Hurunui Water project

Document 5 in a series of 5.

Hurunui River South Branch: Effects and Mitigation

Report prepared by Boffa Miskell Ltd

for

The Hurunui Water Project

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Front Cover Photo: Central inundation area on the South Branch River (BML April 2009)			
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Executive Summary

Five reports have been commissioned by the Hurunui Water Project (HWP) to provide the Canterbury Water Management Strategy Committee with specific information on a range of matters (e.g. salmonid fisheries, lake Sumner values and lake hydrology) relating to HWP's proposed water storage and transport proposal. These summary reports take information from the lodged draft ecological AEE and any additional data and analysis gathered and seek to simplify and distil that information and focus on specific issues raised by the Committee or other "submitters. This report looks at the effects and the potential mitigation related to the damming of the South Branch of the Hurunui.

Summary of Effects

The following table is a summary of the ecological features and their value (or importance), the potential effect and the level of that effect (* denotes a "significant" feature or process as assessed under the District Plan and section 6c (RMA)). Where the Significance of effect (far right column) is medium to very high, it is assumed that mitigation will be necessary.

Feature / Process	Ecological Value	Effect	Significance of Effect
Ozomothamus shrublands	High*	Unlikely, but Possibly Inundated	Low but potential if inundated to be Very High
Wetlands	High*	Inundated	Very High
Divaricating scrub/grasslands	Low	Inundated	Low
Beech forest	Low	Inundated	Medium
Turflands (habitat values)	High*	Inundated	High
Riverbed gravels (incl. habitat values)	High*	Inundated	High
Benthic aquatic invertebrate communities - South branch	Moderate	Change in river species composition to lake species	Low, presuming communities will change to resemble North Branch
Braided river (habitat for braided river bird specialist)	High *	Inundated loss of breeding & feeding sites	High
Lower terrace tributaries (incl. aquatic habitat values)	Low	Inundated	Low
Homestead Creek and upper tributaries	High	Trout access potential	Medium
The glacial braided river valley morphology ecosystem	High*	Change / loss of feature	Medium
Lizards	Unknown (low?)	Inundation	Low?
Terrestrial birds	Moderate-low	Inundation	Low
Invertebrates	Unknown	Inundation	Unknown
South Branch River (below proposed dam)			
River as aquatic habitat	Moderate	Residual flow, stable flow - algae potential	Low depending on reformation densities of benthic communities
Riparian vegetation	Unknown	None	None
Aquatic macrophytes	Very little present	Minor	Very Low

Ecological Processes			
Establishment of submerged macrophytes in reservoir in South Branch	Low-moderate	Draw down in South Branch reservoir exposing vegetation	Medium
Fish passage - South Branch	High	Loss of connectivity for native migratory species	Very High
River sediment loadings	One of two contributors of system (50%)	Loss of sediment resulting in reduced scouring and a factor in algae build up	Low
Residual flows	High*	Seasonal minima are required to support the existing in stream life	Low (with appropriate residual flow regime)

In total some 526 ha of vegetation and habitat will be lost, i.e. changed to open water body and wetland delta.

Summary of key adverse effects on ecological values or processes:

1. Loss of around 223 ha of significant riverbed, wetland and terrace vegetation communities and habitats.
2. Loss of 35km of aquatic habitat, associated with the lack of fish passage
3. Loss of 50% of the sediment in freshes in the south Branch – currently thought to be controlling algae and didymo in the South Branch and lower main stem of the Hurunui River.
4. Loss of braided river bird feeding and nesting habitat for specialist riverine birds

Beneficial ecological effects are also present in the form of a new lake, an open water body, submerged aquatic macrophyte beds and a lake delta that will develop habitat.

Summary of Offsetting

In relation to terrestrial habitats, mitigation for the inundation area is not possible and therefore offsetting is required. Given the types of habitat affected, protection and enhancement of all affected habitat types within the same area is not possible; river terrace wetlands and braided river bird habitat are not common habitat. The following habitat types and areas are proposed as part of the mitigation and are generally located adjacent to the area affected.

