# Addendum to

# "Belmont Quarry – Hydrological analysis of proposed land exchange"

I am the author of the above report and have the qualifications and experience set out in the introduction of that report. I have been provided with comments received on the Belmont Land Exchange Application and have been asked to respond to those within my area of expertise. I confirm that I have adhered to the Environment Court's Code of Practice for expert witnesses when preparing these comments.

## Context

Planning relating to the future of Belmont Quarry consists of two separate, although potentially interrelated, projects. The first is simply a potential land exchange. Should the exchange be agreed, then planning for, and construction of, an Overburden Disposal Area (OBDA) might be progressed by Winstones Aggregates. While the construction of an OBDA is contingent upon the land exchange, the design and construction of the OBDA would be subject to different rules and planning framework to the land exchange. The development of an OBDA needs to be considered separately from the land exchange.

The detailed hydrological analysis provided in *"Belmont Quarry – Hydrological analysis of proposed land exchange"* dated 3 December 2025 (**Hydrology Report**) focused specifically on the hydrological attributes, likely flow regimes, and characteristics of all the areas considered as part of the land exchange. It deliberately did not address the hydrological implications and effects of any potential OBDA. That analysis will be subject to a separate planning application.

The comments within this Addendum therefore relate mainly to the hydrological attributes of the various areas considered as part of the land exchange. It should be noted that the land exchange will have no effect on the existing hydrological processes, characteristics, or flow regimes of the various drainage lines within any of the potential exchange areas. All the hydrological processes will continue to operate and function, in the same manner and scale, as they do at present. At this stage, it is only a change in land ownership and status that is proposed.

## Introduction

As detailed in the Hydrology Report, the various areas proposed for the land exchange are located on the uplifted block immediately west of the Wellington Fault scarp. What is referred to as the 'OBDA', is the land parcel located primarily on the interfluves between six small headwater gullies. The relatively flat slopes on the ridges of this area contrast with the steeply incised small watercourses, and numerous headwater gullies, eroded into the uplifted block. The small catchments, particularly in the headwater gullies, mean that any surface flow is highly variable, both in space and over time. While the lower reaches of the larger streams have perennial flow, the continuity of surface flow (in both time and space) decreases moving upslope, with flow becoming first intermittent and then largely ephemeral[1]. It should be noted, however, that the boundaries between these different 'theoretical' flow regimes vary over time in response to rainfall and antecedent conditions. Therefore, providing a robust definition of the exact nature of the flow regime at a particular location can be problematic, even when applying current guidance[1].

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1 Watercourse categorisation guidance document, GWRC, May 2021.

## Drainage mapping process

The areas considered under the land exchange have a combined area of ~57.3ha. It is impossible to traverse all the various watercourses and drainage lines contained within this area. Therefore, robust modelling of the drainage network, supported by field validation, was undertaken. This is the only way to provide a complete, consistent, and holistic assessment of the hydrological attributes of the various areas.

The method adopted applied a consistent, industry-standard, methodology across all areas. All drainage lines were characterised by their catchment area, topographic form, and number of upstream tributaries. Given the close proximity of these areas, and similarity of geology, climate, topography, and general vegetation, the same rainfall-runoff relationship exists across all exchange areas.

The hydrological modelling therefore provides an accurate quantification of the number, length and size of the various watercourses and drainage lines throughout all areas. It should be noted that the modelling was based on the physical attributes of the landscape and not any arbitrary division of drainage lines and watercourses into perennial, intermittent, or ephemeral reaches. Consequently, in my expert opinion, the comparison provided in the Hydrology Report is both accurate and robust.

The results from the hydrological modelling are summarised in Table 5.2 from the Hydrology Report (***Table 1 of this addendum, below***).

***Table 1: Comparison of stream channel metrics for the different land parcels considered within the exchange.***

| Land exchange parcel | Area (ha) | Longest stream in exchange area (m) | Stream length less than Strahler order 7 | Stream length Strahler orders 7&8 | Stream length greater than Strahler order 9 | Total stream length in exchange area (m) | Upstream contributing catchment area (ha) |
|---|---|---|---|---|---|---|---|
| **OBDA parcel** | 23.24 | 265 | 899 | 723 | 223 | 1,855 | 89.2 |
| **Winstone parcels** | 34.1 | 463 | 449 | 898 | 1,682 | 3,029 | 177.4 |

It is significant that, even excluding all areas currently under QEII covenants, the Friends of Belmont Regional Park (FoBRP) conclude that the proposed land exchange would see an increase in 'Stream Length' within Belmont Regional Park of 17% (**Table 2 of this addendum, below**). This is consistent with the findings presented in the Hydrology Report.

