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MEMORANDUM

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

Review of Alton Perrie's memoranda and the Code of Practice and Environmental Management Plan components of GWRC's flood protection operations and maintenance activities consent applications for the Hutt, Otaki, Waikanae, and Wainuiomata Rivers

EOS Job No: GRE01-14074

Dear Sonia,

Please find below my review of the Alton Perrie's memos on the effects of gravel extraction on the aquatic ecosystem of the Hutt River (Perrie, 2013a and Perrie, 2013b) and the Code of Practice (COP) and Environmental Management Plan (EMP) (Greater Wellington Regional Council, 2014) that is a key component of the four GWRC flood protection operations and maintenance activities consent applications for the Hutt, Otaki, Waikanae, and Wainuiomata Rivers.

1 ALTON PERRIE'S MEMORANDA

"A review of Alton Perrie's memoranda of July and October 2013 and comment on appropriateness of his conclusions and recommendations including, but not limited to, his recommendations to minimise effects"

1.1 GENERAL COMMENTS

While the investigation undertaken had a number of constraints, namely the proposed extraction occurring over only around 400 m compared to the 1,400 m planned, these memos provide useful information on the effects of wet gravel extraction on fish and benthic macroinvertebrates and on the fish fauna of non-wadeable habitats associated with rock lined banks and groynes in the Hutt River. The author has also made a number of pertinent recommendations, some of which should certainly be considered in the EMP.

The memo covering the effects of gravel extraction on fish provides some of the best fish information from a key habitat (riffles) in the Hutt River that is subject to disturbance by gravel extraction. It is clear from this data that the "at risk – declining" bluegill bully is the species that is most likely to be impacted by such disturbance as it is abundant in riffles. While the results of this survey are included in the Hutt River consent application (and the other applications), the potential magnitude of effect on this particular species is not fully acknowledged in those consent applications and associated documents (i.e., the ecological AEE reports).

There are some improvements that could have been made to the fieldwork and reporting. These are noted here such that they can be considered for incorporation into future monitoring or investigative studies:

- It would have been useful to actually measure depths, velocities, wetted width, substrate composition/size, and algal cover (on a quantitative basis) at each site and time. This could involve measurement at a good number of random points through the biological sampling sites. This would provide some empirical evidence of the changes to instream habitat to back up the observations made, allow comparative statistics to be undertaken, and help to interpret the biological data.
- For the electrofishing, the area fished and shock time would have been useful information to present so the reader could ascertain the level of effort expended at each time and site.

- It would be more informative if the electrofishing abundance data had been converted to CPUE based on the area fished at each site and time. This would have allowed for a more accurate comparison for the reader for each species among the sites and times.
- It would be more informative if the fyke net and Gee minnow trap abundance data had been converted to CPUE based on the trap nights. This would have allowed for a more accurate comparison for the reader for each species between the two sites. While it is noted that this was not so important for this survey as it was more focussed on identifying the species present in non-wadeable habitats rather than attempting to measure the impact of gravel extraction, the fact that the results are likely to be copied for use in other documents where the focus is of a different nature (such as the consent application documents which is based on an assessment of effects), then such information would be useful.
- The presentation of macroinvertebrate indices other than just MCI/QMCI would be important, as would some statistical analysis of the data to ascertain whether the changes were statistically significant or not. Since Surber samples were taken, quantitative density data was available, and given wet gravel extraction involves significant disturbance to the riverbed, invertebrate density data (i.e., numbers/m^2) would be relevant (and indeed important) to present – this could be done for all taxa, for the main taxa groups (i.e., Diptera, EPT taxa), and for the five most abundant taxa. Analysis of such data would ascertain if any particular taxa or group were more affected by gravel extraction than others, or whether the affects were similar across groups (i.e., more of an effect on overall density rather than a species-specific effect). This is especially relevant given that wet gravel extraction is a particularly invasive activity that is likely to affect density of all species, but with the potential for variable recovery rates for different species based on their natural ability to recolonise habitats. In comparison, MCI scores could remain similar despite dramatic changes in abundance (as it is based only on presence/absence) and QMCI scores could remain similar despite an overall change in density (if there otherwise little change in the *relative* abundance between each of the species).
- It was good to see that density data (i.e., Surber samples) were collected for the benthic invertebrate sampling, and that there was a level of replication (five replicates per site). However, given the small size of Surbers and the large site area, it would have been ideal to have a greater level of replication to improve statistical power. With sufficient budget the ideal scenario would be to undertake a power analysis to determine the optimal sample size, but I do understand that generally funding is not sufficient to extend to such things. In the absence of undertaking such power analysis my gut feeling would be that greater than five replicates would be needed to gain sufficient power (and therefore confidence) for any analysis.
- The macroinvertebrate NMDS would have benefited from displaying the invertebrate taxa that were the most correlated with the axes. This would have provided insight into which taxa were responsible for the change in community at the impact site and possibly which were more sensitive to the effects of gravel extraction. With the collection of habitat data, this can also be included in the NMDS analysis to determine what habitat attributes the invertebrate communities are most correlated with.

1.2 APPROPRIATENESS OF CONCLUSIONS

The following outlines (in italics) the author's conclusions, followed by my assessment of whether these conclusions are appropriate.

"Gravel extraction from the wetted channel had a significant impact on the macroinvertebrate community in the impact area, however, this impact was relatively short-term and the community recovered to 'before' condition after seven weeks (and potentially before then). No effects were observed at the site located 1.2 km downstream of the gravel extraction area, despite this site experiencing a period of high turbidity under base river flow conditions"

I agree with this conclusion, although it is based mainly on the NMDS graph (which showed a clear pattern), as there was no other statistical analysis undertaken and the tabular comparison of MCI/QMCI scores were inconclusive. It is not surprising the invertebrate fauna of a gravel bed river subjected to periodic bed moving floods is able to quickly recover from the relatively localised disturbance effects of gravel extraction when sources of colonists are directly upstream and downstream. However, as stated in Section 1.1, I would have liked to see some statistical analysis of the data, and the inclusion of other invertebrate metrics and density data over and above the MCI/QMCI scores. This would help to get some understanding of whether some species (or groups) are recovering quicker than others and which taxa or groups may be more sensitive to the effects of wet gravel extraction.

"Bluegill bully was also the most numerically dominant species caught and are expected to be resident in this part of the river system; as such they may be a good indicator species for measuring the effects of flood protection activities on fish communities in the Hutt River."

I agree. Bluegill bullies live and spawn exclusively in the swift water velocities and clean cobble substrate of riffles and appear to be the numerically dominant species in Hutt River riffles. In this particular river, they would seem to be the species most at risk from the impacts of wet gravel extraction and bed recontouring that occurs in riffle habitats. Note that this cannot necessarily be transferred to the Otaki, Waikanae, and Wainuiomata Rivers, and specific surveys are required there to determine which fish species predominate in

the habitats in those rivers most likely to be impacted by gravel extraction and bed recontouring.