Vegetation community Type	Quantity (ha)
Red tussock Wetland	68
River (Homestead Creek)	8
Sub-alpine shrub (Bell knoll)	40
Shrubland/mixed grassland	431
Braided River and river turf	32 (3.5km of river)
Heathland	80
TOTAL	**651**

The potential mitigation areas focus on the array of habitats adjacent to the valley, including the slopes above the proposed lake, the adjacent (south) valley and the river above the lake up to DOC boundary. The potential mitigation in these areas involves their protection and management. Currently, based on the offsetting proposal articulated here, the compensation ratio is roughly 3:1.

However, this does not include those areas of wetland we recommend also need to be found and added to the mitigation package (to account for the braided river habitat and Schenous wetlands affected).

In relation to the aquatic habitats, arising from the results of the analysis and determination of ecological values:

- The flows in the rivers of the South Branch below the dam and the Hurunui main stem must have sufficient water quantity and be dynamic enough to maintain or enhance the existing river ecosystem values. This will rely on an appropriate flow regime set by consents and including flushing rules and sediment addition rules.
- Migratory native fish species should not be isolated through the presence of the storage structures as this could potential cause the loss of species above those structures. A passage system is conceivable but trap and transfer is also potentially viable. In either case there is no proof that such systems will be successful in maintaining upland populations of migratory fish.
- The new “lake” in the South Branch will require a lake level management regime so as not to create water quality issues and habitat quality issues.

1.0 Introduction

Several reports have been commissioned by the Hurunui Water Project (HWP) to provide the Canterbury Water Management Strategy Committee with specific information on a range of matters (e.g. salmonid fisheries, Lake Sumner ecological values and significance and lake hydrology) relating to HWP's water storage and transport proposal. These summary reports take information from the lodged draft ecological AEE and any additional data and analysis gathered, and seek to simplify and distil that information into an easy to read outline of those more detailed reports and focus on specific issues raised by the Committee or other "submitters".

Field work on the South Branch of the Hurunui was undertaken between November 2008 and March 2009. During this time a range of terrestrial and aquatic surveys were conducted and included: electric fishing, spawning gravels and general aquatic physical habitat survey, braided river bird survey, vegetation survey, LENZ GIS mapping analysis, reptile survey, drift dive survey, water temperature monitoring, IFIM transect survey in the lower South Branch, and periphyton and aquatic macro-invertebrate surveys.

The focus of assessments to date has been with regard to the inundation behind a 75-85m dam and downstream aquatic effects. Construction aspects of the dam and proposed lake have not been assessed. Therefore description of communities flooded and fish passage has been the main reporting focus in regard to potential adverse effects.

In ecological terms the effects discussed below are:

- Damming South Branch of Hurunui River :
    - inundation of vegetation communities
    - inundation of fauna habitats
    - loss of fish passage
    - change of aquatic habitat;
- Periodic draw down exposing up to 2km of "old" river bed and terraces;
- Periphyton growth, macro-invertebrate diversity and densities and water temperature;
- Flow regimes and flushing flows down stream.

Not addressed are:

- Effects of construction;
- Altered flow regime downstream of the intake which will potentially affect aquatics systems down stream
- Effects of activities downstream of the Mandamus confluence, or in relation to downstream takes and use of the water from the Hurunui River for irrigation.

2.0 Method for Assessing the "Significance" of an Effect

With regard to the South Branch valley ecosystems, the critical issues relate to the values and quantum of vegetation, habitat and species that will or may be lost through inundation by the dam "lake" and whether those losses represent a significant loss to the ecological district and region.

The array of data collected for the initial Ecological Report has been used to map and determine distributions and biodiversities of areas affected. The following matrices have been used to determine the level of ecological effect. The matrices is a system that allows the categorising of the magnitude of ecological impacts using the following criteria:

Table 1: Effects Magnitude decision matrix.