***Table 2: Summary of the net effect of the proposed land exchanges, excluding land under existing QEII covenants, provided by FoBRP.***

| Discipline | Doc-Give | Doc-Get excl QEII | Net Gain |
|---|---|---|---|
| Area | 23.24 ha | 21.6 ha | Loss |
| Fragmentation | Very low | Very high | Significant loss |
| Ecology (Habitat) | Low-very high | Low-moderate | Significant loss |
| Ecology (Birds) | High (incl pond life) | High | Unchanged |
| Ecology (Bats) | Nil | Nil | Unchanged |
| Ecology (Lizards) | Proportional to area | Proportional to area | Loss |
| Landscape | Moderate | Moderate | Unchanged |
| Recreation | Moderate (with potential) | Low (disjoint and remote) | Significant loss |
| Archaeology | Very low | Very low | Unchanged |
| Aquatic | 1845 m of stream | 2164 m of stream | Yes, by 17% |
| Wetland | High | High | Unchanged |

Consequently, there is no dispute that the land exchange would result in a net increase in the length of streams and associated aquatic ecosystem protected within Belmont Regional Park. The land exchange will not result in any changes to the hydrological processes or flow regimes that are operating in any of these areas currently i.e., there will be no change to the existing hydrology. The existing rainfall-runoff relationships, and patterns and characteristics of drainage will be retained under any land exchange.

## Perennial streams

As stated, defining the inferred flow regime (i.e., perennial, intermittent or ephemeral) of a drainage line is problematic, even when applying current guidance[1]. Despite this, there are perennial streams (i.e., those with continuous temporal and lateral continuity of flow) within the OBDA exchange area. The reaches of the drainage network with perennial flow were marked on Figure 2.1 in the Hydrology Report (***Figure 1 of this addendum, below***).

