



Sonia Baker
Team Leader, Environmental Regulation
Greater Wellington Regional Council
PO Box 11646 Manners St
Wellington 6142

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MEMORANDUM

TO Sonia Baker | Greater Wellington Regional Council (GWRC)
FROM Alex James | EOS Ecology

Review of ecological components of GWRC's flood protection operations and maintenance activities in the Waikanae River and Waimeha Stream consent application

EOS Job No: GRE01-14074

Dear Sonia,

Please find below my review of the ecological components of GWRC's "Resource Consent Application WGN130303: Flood Protection Operations and Maintenance Activities in the Waikanae River and Waimeha Stream". This has involved the review of the actual consent application document prepared by Tonkin & Taylor Ltd, May 2013 (updated October 2014) (referred to herewith as Tonkin & Taylor, 2013 or the application report) and the report "Effects of flood protection activities on aquatic and riparian ecology in the Waikanae River" prepared by David Cameron of MWH, September 2014 (herewith referred to as Cameron, 2014 or the ecological AEE report). I have not covered the proposed mitigation/avoidance/remedies included in these reports, as it is understood these elements will be covered in the Code of Practice, which will be reviewed in a separate memo.

1 DESCRIPTION OF THE EXISTING ENVIRONMENT AND ASSESSMENT OF ECOLOGICAL EFFECTS

"Your opinion on the appropriateness of the updated ecological effects assessment in the Waikanae River application report"

"A review of the updated ecology effects assessment in Cameron (2014) for the Waikanae River and the validity of the conclusions reached"

1.1 GENERAL COMMENTS

The Waikanae River application report (Tonkin & Taylor, 2013) included some information on riparian vegetation, periphyton cover, macroinvertebrates, estuary ecology, and birds that was not included in the supporting ecological AEE report (Cameron, 2014). This is of concern as in my experience the ecological AEE should give comprehensive coverage of ecological matters with the actual consent application document then providing a summary of that information, rather than the consent application having to supply additional ecological information because it was not provided in the ecological AEE report.

The area covered by the consent application has been subjected to various flood protection activities for over 60 years. Hence it is already modified by these activities (e.g., extensive rip rap bank treatment and willow plantings). To determine if this "impact" section of the river shows any signs of such impact, it is important to compare ecological information between this section and the upstream "reference" part of the catchment. There is some impact-reference comparison within the Waikanae River catchment for periphyton, water quality, macroinvertebrates (purely resulting from the locations of the two GWRC SoE monitoring sites). For fish a list of species recorded in the "impact" section of the Waikanae River is provided but there is no explicit comparison of fish faunas between the "impact" and "reference" parts of the catchment, or any idea of relative abundance of these species. Additionally, the bird data is limited to below the SH1 bridge, so does not cover the whole "impact" reach let alone the greater catchment.

www.eosecology.co.nz
info@eosecology.co.nz

PO Box 4262, Christchurch 8140
P 03 389 0538

PO Box 8054, Palmerston North 4446
P 06 358 9566



In the application report, there is a lack of a simple map showing the area covered by the consent application. While the detailed aerial photographs are useful, a single page overview map is beneficial to quickly show the extent of the waterways where flood protection activities occur. Figure 1-1 from the ecological AEE report does this well and should be included in the application report.

Both reports need to have the citations and references checked and corrected for omissions and inconsistencies.

In general, I agree with the determination of effects for most of the proposed activities based my own general knowledge of gravel bed rivers, however many aspects of aquatic and riparian ecology specific to the application area are not adequately covered. The description of the existing environment is missing some important information that in my view is required to adequately determine effects beyond a generic New Zealand gravel bed river. Such specific information is especially important in this instance as an adaptive management regime driven by a "living" Code of Practice document is the proposed means of avoiding/remediating/mitigating the impacts of the flood protection activities for the next 35 years.