"*A total of 11 indigenous and one introduced species (brown trout) were caught or observed during these two investigations. Koura and freshwater shrimp were also recorded. Six of these 11 indigenous fish species, along with koura, are currently classified as threatened species (Allibone et al. 2010; Hitchmough et al. 2007). While this indicates a relatively diverse fish community in this section of the Hutt River, there are likely few other surveys/investigations of a similar level of effort with which to compare it against, including both historical data from the Hutt River or data from other similar large rivers in the Wellington region*"

I agree with the author, however based on the threat classification system used in New Zealand no "Threatened" species were found in the survey. Rather six of the indigenous fish species were classified "At risk – declining", while the other five were "Not threatened". While 11 indigenous and one introduced freshwater fish species (12 species in total) is a relatively diverse fish community by New Zealand standards, without having comparable historical data, including from reaches that do not have a history of flood protection works, no other conclusions can really be drawn.

"Observations indicated that gravel extraction from the wetted channel resulted in a significant change in habitat at the impact site, specifically a shift from riffle-type habitat with a variety of depths and flow velocities to more of a run-type habitat with more uniform depths and flow velocities (ie, less habitat diversity). After seven weeks the overall habitat at the impact site still appeared to be significantly altered, indicating that habitat can take months to re-establish to pre extraction condition."

From the photos provided in the memo there does appear to have been quite a change in the form of the section where gravel extraction occurred. While I agree with the author that there has been a change, it is difficult to determine if this has resulted in a significantly different instream environment in terms of wetted width, water depths, and velocities since these don't appear to have been measured at each site and time.

"While fine sediment was recorded at both the impact and downstream sites, overall cover across the riverbed was typically low, although this likely reflects the higher flow velocities present in the riffle habitat surveyed (ie, fine sediment is unlikely to be deposited in these habitats). Limited observations indicate that the deposition of fine sediment is likely to be an issue in some other habitat types (where flow velocities are low)." and *"Sedimentation, which is likely to affect macroinvertebrate communities (Clapcott et al. 2011), was not recorded at any significant levels in the riffle habitats that were sampled as part of this investigation. However, in some habitats/areas of low flow, significant levels of sedimentation were observed (Perrie 2013). Habitats that are more sensitive to sedimentation should be the focus of any future investigations into the effects of this type of activity on macroinvertebrate communities."*

I agree that deposited fine sediment originating from gravel extraction activities is likely to be an issue in low velocity habitats (e.g., pools, backwaters, slow runs) during the low flow periods when such activities typically occur. The magnitude of this effect depends on the 'natural' levels of fine sediment in these habitats prior to additional deposition resulting from gravel extraction. It would make sense for future investigations to include sampling in such environments.

"Densities of bluegill bully declined at the impact site and while it is expected that the changes in habitat that occurred as result of the gravel extraction contributed to this decline, a similar decline in density was observed at the site upstream of the gravel extraction. These results are therefore not conclusive and changes in density at the impact site may reflect, in some part, natural temporal variation in densities."

I agree, based on this investigation gravel extraction cannot be inferred to have a direct impact on bluegill densities, however it is plausible that gravel extraction may have effects on densities outside the immediate impact area. For example, if timing of the gravel extraction works occurred during the upstream migration of the juvenile bullies then that may have prevented them from migrating into the upstream habitat. Quantitative measuring of habitat conditions would also help to ascertain if there has been a change in conditions at the reference site as well as the impact site. Further investigation is required.

"Overall, gravel extraction resulted in significant changes in habitat, some of which were still evident almost two months after the completion of the activity. Whether the changes in habitat resulted in changes in the fish community/assemblage is not clear, but these changes in habitat are considered to be a likely contributing factor to at least some of the observed decline in densities of bluegill bully. Further work is still required to better understand the effects of gravel extraction on the wetted channel of the Hutt River, especially in regards to medium and long-terms effects on habitat and aquatic fauna."

I agree that gravel extraction resulted in changes to instream habitat but it is difficult to determine how significant these were without key habitat variables (i.e., wetted width, water depth, and velocity) being recorded over the study. I also agree that the effects on fish were unclear and that further work is required to better understand the effects of gravel extraction on the habitat and aquatic fauna. Please refer to my earlier comments in both this section and Section 1.1 regarding what could be done to improve this (albeit within the context of the current studies undertaken).

1.3 APPROPRIATENESS OF RECOMMENDATIONS

"Future assessments of fish communities in river reaches undergoing flood protection activities should be undertaken using a combination of these methods suited or targeted to the habitat types present."

I agree fully. My own experience sampling fish indicates that using multiple methods will often result in additional species being encountered, and that whenever possible more than one fish sampling methodology should be employed. However, the study design should take into account how the data is to be analysed and what the potential confounding affects to the design would be – so that the sampling programme has the best chance to answer the key questions. The invertebrate monitoring programme could also be redesigned with this in mind (see my comments in Section 1.1).

"Baseline monitoring: 1.To help establish the current state of the fish community in reaches of the Hutt River that are affected by gravel extraction, semi-regular (2-3 years) fish surveys should be undertaken using a combination of methods that are suited to the diversity of habitats present."

This is an appropriate recommendation provided survey sites and methodology is standardised. It will be important that the study design is effective in answering the key questions of the monitoring, as changing the sampling design in later years will impinge on the ability to compare back to any 'before' data. Thus time spent now in developing a robust study design will pay off in later years.

I would also suggest an additional 'control' site(s) be established at a location outside the section of river affected by flood protection activities, or at least upstream of the extent of all past and future gravel extraction and bed recontouring activities. Timing of the surveys will also need to be considered, to ensure adequate sampling of the key species.

"Effects-based monitoring: 2. Given that the results of aspects of the before and after investigation were inconclusive, another similar investigation should be undertaken which should include, but not be limited to the following:

- *Descriptions and measurements of meso and microhabitat variables;*
- *Riverbed substrate including assessments of fine sediment cover in depositional environments;*
- *Continuous and spot measurements of turbidity at different distances downstream of the gravel extraction activity;*
- *Targeted fishing of specific species/habitats including bluegill bully;*
- *A longer-time frame than undertaken here (ie, one year +);"*

This recommendation is appropriate and seeks to address many of the limitations of the original investigation. However, I would suggest the sampling design be modified to improve the ability to elucidate any effects (see my comments in Section 1.1 as well as in the following paragraph). I would suggest any effects-based habitat and fish monitoring programme be designed to cover all catchments where wet gravel extraction by GWRC Flood Protection occurs. This will increase the power of any statistical analysis undertaken and overall be of more use to Flood Protection in detecting effects on habitat and fish. I also think that benthic invertebrates should be included in these studies (and I note these have been included as a possibility in the EMP), as with the right design and analysis they should be able to elucidate much about the environmental effects of the work (including how it may affect food for fish). Measurement of periphyton cover should also be included as the recovery of this food resource is a crucial factor in the recovery of invertebrate communities.