Magnitude	Description
Very High	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether.
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed.
Medium	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation.

This then leads on to the significance of effect whereby the value and the magnitude are considered together via the following matrices (and in the absence of considering mitigation).

Table 2: Significance of effect matrix.

<table>
<tr><th colspan="2" rowspan="2">SIGNIFICANCE</th><th colspan="4">Ecological &/or Conservation Value</th></tr>
<tr><th>Very High</th><th>High</th><th>Medium</th><th>Low</th></tr>
<tr><th rowspan="5">Magnitude</th><th>Very High</th><td>Very High</td><td>Very High</td><td>Medium</td><td>Low</td></tr>
<tr><th>High</th><td>Very High</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><th>Medium</th><td>Very High</td><td>High</td><td>Low</td><td>Very Low</td></tr>
<tr><th>Low</th><td>Medium</td><td>Medium</td><td>Low</td><td>Very low</td></tr>
<tr><th>Negligible</th><td>Low</td><td>Low</td><td>Very Low</td><td>Very Low</td></tr>
</table>

These two matrices were used to assist the determination of the level (magnitude) of effect and then the “significance” of effect (without mitigation).

3.0 Summary of Results on Ecological Effects

3.1 Inundation Effects on Vegetation Communities

The proposed dam height crest is to be at 75m, this equates to a maximum contour inundation line of 630 m.a.s.l. (the approximate mean reservoir level will be 626 m.a.s.l and the lowest level will be 605 m.a.s.l.). We have plotted the 640 m.a.s.l. contour (NZ topo 260) as this was the data initially supplied to us. However, we note that during concept development the potential inundation range has changed as the dam height has been lowered. We acknowledge that the difference between the 640 and 630 m.a.s.l. is substantial in terms of which terraces are potentially inundated.

Table 3 shows the areas of vegetation inundated based on the 640 m.a.s.l. These figures were calculated using GIS tools and the vegetation mapping (see South Branch values memo Doc 3), the proposed inundation regime from Rileys associates (2009[1]) and NZ Topo map series Contour data.

[1] Rileys data set and pdf sent to BML showing inundation contour

Table 3: South Branch inundation at the 640 m.a.s.l. Contour line vegetation community quantities:

Vegetation community	Area (ha)	Significant (HDC criteria & 6(c) RMA)
Ozothamnus heathland	27	Yes
Wetland	75	Yes
Riverbed turf land	47	Yes
Divaricating shrubland	116	no
Grassland	108	no
Grassland / Divaricating shrubland	78	no
Riverbed and gravels	74	Yes
Mountain beech forest	1	no
TOTAL	**526**	**223**

We note that if the inundation is on average 626 m.a.s.l then all of the Ozothamnus heathland (27ha) is spared from inundation. However, if it was inundated then there would be a significant adverse effect (magnitude High, value High and the significance of the loss, therefore, Very High).

The loss of the valley bottom wetlands (comprising two particularly large features and a number of smaller features) and river turf lands (numerous inter-braid areas) totalling 122 ha, is a significant adverse effect (magnitude High, value High, significance of effect Very High).

The inundation of 116 ha of semi-indigenous divaricating shrublands of medium value, is an adverse effect (magnitude High, value Medium, significance of effect is therefore Medium) in that the inundation will remove this habitat which as a whole supports a range of indigenous species.

The inundation of the grassland and grassland/divaricating shrubland dominated areas (186ha) is not a significant adverse effect (magnitude High, value Low, significance of effect Low) although it is acknowledged that there are a good number of indigenous grassland species amongst the grazed pastures.

The inundation of riverbed and gravels (74 ha) is a significant adverse effect on important faunal habitat including threatened species (magnitude High, value High, therefore a significance effect of Very High).

There will be a very low adverse effect through the inundation of 1 ha of mountain beech forest (magnitude Low, value Low, significance of effect Very Low).