1.2 DESCRIPTION OF THE EXISTING ENVIRONMENT

A comprehensive description of the existing ecological condition of the area covered by the consent application and the catchment in general is crucial to undertaking a rigorous assessment of ecological effects. The description included in the ecological AEE report and consent application report largely relies on GWRC state of the environment (SoE) data for periphyton and macroinvertebrates (two sites only), the New Zealand Freshwater Fish Database (NZFFD), and a report by McArthur *et al.* (2013) for birds. In my view there are gaps in the coverage of these ecological components while other relevant ecological components are missing entirely. Because the description of the existing environment in the application report is largely drawn from the ecological AEE report, both documents are covered here. These gaps and other identified issues are outlined below:

- » Estuary – A comprehensive description of the Waikanae River estuary is crucial to this application as it includes activities in the estuary extending into the coastal marine area (CMA) (i.e., river mouth realignment, removal of flood debris, an intensive gravel extraction operation in the lower river). The application document and the ecological AEE report each have a short section on the Waikanae River estuary that omit important information I would have expected to be there:
 - There is no information on estuary invertebrates, despite a recent GWRC survey being available (Robertson & Stevens, 2012). This is particularly important given the likely increased deposition of fine sediment that will result from the proposed intensive gravel extraction in the lower river.
 - In the application report (Section 3.9.3 Fish) it is stated the Waikanae Estuary provides a sheltered nursery for a variety of marine fish species. What fish? Why is this not included in the ecological AEE report? What is the source of this information?
 - The estuary is part of a Department of Conservation (DOC) reserve (Waikanae Estuary Scientific Reserve) that includes several regionally rare and threatened plant species. It was unclear if any of these occur in the area covered by the consent application.
- » Aquatic plants – The ecological AEE report states that no records of aquatic macrophytes for the Waikanae River have been located:
 - While I understand that macrophytes are unlikely to be present in most of the Waikanae River main stem, the proposed activities in Waimeha Stream involves mechanical "weed" clearance. While it is likely most of these are exotic species, it is still important to describe the macrophyte communities of the area covered by the consent application and determine their importance as habitat for fish and invertebrates. There may be places where native species or exotic species considered noxious are present. I know of the presence of two exotic invasive macrophytes that are listed as unwanted organisms, *Myriophyllum aquaticum* (parrots feather) and *Lagarosiphon major* (oxygen weed) in Waimeha Stream. This detail is needed to inform the proposed adaptive management regime. While the draft Code of Practice (COP) includes the retention of around 10% of aquatic vegetation to act as a refuge/recolonisation source and where practicable, leaving selected ecological refuge areas, these actions could be better targeted if there was knowledge of the macrophyte species present. For example, perhaps significant patches of native species would be left alone, while special effort would need to be made with noxious species to prevent their spread.
- » Macroinvertebrates – The macroinvertebrate data presented was limited to pre-existing data based on two GWRC SoE sites (2009–2011). There is little information provided in the ecology AEE report regarding macroinvertebrates, and there is key information missing that I would expect to be standard for any AEE report. This is detailed further below.
 - While the presented data provides a broad catchment-scale appreciation of some invertebrate metrics, it does

not provide the required detail. For an application that involves invasive instream activities such as bed recontouring and gravel extraction, more detail on the invertebrate community is required. What are the most common species/taxa in the sections to undergo gravel extraction/bed recontouring? How does the community composition (density/abundance of main species, diversity, evenness etc.) compare to that found outside of the area (i.e., are the communities within the project area distinct or similar to that found outside of the affected area)? Are there any threatened or at risk invertebrates present according to the listing of Grainger *et al.* (2014)? Which EPT taxa are present in the river?