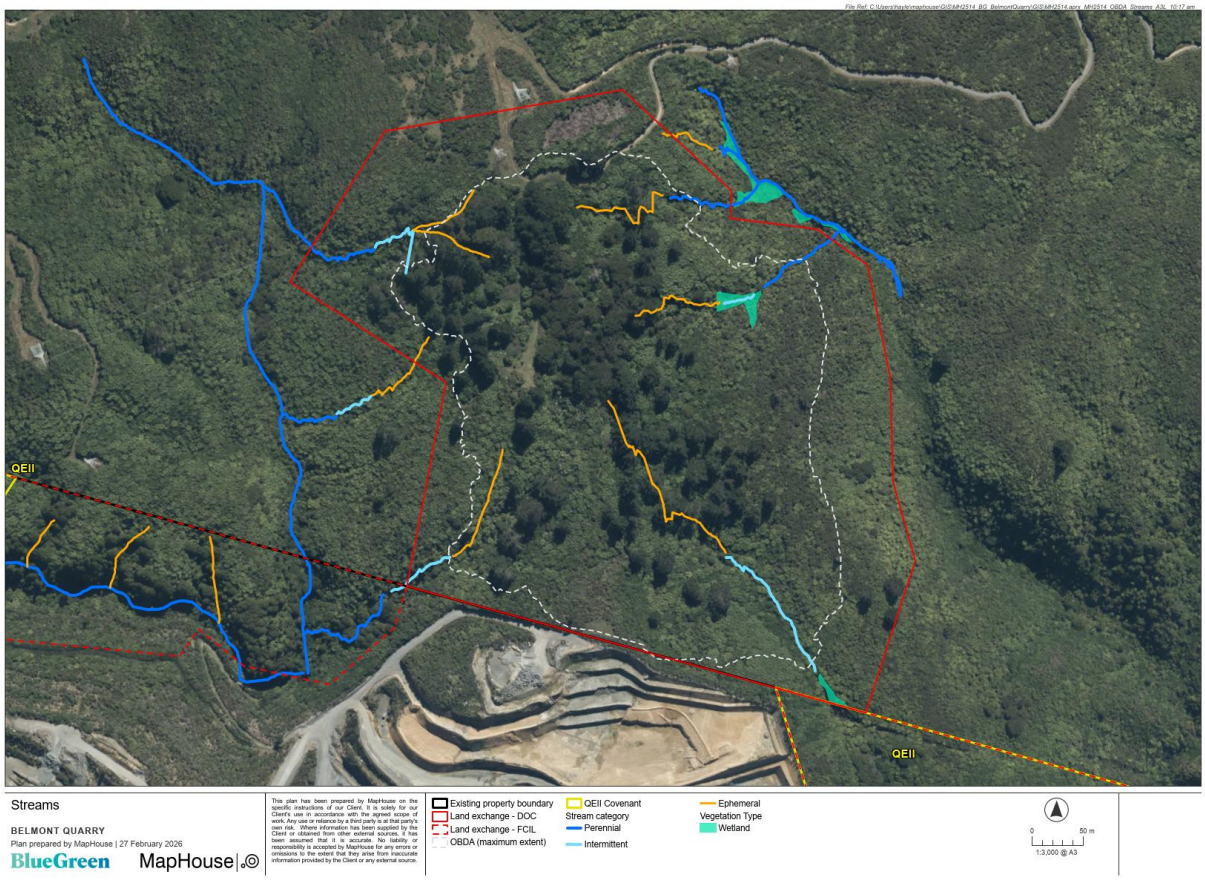


***Figure 1: Figure 2.1 from the Hydrology Report updated to show the land exchange boundary and a potential OBDA, the design and construction of which will be addressed in a subsequent application.***

Excess precipitation can move as surface and/or subsurface flow depending on antecedent conditions, the properties of the regolith, catchment size, and the intensity and duration of rainfall. A key hydrological characteristic of the watercourses in the exchange areas is therefore whether there is continuous surface flow. Hydrologically, the more significant watercourses are those with perennial or intermittent flow. Both perennial and intermittent watercourses are managed in the same manner, as rivers, under the Natural Resources Plan. Because of this, any distinction between these two types of watercourse assumes less significance. The hydrological values of watercourses with ephemeral flow will vary with flow conditions as discussed above.

While there are guidance documents, the assessment of the type of flow regime is often subjective, particularly in small gully heads. This is because the amount of water on the slope depends on rainfall, antecedent conditions, and the volume and characteristics of the regolith[2] ('sponge') which can hold, and then release, excess rainfall.

During any rainfall event, the regolith absorbs rainfall. When the regolith is saturated, from either direct rainfall or subsurface percolation, water will flow over the ground surface. If the regolith is not saturated, any flow will be subsurface until either the regolith thins (so it saturates), there is additional rainfall, or there is inflow of water from other areas at which point the regolith will saturate and surface flow will commence.

Headwater gullies are characterised by highly variable flow, both surface and subsurface, and the higher in the catchment the more variable the flow. Surface flow therefore varies both temporally and spatially. For example, with high antecedent moisture and higher rainfall, surface flow will be greater and more extensive. During periods with little or no rainfall, surface flow may cease, although subsurface flow will continue. It is also possible that, depending on the nature of the regolith, topography, and moisture conditions that surface flow will be intermittent down a drainage line, with water flowing over the surface in some reaches while being entirely subsurface in adjacent reaches. Short lengths of disconnected surface flow do not mean that flow in a stream should be considered perennial.

## Specific responses

Most of the comments provided by the FoBRP relate to the potential effects of establishing an OBDA within the proposed exchange area currently within Belmont Regional Park. These comments have limited relevance with respect to the impact of the proposed land exchange on the hydrology of the different areas. This is because ownership of the land will have no effect on the hydrological processes. These will continue to operate as they do at present. The existing rainfall-runoff relationships, and patterns and characteristics of drainage will be retained irrespective of any change in land ownership.

Only if there is a significant land use change, is there any potential for the existing hydrological processes to be affected.

Therefore, while not of direct relevance to the proposed land exchange, responses to the FoBRP submission relating to hydrology and hydrological processes are provided below.

### FoBRP comment 17

*The Hydrology assessment (Appendix B9) significantly underestimates the streams in the POBDA, and states that it contains no perennial streams, concluding that the proposed dumping of overburden would not affect the drainage characteristics of the area. In fact the POBDA contains streams that have never been seen to dry up in the last 20+ years, and the wetland ecology of the area would be destroyed.*

As described above, and detailed in the Hydrology Report, robust modelling of the drainage networks within all parcels considered for the land exchange, supported by field validation, was undertaken.

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2 The unconsolidated, generally more porous and permeable material, overlying the bedrock.

This is the only way to provide a complete, consistent, and holistic assessment of the hydrological attributes of the 57.3ha being considered as part of the land exchange.

The method adopted applied a consistent, industry-standard, methodology across all areas. All drainage lines were characterised by their catchment area, topographic form, and number of upstream tributaries. Given the proximity of the areas, and similarity of geology, climate, topography, and general vegetation, the same rainfall-runoff relationship exists across all the exchange areas.

The hydrological modelling therefore provides an accurate quantification of the number, length and size of the various watercourses and drainage lines throughout all areas. It should be noted that the modelling was based on the physical attributes of the landscape and not any arbitrary division of drainage lines and watercourses into perennial, intermittent, or ephemeral reaches. Consequently, in my expert opinion, the comparison is both accurate and robust.