All programmes should be designed with the ability to effectively elucidate any effects (or lack thereof), which will require consideration of sampling effort/sample size (i.e., replication and number of sites), confounding factors, timing (i.e., regularity of sampling – when and how often), metrics to analyse. I would also recommend that as many variables as possible are assessed via

quantitative methods so that statistical analysis can be undertaken, rather than relying of observational comparisons.

"Potential management approaches to gravel extraction to help minimise effects: 3. Set limits on the overall extent (ie, length of river) of gravel extraction from any section/reach of river in a given season/year;"

I am unsure whether this recommendation is viable given the locations and volumes of gravel removed is determined by the results of 5-yearly bed level surveys. The amount of gravel entering the portion of the river covered by the consent application is largely a function of the frequency of larger bed moving flood events, thus is not entirely predictable. Therefore a gravel extraction length limit could potentially prevent the extraction of gravels required to meet flood protection targets. However, perhaps there could be a limit on the length or area of river subjected to *wet* gravel extraction, which is the methodology most likely to have direct impacts on aquatic fauna.

"Potential management approaches to gravel extraction to help minimise effects: 4. Set limits on the number of consecutive days worked and provide sufficient break periods (ie, weeks) between gravel extraction activities;"

This is an appropriate recommendation and would go some way to reducing the impacts of gravel extraction.

"Potential management approaches to gravel extraction to help minimise effects: 5. Within a reach where gravel extraction is occurring, where possible attempt to leave at least a proportion of habitats untouched (ie, leave every second riffle etc.)"

This is an appropriate recommendation and would go some way to reducing the impacts of gravel extraction. Perhaps some percentage of wetted area could remain untouched in sections where wet gravel extraction is being undertaken. These untouched refuge areas could be selected based on their provision of suitable habitat for specific fish species (i.e., bluegill bully in the Hutt River) and the ability for incorporation into the design channel alignment.

"Potential management approaches to gravel extraction to help minimise effects: 6. Introduce a policy that where fish are likely to be stranded due a change in river flow etc, a fish rescue and relocation plan is in place."

This is an appropriate recommendation given the observations made of stranded fish and crayfish during this investigation. Additionally, many resource consents that result in channel dewatering require fish rescue and relocation.

2 CODE OF PRACTICE

"An assessment of whether you consider the potential adverse ecological effects can be avoided, remedied or mitigated using the updated Code of Practice (October 2014)"

2.1 GENERAL COMMENTS

The draft Code of Practice (COP), with further refinement, has the potential to be a useful tool to guide flood protection activities in the GWRC. The benefits to having activities across multiple catchments regulated by a single document will lead to consistency and efficiency from both an operational and regulatory perspective. The key to the success of the COP will be in its implementation. You can have the most sophisticated COP in the world, yet it will only work with the complete buy-in and understanding of those on the ground who actually undertake the activities described.

The ability of the updated COP to enable the potential adverse ecological effects of the proposed flood protection activities to be avoided, remedied or mitigated relies on not only the good practice methods, but also on the implementation of the code, and the review process. Thus I have considered these three elements in my assessment.

2.2 REVIEW PROCESS

The COP details a two-tier review process including an annual (ongoing) review and a formal review that will occur at some as yet undefined period (currently described as the "X yearly review"). I acknowledge that a review process is an important and crucial part of the COP/EMP concept, however I have some concerns about the proposed scheme.

Firstly, I am not sure enough monitoring data will be collected on an annual basis to make an annual review process worthwhile. I would suggest an estimate is made of the quantity of data that will be available on an annual basis for the next five years in order to determine after what time period there is enough data to make a review a worthwhile use of time and money. This could be done assuming the current EMP is in place, or preferably after the draft EMP has been finalised. Further, if it has not been done already, I would suggest the cost and time required for the annual review process is estimated to ensure it fits within budget and staff resourcing constraints. The time and cost of collating data, producing a review report, and convening the Technical Panel on an annual basis could be considerable. There is also the issue of the turnaround time of making any alterations to the COP/EMP, seeing these implemented in the field, and then monitoring undertaken. It is highly unlikely this would be able to be achieved in just a year and be available for assessment by the next annual review.

Secondly, the proposed annual review process (based on Figure 2 of the COP) does not appear to include any input from GWRC Environmental Regulation. This is curious since they are the consenting authority and presumably would have made some compliance visits over the year. I would think they should at least be provided with the annual review report and attend the meeting to discuss this report and provide feedback.

Thirdly, the "X yearly review" is intended to be undertaken at some as yet undefined regular period. I do not think this is necessarily the best formal review trigger. Again, as mentioned above, I believe such a review process should be initiated only when there is sufficient new monitoring data to make it worthwhile. Blindly undertaking such a review simply because X years have passed is not necessarily the best use of resources. As with the annual review process, I would suggest the cost and time required for the formal review process is estimated to ensure it fits within budget and staff resourcing constraints.

Fourthly, the formal review process (based on Figure 3 of the COP) does not involve the subject experts, yet aims to summarise the monitoring completed to date. It makes sense to me to have the subject experts summarise the previous monitoring information for inclusion in the formal review summary report.

Fifthly, the formal review process has minimal input from GWRC Environmental Regulation (receive notification of review initiation, review the consent conditions if required, receive updated and final documents). Given they are the consenting authority I would think they should at least be provided with the formal review report and attend the meeting to discuss this report and provide feedback.

2.3 IMPLEMENTATION

I understand a tablet-based interface is in development that will allow operators to identify any features they need to avoid or be aware

of in the field via GIS. I assume this would include those features that can be depicted spatially (e.g., inanga spawning sites, river bird nesting habitat, existing access points, patches of ecologically significant vegetation, public walkways, culturally significant sites, Key Native Ecosystems, etc.). I think this is a useful tool as long as the equipment is robust and reliable, the GIS interface is easy to use, relevant spatial information is updated as necessary, and all practitioners have ready access to tablets and the tool and know how to use it. However, there are many other components of good practice that are not able to be shown via GIS and require good judgement, intuition, and likely referral to the good practice methods outlined in the COP from time to time. For example:

» Identifying situations were fish will be stranded and require rescue/relocation;
» Utilising sediment control methodologies applicable to the soils and gradient of the site;
» Determining which flood debris to leave in channel and which to remove;
» Size and location of aquatic vegetation patches and/or ecological refuge areas to be retained during mechanical clearing of minor watercourses;
» Identifying suitable storage and stockpiling sites;
» Machinery refuelling and maintenance procedures.