- Are freshwater mussels/kakahi potentially present, particularly in the Waimeha Stream?
 - All the macroinvertebrate data is from shallow habitats. Is there any data available on the invertebrates of deeper, non-wadeable habitats?
 - Table 11 (application report) and Table 3-3 (ecological AEE report) present means, thus some kind of measure of variability would be useful (e.g., ranges, standard errors).
 - The SoE data presented for the Waimeha Stream is from the Ngarara Stream tributary, which is outside the area covered by the consent application. Thus no macroinvertebrate data from the Waimeha Stream in the “impact” reach is presented. I know there is recent existing data from this reach collected as part of the MacKays to Peka Peka Expressway project and available online at <http://www.nzta.govt.nz/projects/mackays-to-peka-peka-application/docs/technical-report-30.pdf>. Additionally, the Freshwater Ecosystems of New Zealand (FENZ; Leathwick *et al.*, 2010) is a freely available resource that provides probabilities of encountering various freshwater invertebrates in waterways throughout New Zealand. This could also have been used to at least give a prediction of the likely main invertebrate taxa in this waterway.
 - The Ngarara Stream SoE site is soft-bottomed. Was the soft-bottomed variant of the MCI/QMCI presented in Table 11 (application report) and Table 3-3 (ecological AEE report)? If not then it should be used.
 - The application report omits the Ngarara Stream data so does not even have any basic macroinvertebrate information from the Waiheka catchment, let alone the actual “impacted” reach of the Waimeha Stream.
 - There is no coverage of the invertebrate fauna that lives in the gravel substrate both in the wetted bed and laterally in gravel bars and beaches (hyporheic invertebrates = hyporheos) of the Waikanae River. Wherever bed/beach recontouring or gravel extraction occurs, there will be negative effects on the hyporheos. While such effects are largely unavoidable, it is still important to characterise this fauna and acknowledge as much. Sampling of this fauna may have been undertaken as part of some past research project or survey.
 - The application report notes the finding of the poorly known freshwater polychaete at the GWRC SoE site within the “impact” reach (Site RS10). This is notable additional information that was not included in the ecological AEE report.
 - The ecological AEE report and application report both present GWRC SoE monitoring invertebrate data for the period 2009–2011. I know there is data from these sites for several years earlier than this. Why hasn’t the full period for which there is data available been presented? This would be particularly interesting in determining any trends (or lack thereof).
- » Fish – A summary of NZFFD records are presented in both reports, along with those of an additional survey in the Waimeha Stream.
- The tables of NZFFD records (application report: Table 13 and 14; ecological AEE report: Table 3-5 and 3-6) gives no indication of where each species has been found in relation to the area covered by the consent application. To make effective use of this information, the records should be split into those from in the application area and those outside. A map of site locations would also be useful in the application report. Distribution maps of six fish species in the Waikanae River and Waimeha Stream catchments are provided in the ecology AEE report (Figures 3-1 to 3-6). These would be more useful if they showed the area of the catchment included in the consent application and this data was used to help determine those species likely to be most impacted by in river works.
 - The text of the ecological AEE report states the NZFFD includes 15 NZFFD records from the Waikanae River catchment. There seem to be more than that on the provided maps (Figures 3-1 to 3-6).
 - Tables 3-7 and 3-8 (ecological AEE report) show the results of fish surveys undertaken in the Hutt River by Perrie (2013). While these are useful at indicating the deeper water fauna of the Hutt River and could perhaps give an indication of the effects of gravel extraction in other gravel bed rivers similar to the Hutt River, they are not directly applicable to the Waikanae River in describing the existing environment.
 - The tables of fish data also only present presence/absence rather than any abundance (relative abundance, rank