On the scale proposed, the change in the valley system from a braided river with a semi-indigenous mosaic of glacial valley representative plant communities, to a lake with the potential for upper slope shrublands and grasslands, is found to be a significant ecological change (magnitude High, "ecosystem" value Medium, therefore the significance of effect is Medium.

3.2 Effects of reservoir drawdown

In time the new lake will become a habitat for indigenous and introduced flora and fauna and will have ecological values that have not been determined at this time. The operating regime for the lake however, will have effects on the "new" habitat and the communities it supports.

In very dry years (currently estimated as a 1 in 10 year event (Ward 2009[2])) the South Branch will be utilised in excess of the typical annual ~30% of storage (a 300-500m draw down) to such an extent

[2] Neil Ward PDP, hydrologist, 2009 initial Water Conservation evidence, and 2010 up dated evidence draft for the second WCO hearing.

that may drain the lake down to its minimum 605 m.a.s.l. A 50 million cubic meter 'lake' of "dead storage" will always persist. In such an event, there will be approximately 2km of draw down (Riley's 2009) exposing the "old" river gravels and inundated terraces. The effect of this draw down is unclear as it will depend on the frequency and extent of draw down, which will determine, in part, the condition of the substrate and submerged macrophytes which are likely to have established, and the level of organic matter present.

The effect will also relate to the extent to which edge wetlands have established and on the duration and season during which part of the "lake bottom" is exposed (left dry). If the frequency of this event is low then the probability that submerged macrophyte beds have established will be high (and a desired aspect of the lakes ecological development). Such beds can withstand short periods of dewatering but if longer periods (perhaps greater than 30 days) occur then large scale die back will occur. That dead organic matter may or may not result in adverse effects to water quality and habitat quality when the lake refills. Exposure during the low period will be both beneficial to birds and to midge and black fly populations as well as potentially adverse through anaerobic bacteria establishment and the potential for problem algae. If however, submerged macrophyte beds do not establish well and the substrate is largely bare cobble, gravel and fine sediments, then long term exposure will have minimal adverse effects.

Over time, a lake delta will form on the headwater edges, as in Lake Sumner. On this variably-inundated edge it is expected that aquatic turfs and Schoenus-*Carex* spp. wetlands will develop and form zones dictated by the annual draw down and filling regime (this assumes no grazing). Such lake wetland/turf zone/s are not present on the South Branch River currently, but both are appropriate and tolerant of the standard operating regime.

Lake level management will need to form part of the suite of mitigation actions. Ideally the flora and fauna that develop within the 2km draw down zone will be those species that can manage that regime. To ensure that that is the case, or that the bed remains bare cobble, the lake level management from the start will have to mimic the ongoing draw down regime of the scheme. This may mean using south Branch water annually even when the preference might be for Lake Sumner storage water to be used for irrigation.

Overall, the level of impact of the operating regime on the new lake habitats and species is uncertain. The magnitude of effect of the draw down is likely to be low or medium (depending on what species develop there) and the value (again dependent) medium. The Significance of effect, prior to management, is likely to be Low but still require adaptive lake level management.

3.3 Effects on terrestrial fauna of Inundation

3.3.1 Birds Associated with Braided River habitat

Around 121 ha (7 km) of braided river and turfland habitat currently used by riverine birds for nesting and feeding will be inundated by the proposed reservoir. Based on the numbers recorded during the 2008 survey (in brackets), this will affect Threatened and At Risk species such as: black fronted tern (8) (Nationally Endangered), banded dotterel (93) (Nationally Vulnerable), New Zealand pied oystercatcher (38) (Declining); as well as several non-threatened species including large numbers of southern black backed gulls and smaller numbers of paradise shelduck, Canada geese, white-faced heron, spur-winged plover, Australasian harrier and mallard/grey duck.