The Hydrology Report does not state that there are no perennial streams within the OBDA exchange area. Various reaches of the watercourses with perennial flow are mapped and shown in ***Figure 1*** above.

Any land use change, and potentially the design and construction of an OBDA, are beyond the scope when considering just the land exchange. However, should an OBDA be constructed the existing Cottle's OBDA provides a real example of what can be achieved. It has been shown at the Cottle's OBDA that it is possible to maintain both surface and subsurface flow, the existing flow regime, and existing water quality using a range of industry standard techniques. The design and construction of any new OBDA will ensure that the existing hydrological processes are maintained, including both surface and subsurface flow. The current discharge into each of the various drainage lines within the OBDA will continue. It is therefore incorrect to suggest that the wetland ecology of the area down-gradient would be destroyed.

As shown in ***Figure 1***, a significant buffer is proposed between any OBDA and the boundary of the exchange area. It is my expert opinion that it is possible to design an OBDA, with its associated drainage and sediment control, so that any effects on hydrological processes are less than minor at the boundary of the exchange area. There will be no measurable adverse effects on hydrology or hydrological processes beyond the boundary of the exchange area. The OBDA will not affect any wetlands or the flow regimes of any streams down-gradient of the OBDA.

FoBRP comment 38

*In late 2025 the applicant revised the POBDA western boundary to exclude one population of swamp maire. The FoBRP regards this as a welcome but token adjustment since (see Fig 2.1 on p3 of the Hydrology Assessment) the watercourse upstream of the "excluded" swamp maire would still be buried in overburden. As J T Salmon points out (on p168 Native Trees of New Zealand): "if the swamp or bog is drained, the tree dies within one or two years". Regardless of the western boundary adjustment, the largest wetland and associated flora (upstream of the pond, in the south-east) would still be destroyed by the proposed overburden disposal.*

The only wetland that will be adversely affected by the development of an OBDA is that located within the OBDA (***Figure 1)***. As explained above, by applying the hydrological principles and practices from the existing Cottle's OBDA, the hydrology of the remaining wetlands will be unaffected by the development. The operation of the existing Cottle's OBDA proves that existing hydrological

processes can be maintained down-gradient of an OBDA. Consequently, there is no uncertainty or risk to the existing hydrological processes from developing a new OBDA in the exchange area.

FoBRP comment 70

*The Hydrology assessment can be found in Appendix B9. It claims that the POBDA area only contains intermittent and ephemeral streams, ie, that there are no streams that flow continuously. This seems to be based to a large extent on what is depicted on the LINZ topographical maps, and Strahler stream order in combination with a digital terrain mode, rather than by repeated field observations. LINZ topographical maps are known to show watercourses where none exist (eg on karst landforms) and they are not intended to provide a reliable source of hydrological information.*

This is incorrect as discussed in both the Hydrology Report and this addendum. The mapping of watercourses and drainage lines has used consistent, robust, industry-standard tools. Comparison of the hydrological attributes of the various exchange areas is therefore robust and accurate. Perennial streams have been mapped in the OBDA (***Figure 1)***. The hydrological assessment was not reliant on what is shown on LINZ topographical maps.

The reference to karst landforms is irrelevant. There is no limestone or marble in the area and consequently no karst landforms or karst hydrology. The bedrock in this area is relatively impermeable greywacke, with generally thin overlying regolith. Consequently runoff, and particularly the erosion of drainage lines, is dominated by surface processes. The illustration of 'streams' on LINZ topographical maps is consistent but constrained by the scale of the maps and the technology available when the maps were drawn. Irrespective of this, the identification of drainage lines in the Hydrology Report, and reaches of streams with perennial flow, did not rely on the LINZ topographical maps. The identification and mapping of drainage lines is discussed in more detail in the Hydrology Report.

FoBRP comment 71

*Consequently the Hydrology assessment significantly undervalues the importance of the stream courses within the POBDA. In particular (p8) "The [LINZ's topographical map] shows no streams in this area (Figure 2.5). Consequently, there is likely to be only limited surface flow in the proposed OBDA. The existing rainfall-runoff relationships, and patterns and characteristics of drainage, will be retained during any land exchange". This is simply incorrect: members of FoBRP have been visiting the area over the past 20 years and have never seen a lack of flow in the stream that feeds the wetland supporting swamp maire and ramarama, upstream of the pond. These observations over a long period of time are unique to community members, and not something a desktop survey could hope to capture.* ***Perennial streams definitely exist within the POBDA, and they must be accounted for in the application.***

There are some watercourses with perennial flow within the OBDA exchange area and these were marked on ***Figure 1***. The nature and characteristics of streamflow generation, including both surface and subsurface flows, are discussed in detail above and in the Hydrology Report.