- abundance etc.), which means that it is impossible to know what species are more abundant and what the general community composition is like.
- The presented fish information gives an indication of the species present but not about which species will be affected the most by the more invasive activities such as gravel extraction and bed recontouring. In essence the authors need to cover which of the various fish species we should be most concerned about.
 - Some information on inanga spawning locations is presented. A map of these would be most useful. It is also stated that trout spawn in the reach of the Waikanae covered by the consent application as well as upstream with a map in Appendix B of the ecological AEE report, but there is no information on the other species that may spawn in the reaches affected by gravel extraction and bed recontouring (e.g., torrentfish, bully species).
 - In the ecological AEE report the results of annual drift diving trout surveys are presented, however, the exact locations and reach lengths of these surveys is not provided. There is however, a table in the application report with reach lengths and co-ordinates. Ideally the survey reaches should be showed on a map and included in the ecological AEE report and application report.
 - More information is required on whether trout actually successfully spawn in the “impacted” reach of the Waikanae River. Are redd counts ever undertaken by Fish & Game?
 - What is the level of customary, recreational, and commercial fishing for eels in the Waikanae River and Waimeha Stream. This may affect their abundance and distribution.
- » Water quality – The water quality data presented were from GWRC SoE sites (2009–2011)
- It is stated the latest GWRC water and ecology trends report covers the period 2004–2011. Why wasn’t the earlier data included in Table 3-1 (ecological AEE report) or Table 9 (application report)?
- » Gravel bar and beach flora and fauna – apart from riverbed nesting birds (or the lack thereof) there is no information on the flora and fauna of gravel bars and beaches that may be impacted by gravel extraction and bed recontouring. While the vegetation colonising such environments is more than likely composed of fast growing exotic species and these environments are periodically reset by large bed-moving floods, there is the potential that periods between large floods could see the development of plant communities that may have some native vegetation and provide habitat for native fauna. Disturbance of these plant communities through gravel extraction and bed recontouring could negatively affect any such native flora and fauna. Some basic information on what native flora and fauna are present in such environments is required to determine if there are any negative ecological effects of flood protection activities that disturb gravel beaches.
- » Riparian vegetation
- Section 3.8 of the application report gives a brief description of riparian vegetation, something that is missing from the ecological AEE report, which despite having “riparian ecology” in the title, presents virtually no information on riparian vegetation. While some 53% of the flood protection reach of the Waikanae River is managed willows, what is the remaining 47%? There appear to be some remnant patches of kohekoke/tawa/titoki forest adjacent the Waikanae River. Does the area covered by the consent application include parts of any of these? Is there the potential for willow plantings or other flood protection activities to damage these remnants? Are there any significant areas of native plantings?
- » Birds
- A table of all bird species recorded in the 2012 survey by McArthur *et al.* (2013) is provided (application report: Table 16; ecological AEE report: Table 3-9). More information on which species are likely to be using habitat affected by the various activities (e.g., gravel extraction, beach recontouring, willow maintenance, etc.) is required. While there are unlikely to be any nesting by riverbed nesting birds, there are likely other species that utilise riverbed and river mouth/estuary habitat. For example, which species feed and rest on gravel bars/beaches, which species may be nesting or roosting among the riparian vegetation (including willows) and when? Which of the list of species should we be most concerned about?
 - McArthur *et al.* (2013) notes, “the identity and number of all native birds on or associated with the riverbed were recorded in 1 km sections within each survey area. Although the results are not reported here, this was done to provide the opportunity to allow comparisons of bird abundance to be made between individual 1 km reaches of river, assisting us to identify reaches of river that support relatively high numbers of key species with a higher degree of spatial resolution.” Thus GWRC has much higher resolution bird distribution data available than what has been presented in the ecological AEE report and application report. I suggest this would be useful information to include.
 - The McArthur *et al.* (2013) survey covered the area of the Waikanae River from SH1 downstream to the estuary,

thus did not cover the entire reach covered by the consent application, nor any of the catchment upstream. Are river nesting birds present or likely to be present in these unsurveyed areas?

- Given the Waikanae Estuary Scenic Reserve is noted to be visited by more species of coastal and aquatic birds than any other site on the Wellington coast, then I would expect an additional list of these species to be included. Given its ecological importance, surely there is additional avian survey information beyond that of McArthur *et al.* (2013) that could be included?
 - There is no bird data for the Waimeha Stream.
 - The application report mentions fernbird being present in the Waikanae Estuary area. This was not mentioned in the ecological AEE report.
- » Herpetofauna – Not covered at all. Are there any skinks or geckos known or potentially present in the area covered by the consent application?

