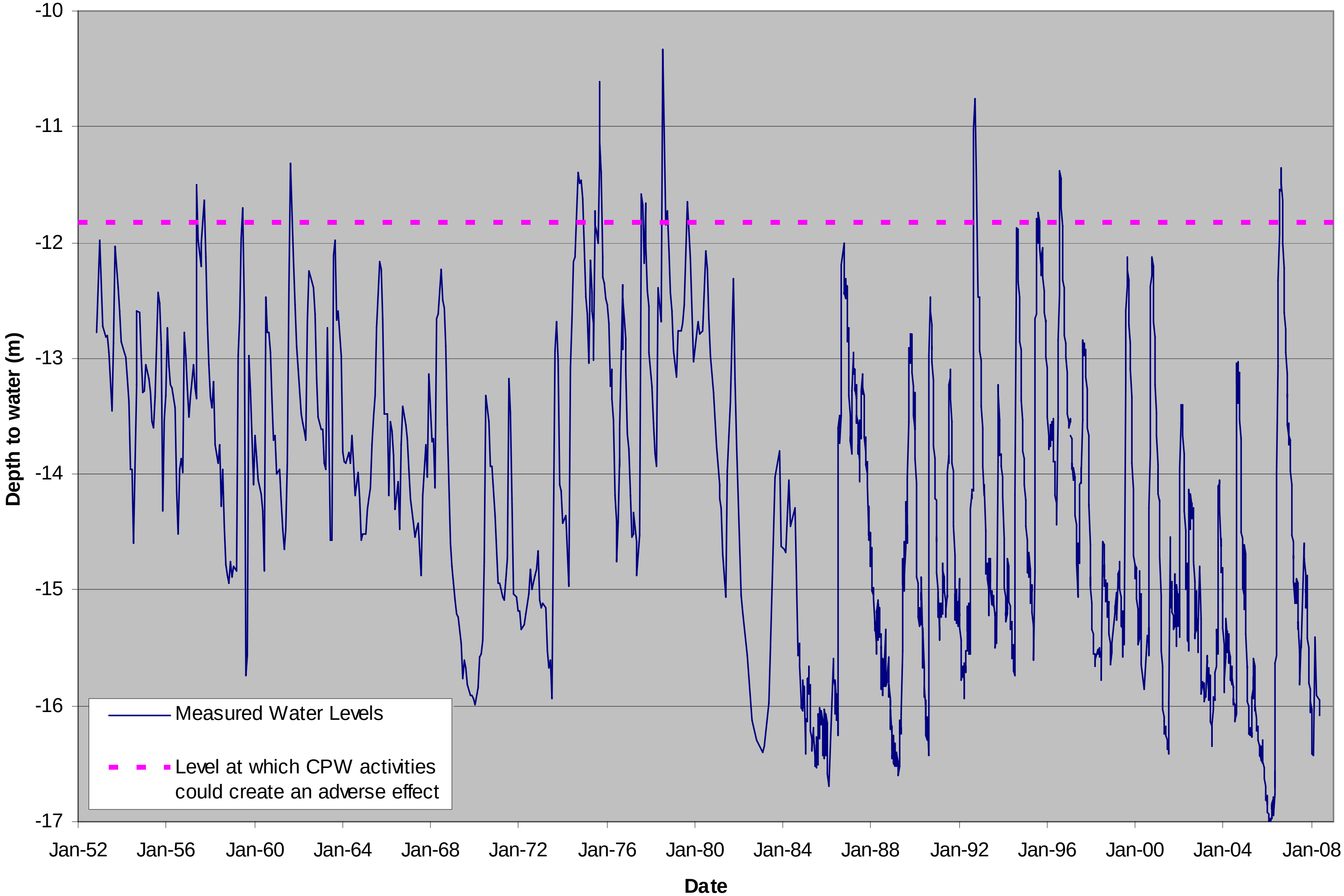


Figure 5: Long Term Water Level Records From Well M35/1080