As stated above, a land exchange is simply a change of ownership. Therefore, as stated "*The existing rainfall-runoff relationships, and patterns and characteristics of drainage, will be retained during any land exchange".* Changing ownership will have no effect on the pattern of rainfall, the existing rainfall-runoff relationship, or the hydrological environment. If these attributes do not

change, there will be no changes to hydrology. In my opinion, it is important to separate the potential hydrological effects of the land exchange from those that might result from subsequent land use decisions. The effects of those decisions will be identified, controlled, and managed through a separate process.

Despite the above, it is my opinion that an OBDA could be developed within the exchange area that maintains, and potentially enhances, the hydrological environment downstream of the OBDA. The design, construction and management of the existing Cottle's OBDA provides working example of how this could be achieved.

FoBRP comment 72

*This is illustrated in Figure 2.5 (p8 of Appendix B9): A dashed red region is used to vaguely indicate the area of "the proposed OBDA and the lack of any streams shown in this area". The lack of care and attention in this assessment is, frankly, appalling*.

The detailed and comprehensive mapping of watercourses and drainage lines is discussed in detail above and in the Hydrology Report. No reliance was placed on Figure 2.5 when identifying the streams and watercourses in the area. That drainage network analysis was done using high-resolution topographic data and a range of hydrological analysis tools which are considered 'industry standard'.

FoBRP comment 73

*This point is important, because this stream feeds not only a rare, uplifted wetland, but also flows into the Firth block, immediately downstream. Burial of this stream, and consequent addition of fines and soil particulates into it, would adversely affect the QEII protected lands downstream. This would presumably contravene the terms of the Firth Block QEII covenant.*

The infilling of a gully does not need to stop all runoff and hydrological processes. Any rainfall over the area, in excess of evapotranspiration requirements, will still runoff either over the surface or via subsurface drainage. As shown at the Cottle's OBDA, it is possible to control subsurface drainage to maintain existing flow paths, to separate clean and dirty surface flow, to discharge clean water into original flow paths, and to treat dirty water to avoid the discharge of sediment. Consequently, the concern expressed by the FoBRP can be avoided through standard industry practices and local experience that have been shown to be effective at maintaining hydrological processes and the existing flow regime.

It is also not correct to refer to an "uplifted wetland" as if it is a distinctive landform. The wetland is simply an area of impeded drainage within a topographic depression that just happens to be above the Wellington Fault scarp. The wetland formed subsequent to uplift of the scarp and so cannot be described as an "uplifted wetland". Had the wetland been present prior to uplift, it is my expert opinion that this area would have drained and therefore ceased to function as a wetland.

Any land use change, and potentially the design and construction of an OBDA, are beyond the scope when considering the land exchange. However, should an OBDA be constructed the existing Cottle's OBDA provides a real model as to what can be achieved. It has been shown at Cottle's that it is possible to maintain both surface and subsurface flow, the existing flow regime, and existing water quality. Since the existing hydrological processes will be maintained within any OBDA, including both surface and subsurface flow, and the current discharge into each of the various

drainage lines within the OBDA will continue, it is not correct to suggest that the wetland ecology of the area would be destroyed. That said, any hydrological changes associated with constructing an OBDA will be managed to ensure they do not adversely affect the wetlands or their ecological values.

FoBRP comment 76

*After the initial discovery of 14 swamp maire within the POBDA, the applicant brought the western boundary eastwards in an attempt to mitigate the impact, ostensibly by avoiding the swamp maire. However the submitted plans (eg Fig 2.1 on p3 of the Hydrology Assessment) show the catchment upstream of these trees to be within the POBDA, and if the hydrology in this gully is modified, this grove of swamp maire could be expected to die within one or two years, as was explained in section 3 above.*

Any land use change, and potentially the design and construction of an OBDA, are beyond the scope when considering the land exchange. However, as stated above, should an OBDA be constructed, the existing Cottle's OBDA provides a real model as to what can be achieved. It has been shown at Cottle's that it is possible to maintain both surface and subsurface flow, the existing flow regime, and existing water quality. Since the existing hydrological processes will be maintained within any OBDA, including both surface and subsurface flow, and the current discharge into each of the various drainage lines within the OBDA will continue, it is not correct to suggest that the wetland ecology of the area would be destroyed. Any hydrological changes associated with constructing an OBDA will be managed to ensure they do not adversely affect the wetlands or their ecological values.