For this reason, it will be important to have a version of the good practice methods section of the COP in a format that is practical for field use. This could be in the form or a ring-bound booklet or as a PDF file that can be read on a tablet computer. The current format of the good practice methods contain a lot of repetition and information that is not required in a practical sense in the field from the perspective of the person doing the work (e.g., a full description of the activity, RMA information, "Key Potential Benefits"). Implementation of the COP would benefit from the production of a professionally designed "Good Practice Methods" document that is aimed at the staff in the field (i.e., the bulldozer driver). This would involve just the potential adverse effects of the activity they are undertaking along with required actions to avoid, remedy, or mitigate any negative effects and any restrictions that might apply to that activity. The document should be as concise as possible, with good visualisation of the subject matter (including photos and diagrams etc. of good practice methods in action) to increase the likelihood of the end user reading it. In our experience with working with contractors on site, the people in the field (i.e., those actually undertaking the work) often do not read the full documents that are technically supposed to be read by all personnel (and sometimes these are not made available to staff on the ground). While this may be a technical breach of conditions, it is nevertheless the reality that should be accounted for when designing a resource for use by staff on the ground.

Another potential issue with implementation of the COP is the fact that commercial operators undertake some of the more invasive activities such as gravel extraction. It is possible that such operators may be resistant to some of the required actions and restrictions because they don't understand the need for it, or may not undertake them in an adequate fashion because of a lack of investment in or understanding of what the COP is hoping to achieve. Thus the adequate implementation of the COP will rely on effective communication with the contractors and with having on the ground support for them. In relation to the latter I would think that it could be helpful for the COP to supply the contractors with a suitably qualified ecologist that understands the programme and its aims, and who can provide ecological oversight and advice.

2.4 GOOD PRACTICE METHODS

In general, the actions of the general and individual activity good practice methods will go a long way to avoiding, remedying or mitigating the effects of the described flood protection activities. The below comments refer to where I disagree or strongly agree with content or believe additional actions should be included.

2.4.1 GENERAL GOOD PRACTICE METHODS

Table 6: Works restriction periods

I strongly support having restriction periods specific to each river. I realise the restriction periods outlined are interim at the present time and further work is currently underway on a more targeted approach to avoid works in critical fish habitats and critical times while maintaining flexibility for GWRC Flood Protection to effectively manage the flood hazard. It is highly likely that with appropriate and targeted monitoring and research that restrictions based on specific fish species that are most vulnerable to certain activities can be developed. There is also the potential to define works restrictions on an individual activity basis. For example, perhaps some relatively minor activities (e.g., groyne or rock-lining maintenance) would be acceptable at times when other more invasive activities (e.g., gravel

extraction and bed recontouring) may not.

Operation & maintenance of machinery

This would benefit from requiring a spill kit specific to the conditions to be on immediate hand at each work site. Additionally, if practical it would be beneficial if all machinery used in the rivers had biodegradable hydraulic fluid. Recent works in the Avon River, Christchurch involved excavators with biodegradable hydraulic fluid.

Sediment control

For out of river works, the following action point should be added, "Formulate an erosion and sediment control (ESCP) specific to the site conditions (e.g., soil type, gradient, proximity to water ways and stormwater intakes)".

Formation of access from the banks to the river bed

There is an action point referring to the avoidance of vegetation clearance adjacent to Key Native Ecosystems. I support this, however it is notable that no such areas were described or identified by the ecology AEE reports or consent application reports. If such sites are present in the area covered by any of the consent applications, then these should be included on the tablet-based GIS system and any documentation.

Maintenance and protection of ecological values

This item needs to be updated to include the following actions "The protection of any identified significant growths of native macrophytes (aquatic plants)" and "The rescue of any fish, koura (freshwater crayfish), or kakahi (freshwater mussel) stranded or removed from a watercourse by flood protection activities"

The language used weakens some actions that are likely to be highly beneficial to instream ecology. For example, "rather than mowing river berms right to the bank edges, *consider* establishing appropriate vegetation on bank edges, or at least allow grass to grow longer at the bank edge" and "in soft-bedded streams where weed or silt removal is required, *where practicable, consider* staggering the removal programme so as to maintain some areas of vegetation at intervals along the stream, or on one bank of a stream, so as to maintain a minimum level of fish habitat". I am concerned the use of these terms makes it all to easy to not undertake these actions and stick to the status quo.

Consideration of opportunities for environmental enhancement

There is an action point referring to the retention and enhancement of native vegetation adjacent to any identified Key Native Ecosystems. I support this, however as previously noted no such areas were described or identified by the ecology AEE reports or consent application reports. If such sites are present in the area covered by any of the consent applications, then these should be included on the tablet-based GIS system and other documentation.

It is stated, "The person responsible for supervising on-site works shall endeavour to create opportunities for the maintenance of aquatic and terrestrial ecological habitats wherever possible." I am concerned the term "endeavour" is too open to interpretation and some people may see this action as optional and do very little, while others may be passionate about environmental enhancement and do a lot. I would prefer all opportunities for environmental enhancement is identified at every work site and some process in place to ensure the most suitable ones are undertaken. It is also likely that the person responsible for supervising on-site works will have little in depth understanding of aquatic or terrestrial ecology and thus may not know what opportunities there may be to maintain or enhance values.

As it is, this good practice item gives no clear, definitive direction for implementing environmental enhancement. It may be useful to develop enhancement targets specific to the riparian and instream characteristics of each river to guide environmental enhancement. Such a programme would also benefit from an independent site review by an appropriately experienced and qualified ecologist(s) at each work site/area to identify what could be done specific to that site. This could form part of the ecological oversight role suggested in Section 2.3. This would then give the contractors/operators a clear road map to what they are to do, and ensure that opportunities are not missed.

2.4.2 INDIVIDUAL ACTIVITY GOOD PRACTICE METHODS

Rock & Block Groynes

It is stated, "Structures must be designed and approved by a suitably qualified person to ensure in particular that: they do not constrict flows or reduce the channel". Construction of groynes will always reduce channel capacity to some extent while the groynes themselves often constrict the flow by diverting it away from the bank. Thus this action needs to be altered to account for the realities of the construction and function of such structures on the river.

Rock Lining

The long-term adverse effects list needs to have added "Limited/no potential for riparian vegetation to establish near the waters edge" and "Rendering the site unsuitable for inanga spawning (for those areas in the spawning zone)".

An action needs to be added stating, "Along the toe of the rock lining extra outlying boulders will be added to increase habitat diversity and create fish cover".

I support the restriction "Areas of rock lining will not be constructed in identified inanga spawning areas unless absolutely necessary and an off-set plan is developed in conjunction with a suitably qualified ecologist", however this should be expanded to cover all areas within the zone of *potential* inanga spawning habitat (i.e., stretches of the bank that do not currently have suitable vegetation but are within the tidally influenced reach where inanga may have spawned in the past and could conceivably spawn again).

Channel diversion cut

The list of potential adverse effects needs to have added "Stranding of fish if works result in dewatering of existing wetted channel, side channels, or backwaters". Additionally, the list of required actions should have the following added, "Fish, koura (freshwater crayfish), and kakahi (freshwater mussel) rescue and relocation are undertaken from any habitats dewatered by the cutting of diversion channels without delay."