At a national and even regional level the river in the inundation section is minor in relation to the habitat it provides and the quantity of birds it supports. There are estimated to be between 8,000 and 10,000 black fronted tern in New Zealand (O'Donnell & Hoare 2010) of which the section of river to be inundated supports perhaps 10 birds from year to year. There are reported to be around 50,000 banded dotterel (Heather and Robertson 1996[3]) of which 90-100 breed in and utilise the potentially inundated reach. And there are between 80-120,000 NZ pied Oyster Catchers (Heather and Robertson 1996, Fuller et.al. 2009[4]) of which perhaps around 40-50 are present every year.

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[3] Heath, B.D. & Robertson, H.A. The Field Guide to the Birds of New Zealand 2000. Penguin books (NZ) Ltd.

[4] Fuller, S., McLennan, J., Dowding, J., Barea, L. and Craig, J. 2009: Assessment of potential avian mortality at the proposed Taharoa Wind Farm, Taharoa Beach, Kawhia, Waikato. Unpublished report to The Proprietors of Taharoa C, Department of Conservation and Waitomo District Council. Pp 115.

Neverthelesss, the section of the South Branch River proposed to be inundated provides breeding habitat for black fronted tern, NZ pied oystercatcher and banded dotterel. As such work would be required to determine if birds "displaced" by the inundation birds would move upriver, to other suitable habitats nearby or not return to the area at all. If banded dotterel do not return then there will be a significant adverse effect (magnitude High, species value High, significance of effect Very High).

Some form of mitigation/offsetting, will be required and the following factors should be considered given that they are responsible for limiting population levels of these birds:

- Predation;
- Habitat loss;
- Habitat modification (particularly through weed invasion).

3.3.2 Other Terrestrial Birds (and their Habitats)

Inundation of 219 ha of heathland, wetland, shrubland and beech forest will remove the habitat for and number of bird, invertebrate and reptile fauna. Eleven terrestrial bird species were recorded within these habitats. Seven of these are common introduced species (finches, song thrush, skylark etc). Two of the four indigenous species are classified as At Risk: New Zealand pipit and western weka. The western weka record was based on a single call heard on the northern bank of the river, in the western half. Such a record is unusual as this species is only rarely found this far east of the main divide.

Inundation of the area proposed does not directly affect the terrestrial bird fauna present, being largely common exotic species associated with the grassland and shrubland and able to fly away. It is unlikely that there will be a population effect of the loss of that habitat area. The magnitude of effect is considered to be Medium and value Low, therefore the significance of the effect is Very Low.

Currently there is insufficient data on reptiles and invertebrates within this habitat to make a conclusive assessment of the significance of the inundation effect.

3.4 Aquatic Habitat Effects

The inundation of around 7 km of braided river habitat and the resultant change to a managed variable level lake is a substantial habitat change affecting the fish populations, both trout and native. In regard to trout, a lake will offer greater habitat opportunity than the current braided river section (above the gorge and below Lake Mason confluence). However, some of the native fishes are not known to succeed in a lake condition, especially one with greater potential trout predation. It is anticipated that in the first instance the Canterbury river galaxid populations will be forced to move up stream and not exist in the lake. Koaro, upland bully and eel are all capable of forming lake populations, as seen in Lake Sumner. It is anticipated that these species will at least persist, if not benefit, in the new lake, but that cannot be guaranteed. It may be that these fish will not form lake populations (this was the opinion of Dr Joy in the Mokahina hearing evidence in opposition to the NIWA evidence in regard to the formation of a lake on that terrace).

The alpine galaxids will retreat up the main stem and the tributaries, as will banded kokopu in Homestead Creek. Provided the new lake forms a healthy submerged macrophyte flora (which it should) and that annual fluctuations are no more than the anticipated roughly 30% of volume, a substantial area of lake habitat will be formed. Lake management will need to address macrophyte build up, sediment build up and recognise that new ecological values will reside especially in the lower, "dead" storage, area.

A potential negative effect associated with the creation of the lake is the access of trout to the upper Homestead Creek. Our sampling showed an absence of trout above the water falls and the this may be the reason for the presence of banded kokopu, Canterbury river galaxids, koaro and small eel. The inundation is such that the current trout barrier (i.e. the waterfall) would not be directly "breached", but the higher lake waters may increase the chance of trout access. The magnitude of such an effect we deem as Medium and the value (given the potential to be the most inland banded kokopu population) is High, therefore the significance of the effect is High.