1.3 ASSESSMENT OF ECOLOGICAL EFFECTS

To fully assess the effects of a proposed activity on the environment, one first must have a full understanding of the existing environment. Based on Section 1.1 and 1.2 above, it is clear there are key information gaps. However, it must also be noted the Waikanae River has been subjected to various flood protection activities for some 60 years and the activities proposed in the consent application are not new to the catchment. Like so many New Zealand rivers it has been severed from its floodplain by the construction of stop banks, which in turn has altered rates of gravel accumulation. Hence, in general the river fauna now present is a fauna that is tolerant to such alteration and we will never know how the diversity and abundance of species differs to the pre-impact state. It is also a fauna that is adapted to persisting in a dynamic gravel bed river where floods that redistribute bed gravels are relatively regular. We know for certain that there have been certain negative ecological impacts from flood protection works (for example the disruption of inanga spawning habitat and reduction of aquatic habitat area) but there may well have been and continue to be undetected impacts, some of which could be avoided/mitigated/minimised by refining flood protection practices.

As the ecological effects in the application are largely drawn from the ecological AEE report, the comments on these documents are combined. In general I agree with the determination of effects for most of the proposed activities. The following comments cover those areas of the AEE where my opinion differs from that of the application report and/or ecological AEE report or where relevant information is missing:

- » Application report: Many of the proposed activities are not new to the Waikanae River, thus a map showing where the main existing flood protection features (i.e., willow plantings, rip-rap rock lining, groynes, etc.) are would be most useful to gain an appreciation of the location and extent of pre-existing channel modifications.
- » Application report: Section 6.1: Positive Effects. As stated in this section there is no doubt the flood protection works over the last 60+ years have had huge economic and social benefits through the prevention of the flooding of surrounding land. This section could however be expanded to cover positive ecological effects including:
 - The potential for bed recontouring activities to actually increase river habitat variability or at least maintain, that which is already there (which would be an improvement over how it was done in the past).
 - The construction of groynes creates structures that have the positive effect of creating deep, slow pool habitats, which are probably not dissimilar to those that naturally would have resulted from fallen trees and associated debris dams when the riparian zone had native vegetation. Likewise, debris fences, debris arrestors, and timber groynes also mimic to some extent natural debris dams, however, these are likely to be regularly cleared of debris thus diminishing any positive effect.
 - Rip-rap boulders at the water edge and below the surface provide a stable surface for the spawning of some fish species (i.e., bullies) and some aquatic insects that lay eggs on the undersides of larger rocks.
- » Application report (Section 6.2 Discharge of sediment) and Ecological AEE report (Section 5.2 Water Quality)
 - Useful information is presented on the actual measured impacts of gravel extraction and truck crossing on turbidity and TSS in the Hutt River and for riprap placement, truck crossing, and bulldozer thalweg cutting in the Waikanae River on TSS. While it appears that river works do not increase turbidity/TSS to levels any greater than recorded during floods, the important difference is that river works are generally undertaken at low flow periods, such that any suspended sediment relatively rapidly settles out and is deposited on the riverbed in low velocity environments. While suspended sediment as a result of river works is a relatively short term

disturbance, deposited fine sediment may cover the gravel bed and fill the interstitial spaces between the rocks where invertebrates and smaller fish live for an extended period of time depending on when the next significant fresh/flood occurs. Thus the effects of works on downstream deposited sediment is at least as important, or arguably more important a factor than suspended sediment and its effects need to be covered in the application report. The Hutt River gravel extraction habitat mapping report (Appendix A of the ecological AEE report) did measure deposited sediment, but only from shallow run habitats, not from pools, backwaters, or side eddies where suspended fine sediment would be more likely to settle under low flow conditions.