Bed recontouring

The list of required actions should have the following added, "Fish, koura (freshwater crayfish), and kakahi (freshwater mussel) rescue and relocation are undertaken from any habitats dewatered by bed recontouring without delay."

The restrictions should include an item to avoid the inanga spawning period for those waterways where inanga spawning occurs. This could involve restricting bed recontouring in this period within some distance upstream of inanga spawning habitat (i.e., 2 km). This is to ensure the sediment mobilised by bed recontouring does not disturb spawning fish or smother eggs.

Removal of flood debris

To the potential adverse effects the following should be added "A reduction of woody material and dissolved organic carbon (DOC) reaching downstream reaches, the estuary, and marine area adjacent the river mouth".

I support the action that large logs or other debris will not be removed unless necessary to maintain channel capacity. Note that this currently reads, "Large logs or other debris should not be from the channel unless necessary……" with the word 'removed' omitted. I assume this is a typo that needs correction. However, I think some kind of criteria to assist staff in the field decide what should be removed and which should not could be useful as some people may be keen to remove everything they see. This is another measure that supports the implementation of ecological oversight to help with these decisions. However, there is also the issue with this item that there will be a point of contention between the opinion on the effect of any material on maintaining channel capacity. A line of command needs to be established here so as decisions can be made as to what can remain without concern of flood risk, otherwise the contractor will likely err on the side of caution and remove all material.

Gravel extraction from the flowing channel (wet extraction)

The "Release of nutrients trapped in sediment" is mentioned as a potential adverse effect, however I note this was not covered in the ecological AEE report.

The list of required actions should have the following added, "Fish, koura (freshwater crayfish), and kakahi (freshwater mussel) rescue and relocation are undertaken from any habitats dewatered by gravel extraction without delay."

The restrictions should include an item to avoid the inanga spawning period for those waterways where inanga spawning occurs. This could involve restricting wet gravel extraction in this period within some distance upstream of inanga spawning habitat (i.e., 2 km). This is to ensure the sediment mobilised by wet gravel extraction does not disturb spawning fish or smother eggs.

Mechanical clearing of minor watercourses

One of the potential benefits includes "improved fish passage". I do not think the removal of macrophytes from a watercourse can improve fish passage. I would ask that this be removed from the list of benefits.

I strongly support the recovery and relocation of fish trapped in excavated material to clear water upstream of works and having at least one observer in addition to the digger operator present to assist with this work. Such recovery can be time consuming so having a dedicated person(s) to rescue aquatic biota is a necessary component. I would suggest the term "fish" is replaced with "fish, freshwater crayfish, and freshwater mussels".

I strongly support the retention of 10% of aquatic vegetation within the cleared watercourse "to assist with recolonistion of aquatic organisms and plants". I would expand this to include "and provide refugia for aquatic fauna". I recommend another action stating, "Any significant patches of native macrophytes are identified and included within the 10% of aquatic vegetation retained".

Some watercourses maintained by GWRC Flood Protection are known to contain noxious weeds (e.g., *Myriophyllum aquaticum* (parrots feather) and *Lagarosiphon major* (oxygen weed) in Waimeha Stream). It would be sensible to include an action detailing the procedure for dealing with excavated material that includes such noxious species. I assume this would be consistent with GWRC policies around disposing of noxious plant material.

Mechanical clearing – Opahu Stream (Hutt River)

I note that there is an action to ensure that "an appropriate free-draining bucket is used". Given the clearing of Opahu Stream apparently is predominantly to remove silt, is such a bucket effective at undertaking this task efficiently?

I strongly support the recovery and relocation of fish trapped in excavated material. It is stated, "where possible, at least one observer, in addition to the digger operator, is present to assist with finding, capturing and relocating of trapped fish". I suggest the "where possible" is removed and it is mandatory to have dedicated person(s) to rescue aquatic biota. We have had much success in rescuing fish from removed sediment, including electrofishing the sediment pile if it is wet enough (this is far more effective than having someone try to sift through a pile of sediment).

It is unclear whether macrophytes are present in Opahu Stream. If they are then I would suggest the following actions are added: "In general, 10% of the aquatic vegetation within the cleared watercourse is retained to assist recolonisation of aquatic organisms and plants", "Additionally, where practicable, selected ecological refuge areas are left in the channel at intervals to assist recolonisation of the invertebrate populations present in the watercourse", and "Any significant patches of native macrophytes are identified and included within the 10% of aquatic vegetation retained".

Some watercourses maintained by GWRC Flood Protection are known to contain noxious weeds (e.g., *Myriophyllum aquaticum* (parrots feather) and *Lagarosiphon major* (oxygen weed) in Waimeha Stream). It would be sensible to include an action detailing the procedure for dealing with excavated material that includes such noxious species just in case they are or become present in Opahu Stream. I assume this would be consistent with GWRC policies around disposing of noxious plant material.

Mechanical clearing – Chrystalls Lagoon (Otaki River)

I note that there is an action to ensure that "an appropriate free-draining bucket is used". Given the clearing of Chrystalls Lagoon is predominantly to remove silt, is such a bucket effective at undertaking this task efficiently?

I strongly support the recovery and relocation of fish trapped in excavated material. It is stated, "where possible, at least one observer, in addition to the digger operator, is present to assist with finding, capturing and relocating of trapped fish". I suggest the "where

possible" is removed and it is mandatory to have dedicated person(s) on site to rescue aquatic biota. We have had much success in rescuing fish from removed sediment, including electrofishing the sediment pile if it is wet enough (this is far more effective than having someone try to sift through a pile of sediment).

I suggest a further action is added: "Undertake fish removal and relocation immediately prior to excavation works to remove as many fish as possible before disturbance by excavator".

Some watercourses maintained by GWRC Flood Protection are known to contain noxious weeds (e.g., *Myriophyllum aquaticum* (parrots feather) and *Lagarosiphon major* (oxygen weed) in Waimeha Stream). It would be sensible to include an action detailing the procedure for dealing with excavated material that includes such noxious species just in case they are or become present in Chrystalls Lagoon. I assume this would be consistent with GWRC policies around disposing of noxious plant material.

Mowing from the river bed

I would like to see alternatives to mowing from the riverbed developed. While only undertaken in two streams (Stokes Valley Stream and Porirua Stream), this method does not set a good example to the public on how streams should be treated and unnecessarily disturbs and compacts the riverbed.

If such a method remains in the document then at an absolute minimum there should be a requirement for the machinery in the channel to use biodegradable hydraulic fluid. However, I would prefer that use of machinery in the channel for lawn mowing be not undertaken at all.

Maintenance of berms, stopbanks, structures and tracks

The activity includes the mechanical clearance of stormwater drains. Some stormwater drains will have fish present. Thus I suggest the inclusion of the fish recovery/relocation action for those stormwater drains that are cleared when containing water.

Planting on berms

I strongly support the restriction of willow plantings to the river edge buffer zone. Currently this buffer zone is generally 20–30 m wide, however it would be good for research to be undertaken to determine the optimal width of the willow front-line so the zone of willow planting could ideally be reduced over time and replaced with natives behind.

I strongly support the use of native plants behind frontline willow plantings. I do note however that this is a consideration in the COP rather than a mandatory activity. While I appreciate there are issues around funding and maintenance of such plantings and that substantial native plantings have already been undertaken on some rivers, I would prefer to see some definite commitment to native plantings included in the COP.

River mouth cutting

The potential adverse effects list needs to have added: "Stranding of fish and invertebrates where the cutting results in the dewatering of parts of the channel or associated backwaters and mudflats."

The list of required actions should have the following added, "Fish recover and relocation is undertaken from any habitats dewatered by river mouth cutting without delay."

The restrictions should include an item to avoid the inanga spawning period for those waterways where inanga spawning occurs. This is to ensure passage to the ocean by newly hatched inanga is not disrupted by mouth cutting earthworks.

Construction of new structures in the CMA

This activity page is mostly blank. I assume it is still under development.

2.5 APPENDICES

2.5.1 APPENDIX 1 FLOOD PROTECTION DEPARTMENT VISION AND GOALS

The Flood Protection Department Vision, "A prosperous community safe from the consequences of flooding with rivers and streams in a natural state providing ecological diversity and recreational opportunities" does not make sense as technically the rivers and streams will never be in a natural state due to land use change and the very flood protection activities that have been undertaken over the past 100 years. I would suggest an amended vision along the lines of "A prosperous community safe from the consequences of flooding with rivers and streams in the best condition possible providing ecological diversity and recreational opportunities"

2.5.2 APPENDIX 3 HABITAT ASSESSMENT TEMPLATE

The pre-works habitat assessment needs to include an assessment/estimation of any areas of the currently wetted channel that are likely to be either filled in or dewatered by the proposed activity. This will enable planning of any fish recovery and relocation activities that may be required as part of the work programme and ensure they are not an afterthought.

3 ENVIRONMENTAL MONITORING PLAN

"An assessment of the suitability and robustness of the parameters in the draft Environmental Monitoring Plan included in Section 2 of the Code of Practice document"

3.1 GENERAL COMMENTS

It is clear the Environmental Monitoring Plan (EMP) is in an early stage of development as the exact methodology for many aspects are yet to be determined. I would hope appropriate specialists are involved in detailed design of each element of the monitoring program (i.e., sampling methodologies, sites, analysis, triggers). It will be especially important for the monitoring programme to be of sufficient rigour to be able to determine flood protection effects from natural background variability (this is closely linked to study design and replication sufficient enough to determine a significant effect with any measure of certainty).

Some of the monitoring parameters outlined in the draft EMP do not seem to be worthwhile while some of the methodologies that are presented may be inappropriate. These are outlined below, along with any other comments.

Additionally, I have concerns about the potential cost of the EMP. Budgets and staff resources are finite, thus often the best place to start when developing a monitoring program is to decide how much there is to spend, deciding who is doing the work (i.e., outsourcing or using GWRC staff resources), and then streamlining the program to get the most from the resources available. In practice this may result in dropping some monitoring components and focussing on a few key indicators. Ensuring the work being undertaken is actually appropriate and will be able to answer the questions is also important when making such a big commitment of resources – monitoring for the sake of monitoring is not a good use of resources.

3.2 BASELINE MONITORING

3.2.1 RIPARIAN VEGETATION

It is proposed to monitor riparian vegetation in each of the rivers using aerial photography supported by selected site visits in order to assess changes to such vegetation by flood protection activities that may significantly alter character of the river environment (enhance or degrade). The two flood protection methodologies that may alter riparian vegetation are predominantly vegetative bank protection (willow planting) and hard bank protection (mostly using rip rap rock lining). Each of the consent applications present percentage values for the length of the bank already subjected to these treatments, thus we already have an idea of the length or riparian vegetation that is and is not directly affected by flood protection activities. Assuming records are kept of all new future bank treatments in areas where there are currently none, then we will have an idea of the length of bank being altered every year or review period. Therefore I cannot see the reason for spending time monitoring riparian vegetation using aerial photography (and some site visits) on a broad scale when far more accurate information on flood protection activities is already recorded. Aerial photography will also do little to assess changes in remnant patches of native vegetation, which in some instances could be limited to a small patch of plants growing under a larger canopy of exotics.

Any baseline riparian vegetation surveys would be more relevant if they were geared towards monitoring the location, persistence, and condition of any existing native vegetation, including significant areas of planted vegetation as well as any natural native vegetation. This would allow the more ecologically valuable (from a biodiversity perspective) patches of riparian vegetation to be protected from flood protection activities and potentially enhanced and enlarged by appropriate maintenance, pest control, and additional plantings. Such remnant areas of native vegetation could be under existing willow canopies and thus would never be picked up in the proposed aerial photography monitoring anyway.

3.2.2 RIVER BIRDS

Not being an expert at river bird monitoring, I do not know if the recommended sets of three annual bird surveys with five years between surveys (i.e., in years 2012, 2013, 2014, 2020, 2021, 2022) are an appropriate method of monitoring riverbed populations. I would suggest specialist comment is sought from a suitable avian expert.

For three river-nesting bird species triggers (banded dotterel (25%), pied stilt (25%), black-fronted dotterel (50%)) based on declines in the average number of breeding pairs detected between one three-year set of surveys and the next has been proposed for the Otaki River (these species do not apparently breed on the Hutt or Waikanae Rivers currently). What is the rationale behind these percentage triggers? Theoretically a change from an average of four to three breeding pairs would initiate further investigation, and I am unsure

that would be justified. Additionally, the 'further investigations' would aim to find a causal link between bird numbers and a flood protection activity. With all the variables that may affect bird numbers on this timescale (i.e., predation, disease, major flood events, other human disturbance) I am unsure how you could identify a flood protection activity as a culprit, especially if key data from previous years (e.g., predation pressure, nesting success, food resources, etc.) is not available. I am not sure the 'further investigations' component of the river bird baseline monitoring is workable in practice. Additionally, perhaps the numbers of chicks fledging would be more indicative of breeding success and the persistence of each of the species than simple counts of breeding pairs, although I imagine this would involve a more intensive and expensive survey effort.

3.2.3 FISH COMMUNITIES

Baseline fish monitoring is proposed to be undertaken "in general accordance with the New Zealand Freshwater Fish Sampling Protocols (Joy, David, and Lake 2013)". These methods are for wadeable streams, which are defined in the protocols as at least 90% of the site being ≤0.6 m deep and a wetted width of ≤12 m. With three of the four main rivers generally being wider than 12 m (e.g., based on aerial photography, the Hutt River is up to ~75 m wide, the Otaki River is up to ~80 m wide and the Waikanae River is up to ~35 m wide), following the 150 m minimum survey reach of Joy *et al.* (2013) may result in too large an area than can be effectively surveyed via electrofishing in a single day. This would have methodological and significant cost implications. Given this baseline monitoring is for a specific purpose, I would suggest avoiding blindly following a protocol designed for the general monitoring of fish communities and rather develop specific methods targeted at the species and instream habitats that are most influenced by flood protection activities. This could involve the sampling of set areas of the habitats most affected by the more invasive flood protection activities (i.e., gravel extraction, bed recontouring, or where appropriate, mechanical macrophyte/silt removal), and should be designed to gain quantitative data on both the fish and the habitat within the survey area. As stated in Section 1.1 and 1.2 of this memo, the design of these surveys, and the ability to undertake meaningful statistical analysis with a good level of statistical power is important to gain the most out of the programme, and to answer the question of whether or not there is an effect of the activity.