- » Application report (Section 6.32) and Ecological AEE report (Section 5.3.2): Rock lining
 - Is it known if any existing rip-rap has disrupted inanga spawning habitat in the lower Waikanae river?
 - The ecological AEE report states that rock rip-rap could potentially destroy inanga spawning habitat, but this is omitted from the application report. While there do not appear to be any immediate plans for rock lining in this section of river, the consent application makes it clear that Flood Protection want to have the option to utilise all the described activities if deemed necessary. Therefore this potential should also be mentioned in the consent application document.
- » Application report (Section 6.9) & Ecological AEE report (Section 5.9): Vegetative bank protection
 - I agree that for larger rivers there are no native plant species that allow an effective, reliable, and relatively inexpensive means of soft engineering. It is of concern, however that some 53% of the riverbanks in the application area are now willow lined. It would be useful if the application provided evidence that all these willows (and the required on-going maintenance) are actually needed and a good use of resources. In the past were areas just planted in willows because "that is how you do flood protection" or was there a real need? Is there the potential that based on bed morphology and bank erosion potential that some reaches don't actually require willows and could over time be "retired" and converted to appropriate native planting?
 - It is stated that the reduction in biodiversity by having a mono culture of willows is offset by the significant planting of native vegetation in the river corridor and that this contributes significantly to the increase in biodiversity values. Have any studies been undertaken to determine if such plantings are providing anything more than aesthetic benefits (e.g., have they resulted in increased abundance of native birds, invertebrates, lizards, fungi, etc.)? It would be useful to cite such research if it has been undertaken.
 - The ecological AEE report states that based on a review of the effects of willows on stream ecosystems, they provide benefits such as provision of shade and shelter, control of water temperature, and control of sediment and nutrient levels. Additionally, it is concluded that on balance vegetative bank edge protection is expected to enhance some forms of fish habitat and the overall effect on native fish and trout populations is likely to be positive. I would suggest this is a generalisation that does not apply to the Waikanae River, where based on the recent aerial photographs provided in the consent application, willows directly on the waters edge seem to occur in relatively few locations with the majority of the water's edge being gravel beaches. The width of the channel also results in the edge willows (or any vegetation for that matter) having lesser impact on shading or control of water temperature than in smaller streams where full canopy cover can be achieved. Thus the positive effects of willow bank edge protection and channel shading are overstated in this instance.
- » Application report (Section 6.10) and Ecological AEE report (Section 5.10): Channel maintenance
 - To adequately determine the effects of the removal of aquatic vegetation and silts from Waimeha Stream, we must have an idea of the fauna and flora of such environments. For this stream we have some idea of the fish present but not of the macrophytes. I am familiar with the stream and know there are some noxious macrophytes present, but are there any native species? Also, given noxious species are present then there should be specific guidelines to prevent their spread included in the Code of Practice.
 - The ecological AEE report states that "Where mechanical weed removal is undertaken in perennial streams consideration given to requiring at least one observer, in addition to the digger operator, to check for trapped fish and to facilitate their capture and return to the watercourse." What does "consideration" mean in this instance? I would suggest a dedicated person to rescue fish be a requirement rather than a consideration. This is a matter to be defined in the Code of Practice (see my separate review of that document).
 - I agree that the clearance of flood debris should be limited to only those items that present an immediate risk to flooding so that other logs/debris are left in the channel where they can provide habitat for fish and invertebrates. However, some criteria on what are left and what is removed needs to be in place to prevent the removal of material by over-zealous operators. This is a matter to be defined in the Code of Practice (see my separate review of that document).