The EMP has set fish survey locations for the Hutt, Waikanae, Otaki, Wainuiomata Rivers and the Waimeha Stream. All these locations are within the area affected by flood protection activities. In order to determine any effect of the activity, there would need to be suitable control sites established outside this area. I would expect there would need to be more than one control site, to provide some protection against other unforeseen events in the river that could affect the control sites, and to account for natural variability.

The EMP states "It is noted that considerable natural variation in fish abundance and diversity can occur as a result of seasonal migrations or disturbance by flood events, or drought, and that the influence of FP activities may be difficult to discern by baseline monitoring as currently proposed. For that reason site specific event monitoring of fish populations using a before/after/upstream/downstream design is also proposed for large scale works (see Section 2.3)." I agree with this statement, but it calls into question why this generalised baseline fish monitoring is even proposed if it is not going to be useful. As mentioned above, I suggest the development and use of specific methods targeted at the species and instream habitats that are most influenced by flood protection activities rather than the blind following of a generalised protocol.

3.2.4 INANGA SPAWNING HABITAT

I support the undertaking of an inanga spawning survey to update that done in 2000–2001. However, I would suggest that effort is also put into identifying where inanga would be likely to spawn if suitable habitat was available. This will enable the remediation of such habitat to be incorporated into flood protection activities wherever possible (e.g., native plantings, weed control) and potentially indicate suitable locations for any offsets that may be required to compensate for some activities.

3.2.5 TROUT ABUNDANCE

I do not think the current trout abundance drift dive surveys collect any worthwhile information from the perspective of determining the effects of flood protection activity. Brown trout are highly mobile and there are so many other factors influencing their abundance and distribution in a catchment (e.g., floods, droughts, spawning success, recreational take) that make determining if localised gravel extraction and bed recontouring are having any impact on abundance impossible. There are simply too many other confounding factors.

There are also issues with the methodology, which relies on visually identifying trout, meaning that abundance is strongly affected by water clarity, the numbers of divers undertaking the survey each year (more people equals more eyes, equals more trout?), and diver

experience. This makes year-to-year comparisons difficult. Further the proposed monitoring does not include any assessment of spawning success or recreational take, both of which I would have thought are critical to determining trout numbers.

In some rivers, there is the potential trout spawn in the areas also subject to flood protection activities. I was surprised there was no mention of counting/identifying/protecting trout redds in such locations.

3.2.6 POOL AND RIFFLE COUNTS

I support the quantification of these habitats, however counts are proposed to "be undertaken by representatives of Wellington Fish and Game and GWRC according to an agreed methodology using aerial photography mosaics flown no more than 12 months prior to the count." I am dubious that effective pool and riffle counts can be undertaken from aerial photography without some ground truthing. How are features (especially backwater pools) obscured by vegetation accounted for? Is this a simple count of pools and riffles or does it attempt to measure the area of these habitats? Within what could be considered "pool" habitat there is considerable variability from a relatively shallow backwater, to a hole 2+ metres deep. How does this methodology deal with such variability in depth and presumably, ecological value? There are established criteria for habitat mapping that could be utilised that would include ground-truthing and measuring size of the habitats.

3.2.7 DEPOSITED SEDIMENT

I support baseline monitoring of deposited sediment, however the proposed methodology needs improvement. I would suggest deposited sediment is quantified in the more depositional habitats (pools, channel edges, backwaters, slow runs) as well as in the main channel. It should also be measured at more than one control site that is upstream of any past or future gravel extraction or bed recontouring activities. It is proposed to measure deposited sediment using the "SAM-2 – In-stream visual estimate of % sediment cover" and "SAM-3 – Wolman pebble count" of Clapcott *et al.* (2011). While these are both adequate methods, I would expect that one or both of the "resuspendable sediment" methods (i.e., SAM-4 – Resuspendable sediment (Quorer method) or SAM-5 – Resuspendable sediment (Shuffle index)) would be more appropriate for providing some indication of the fine sediment within the top ~10 cm of river bed. Thus I would suggest that the 'resuspendible' methods also be undertaken.

I would also suggest consideration is given to determining the nutrient content of the fine sediments of the various rivers. This will indicate whether the mobilisation of fine sediment during times of relatively low flows results in a nutrient plume or not.

As mentioned several times in this memo, the design of these programmes, including the location of sites, number of sites/level of replication (i.e., the power), and methodology used will all ultimately determine the usefulness of the monitoring, and whether or not it will be able to adequately answer the monitoring question. The programme should therefore be designed by (or with input from) someone also experienced in statistical analysis.

3.2.8 NATURAL CHARACTER INDEX (NCI)

While the NCI is a potentially useful tool in quantifying human impacts on river character, it would appear to be in a relatively early stage of development, and I am unsure if it is of particular use in the context of the flood protection consent applications. The rivers in question are already highly modified and are managed through keeping their courses relatively static and cutting them off from their natural flood plains through stop banking. Williams (2013) states "A NCI has been determined using some basic physical features of the channel for the scheme reaches of the Otaki, Waikanae and Hutt rivers, to give a high level index of natural character." with these basic features being:

- The active (clear) bed of the channel, the bankfull width and the permitted floodplain width;
- Channel sinuosity from flow length and direct valley length;
- And pool-run-riffle sequences.

The first two features are unlikely to change from the status quo since these are the very things that flood protection works aim to control (i.e., constraining the channel form and width). Pool-run-riffle sequences may be influenced to some extent by gravel extraction, and bed recontouring, but overall, gravel supply and floods drive the formation of such features. Indeed Williams (2013), states "The index would not differentiate between naturally influenced changes and river management effects, and would include the indirect impacts from catchment or climatic changes, as well as direct impacts from local river system changes affecting river reaches." Hence, I do not think the NCI is likely to change significantly as a result of flood protection activities. Further, the EMP states, "It should be noted

that this science is relatively new and that further work is required to develop and refine the NCI for use in the rivers of the Wellington Region." While this is a worthwhile undertaking, and the flood protection activities undertaken by GWRC provide a good case study, I would question why the NCI has been included in the EMP at this stage. Perhaps if it is shown to be an effective tool in the future then it can be incorporated into the EMP through the review process, but currently its usefulness and justification for inclusion are questionable.

From an ecological perspective, there is as yet no indication there is any relationship between NCI and the ecological condition of a particular section of river (i.e., is the ecological condition of a high NCI reach greater than one with a lower NCI?). I can see no reason why a riffle in a high NCI reach would be any different to one in an adjacent reach with a lower NCI, and hence would have a similar fish and aquatic macroinvertebrate fauna.

3.2.9 SUGGESTED ADDITIONAL BASELINE MONITORING

GRAVEL BEACH VEGETATION AND FAUNA

No monitoring of gravel beach vegetation or fauna is proposed. While many of the plant species colonising gravel beaches between significant bed moving floods (or gravel extraction, bed/beach recontouring, beach ripping) are exotic "weedy" species, there is the potential that some native plants that specialise in such environments are present. I would suggest appropriately experienced persons undertake some baseline plant and fauna surveys, initially to determine if any native species of ecological value are present on the gravel beaches in any of the rivers, and if they should be included in any events-based monitoring.

MACROPHYTE COMPOSITION

While many of the macrophytes that are removed from tributary streams and drains in some of the catchments are probably exotic species, there is the potential that some native species are present. I would suggest some baseline information is collected on the macrophyte composition in such waterways. If natives are found to be present, then perhaps significant patches of such species can be left alone (i.e., incorporated into the 10% of aquatic plants retained in the COP), which will both assist them to persist and also provide refugia for fish and invertebrates to help minimise the negative effects of mechanical macrophyte and sediment removal.

FRESHWATER MUSSEL/KAKAHI POPULATIONS

Some of the tributary streams and drains where mechanical clearance of silt and macrophytes is the main flood protection activity could conceivably have populations of freshwater mussel/kakahi. I would suggest these waterways are surveyed to determine if mussels are present. This could potentially be done the next time mechanical clearance is undertaken. If they are found to be present, then this would lead on to ensuring the correct methodologies are employed to minimise the negative impacts of mechanical macrophyte/silt removal on kakahi populations (e.g., returning mussels removed from the bed back the waterways, identifying any particularly dense mussel beds and potentially leaving these undisturbed, timing of sediment removal to avoid their spawning period when they are more susceptible to disturbance.

3.3 EVENT MONITORING

I have already commented on proposed type of monitoring to be undertaken as part of the proposed Event Monitoring under Section 1.3 (Event-based monitoring: 2) on page 4 of this memo. **Those recommendations should be considered here in addition to the comments made below.**

3.3.1 MINOR, MODERATE, AND LARGE SCALE WORKS

The initial approach for event monitoring is to focus on those activities deemed to have the most potential for adverse effects (i.e., wet gravel extraction and bed recontouring). While this is a sensible general approach, I would suggest the first port of call on deciding whether event monitoring is required is a determination of the ecological value of any habitat that is to be disrupted. For example, if the activity were going to potentially disturb inanga spawning habitat, then perhaps some monitoring would be worthwhile to ensure the activity has not had an adverse impact on spawning and spawning habitat.

The determination of the extent of event monitoring is proposed by the EMP is based on the length of wetted riverbed length affected and the number of days for in-river works are scheduled. Works are categorised as:

» Minor Scale Works – affecting less than 150 m of wetted riverbed length and/or no more than three days of in-river works. No

site specific monitoring is proposed for work sites in this category.

» Moderate Scale Works - affecting between 150–500 m of wetted riverbed length and/or between three and six days of in-river works. In addition to the baseline monitoring, site-specific before/after habitat assessments will be undertaken at each work site by the operations supervisor using the habitat assessment template.

» Large Scale Works – affecting greater than 500 m of wetted riverbed length and/or more than six days of in-river works. At these works, in addition to the baseline monitoring, a site specific EMP will be developed prior to the commencement of work by a suitably experienced aquatic ecologist. This may include some or all of the following: monitoring of water quality, deposited sediment, macroinvertebrates, fish, and estuary ecology, along habitat monitoring and NCI calculation.

I am not convinced the level of event monitoring required being tied to disturbance of some length of riverbed length and/or days of in-river works is the best way. As mentioned above this ignores the ecological values of the habitats being disturbed and opens the programme up to abuse or mismanagement – i.e., scheduling works to disturb only 490 m of river ay any one time so as to avoid additional monitoring requirements. Additionally, this method does not account for the varying sizes of rivers managed by GWRC Flood Protection whereby, for example, a 150 m long bed recontour in a large river such as the Otaki may not have as big an effect as it would on a smaller river such as the Wainuiomata.

I would suggest an alternative scheme based on first considering the ecological value of the habitat to be disturbed in the context of that particular river catchment, and secondly on the area (rather than length) of wetted riverbed to be disturbed is developed. This categorisation scheme also needs to include those activities that disturb native riparian vegetation (both natural and planted).

I am also concerned about the suitability of the operations supervisor to undertake the site-specific before-after habitat assessments, as it is likely that this person would not have a river ecology background and thus may not be qualified to do such an assessment. The assistance of an independent ecological overseer (as mentioned in several previous sections) would be worth considering.

3.3.2 MECHANICAL WEED REMOVAL FROM LOW GRADIENT STREAMS

It is proposed to monitor fish on all perennial streams before and after clearance operations presumably to determine the effect of weed clearance on fish communities. I would suggest that we already know that mechanical weed removal removes fish (and invertebrates) from waterways (James, 2013; Greer, 2014) so I would think a better use of resources would be to concentrate the effort into having relevant people onsite to return fish and large invertebrates (e.g., koura & kakahi) to the waterway. Additionally, there are confounding factors relating to the proposed monitoring – for example, fish are generally easier to catch/observe after weed removal due to the reduced cover. Such fish monitoring would also miss freshwater mussels, which may be present in some of the affected waterways. I would suggest the resources be invested in providing relevant people to be on site to return fish and large invertebrates during/following removal, including identifying and measuring all individuals rescued (including noting if alive or dead) from the excavated material so that analysis and reporting can be done on the results (to work out how effective such rescues are).

3.3.3 DISTURBANCE OF GRAVEL BEACHES

I support the proposed surveys of gravel beaches in the Otaki River wherever such habitat may be disturbed between August and February to ensure breeding of riverbed-nesting birds is not disrupted by flood protection activities. I however think there should be surveys of gravel beaches beyond birds (i.e., any native vegetation or non-bird fauna?). The need for such event-based surveys would be informed by the results of the recommended baseline surveys.

3.4 SUGGESTED ADDITIONAL RESEARCH

» Investigation into whether all the willow plantings undertaken to date are actually necessary or if some selected riparian areas could be effectively retired from willows over time and planted with suitable natives. This could be sections where the risks of lateral bank erosion are minimal.

» Research into the optimal width of frontline willow plantings. What is the minimum width of willows required in the riparian buffer zone to achieve the objectives of vegetative bank protection? If these were found to be less than what is currently planted, then perhaps over time, the width of willows plantings in some locations could be reduced leaving more space for native vegetation.

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