- » Application report (Section 6.11.1) and Ecological AEE report (Section 5.10.3): Beach ripping
 - The effect of beach ripping cannot be determined in the absence of information on the flora and fauna of gravel beaches beyond birds. Are there any native flora or fauna present?
- » Application report (Section 6.11.5) and Ecological AEE report (Section 5.11.2): Bed recontouring
 - There is no mention in the construction effects of the direct mortality of fish and invertebrates that are in the former channel that is either filled in or dewatered. This needs to be resolved.
- » Application report (Section 6.12) and Ecological AEE report (Section 5.10.5): Gravel extraction
 - This section covers the general effects on and the recovery of fish and benthic invertebrate communities well, however there is limited information on the fish species we should be most concerned about when it comes to gravel extraction. It is thus impossible to determine the effects at a level more specific to this river. Additionally, the full effects of this activity cannot be determined in the absence of information on the flora and fauna of gravel beaches including native plants, terrestrial invertebrates, and hyporheic invertebrates.
 - As described earlier, the effects of deposited fine sediment are not well covered.
 - There is no mention of the direct mortality of fish and invertebrates that may result if gravel extraction results in a change in flow path of the river that leaves fauna stranded. This occurrence was observed by Perrie (2013).
 - Gravel extraction in the Waikanae River is proposed to include a major initial extraction phase in the lower river and it is acknowledged in the application report that the effects of this on aquatic ecology are potentially significant in the short-term. More specific information is required on the fish and invertebrates of this deeper section of river as well as on the fauna of the estuary, as this activity is likely to result in significant suspension and deposition of sediment in downstream environments. The Waikanae Estuary already apparently has a high sedimentation rate so the effects of this additional short-term pulse of sediment needs to be considered, particularly on estuary invertebrates and the birds that feed on them.
- » Application report (Section 6.14) and Ecological AEE report (Section 5.12): Activities in the CMA
 - I do not think an adequate assessment of environmental effects can be made for the realignment of the Waikanae River mouth given the paucity of information on the current state of estuary ecology, particularly the invertebrates and feeding areas that attract shorebirds.
- » Application report (Section 6.16) and Ecological AEE report (Section 6): Cumulative effects
 - A section of the Waimeha Stream is to be realigned as part of the MacKays to Peka Peka Expressway project. This section is managed by GWRC Flood Protection, thus I would have expected this realignment to be included as a potential cumulative effect.

2 FURTHER INFORMATION

"Identification of any further information the EOS should be provided with to complete the assessment of environmental effects for the Waikanae River"

This section is divided into two parts: information that is definitely required to complete the assessment of environmental effects, as well as information that could be included in the Environmental Monitoring Plan (and thus collected/obtained later).

2.1 INFORMATION REQUIRED TO COMPLETE AEE

Information gaps and other deficiencies in the information provision are detailed in Section 1. The following is a summary of the key matters requiring resolution, but it will be important to also refer to Section 1 for additional detail:

- » More effective maps should be provided, in particular, the NZFFD records maps (and all maps for that matter) should clearly indicate the sections of rivers and tributaries covered by the consent application, the application report should include a map of ecological survey site locations, and a map showing existing flood protection features (i.e., willow plantings, native plantings, groynes, rock lining, debris fences, etc.) would be highly useful.
- » Given the consent application involves activities in the estuary and CMA, as well as a major gravel extraction exercise in the lower river that will more than likely result in sediment deposition in the estuary, a more thorough description of the Waikanae River estuary and the potential effects of flood protection activities in this environment is required.
- » The description of the existing environment needs to provide an effective comparison of the ecology of the area covered by the consent application (the "impact" section) with the upstream catchment outside the influence of flood protection activities (the "reference" section).

- » The description of the Waikanae River benthic macroinvertebrate community needs to be expanded to better describe the typical community of the area covered by the application, especially in habitats that are impacted by gravel extraction and bed/beach recontouring.
- » More detailed information on the fish species and their abundance, and which species we should be most concerned about such as those that are abundant and spawn in the area covered by the consent application, especially in habitats that are impacted by gravel extraction and bed/beach recontouring.
- » A more complete description of riparian vegetation in the application area, specifically covering any remnant native vegetation or significant areas of native plantings.
- » More detailed information on the bird species that we should be most concerned about such as those native or endemic species that roost, feed, nest, or rest in the area covered by the consent application. Riverbed nesting birds have been covered, but there are likely other species that utilise riverbed and river mouth/estuary habitat. Additionally, estuary birds are not well covered given the apparent importance of the Waikanae Estuary to shorebirds.
- » Coverage of herpetofauna that could be present in the consent application area.

2.2 INFORMATION TO OBTAIN LATER VIA EMP

- » A description of the macrophyte communities (e.g., species present, abundance, native species, noxious species) present in the application area, namely the Waimeha Stream.
- » A description of the flora and fauna that colonises the gravel beaches/bars of the Waikanae River in the periods between bed-moving flood events.

3 REFERENCES

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	PERSON	JOB TITLE
Prepared by »	Alex James	Freshwater Scientist
Approved for release by »	Shelley McMurtrie	Aquatic Scientist