3.5 Fish Passage

With the construction of a dam in the upper gorge location and at a height of around 75m, fish passage from the downstream section to the up stream/lake section is highly unlikely. This will be an issue for migratory koaro, eel and banded kokopu, longjaw galaxiid (if present) populations.

While the primary adverse effect is stopping upward migration, we assume downward migration could be catered for – but recognise that that will depend on the style of residual out flow finally accepted and whether there is a hydropower turbine on line.

The magnitude of the affect on migratory species is Very High and the species value is High, therefore the significance of effect Very High.

In regard to trout, Dr Young, in his WCO evidence (2009), suggested that the South Branch trout populations do not migrate to the sea for breeding but that they require movement between catchments to enable the large body sizes attained. We consider it likely that a "land locked" brown trout population will form and be healthy in the new lake the 35 kilometres of upper South Branch River. Magnitude of effect is Medium, the species value is Low, therefore the significance of effect is Very Low.

In regard to salmon, their passage is also stopped by the dam. Salmon spawning is the subject of an earlier report (Document 1 in this series) and that discussion shall not repeat here, other than to note we are in agreement with Fish and Game that if the loss of 60% of the salmon run occurs every season post dam construction, then the salmon run in the Hurunui will trend down much more rapidly that it does currently. The magnitude of effect is High, the species value is Low, therefore the significance of effect is Low.

3.6 River Flows and Flow dependents

A residual flow in the South Branch (below the dam), is proposed to be 4.5 m/s^3 (around MALF) for the maintenance of in-stream biota. The 4.5 m/s^3 is supplemented below the North Esk River confluence and that river supplies sufficient variability in flow so as to mimic the natural state (Ward 2009). IFIM analysis has indicated that for native fish 3 m/s^3 is optimal, while for trout a 4.5 cumec flow will retain 100% trout habitat.

The other important potential issues are periphyton growth, didymo growth, water temperature and the relationship with river stability and absence of sediment load (scour and erosion).

Stabilising the flow below the dam may allow the development of abundant native and exotic algae and macrophyte. This will not be adverse but may result in a change in the communities present, particularly the abundance of specific benthic invertebrate fauna. However, such lower stable flows may also promote seasonal algae problems.

There is a hypothesis that didymo has not spread to the South Branch and the Hurunui below the South-North Branch confluence because of the "high" sediment loading during freshes causing effective substrate scouring. Around half the sediment loading of the South Bracnh comes from the South Branch above the gorge. Didymo is prominent between the lake outlet and confluence on the North Branch possibly because of the absence of either high volumes of water and/or sediment-loaded freshes. A dam on the South Branch will both entrain around half of the sediment and remove part of the freshes delivered to the South Branch. While that increase in stability may allow native algae and macrophyte to establish it may, following the above theory, also allow didymo to establish. A caveat to this theory is that didymo is found in other, larger rivers with bigger flows and higher sediment loads (e.g. the Waitaki River). Magnitude of effect Medium, value of the periphyton system Medium, significance of effect Low.

4.0 Mitigation

4.1 Mitigation of reservoir drawdown

In order to mitigate potential adverse effects related to lake draw down we recommend that an appropriate lake level management plan be established that caters for the maintenance of healthy lake edge habitats.

5.0 Potential Offsetting

5.1 For vegetation community (habitat) loss

The loss of vegetation communities and habitats resulting from inundation by the proposed lake cannot be avoided, remedied or mitigated. The only option is to offset the losses and changes.

Offsetting for the losses and changes involved in the inundation of the South Branch of the Hurunui is problematic in part due to the extent of the vegetation communities and the difficulties associated with finding "like for like" ecosystems, which to date, has been the preference of both ecologists and the Environment Court. The primary aim, in our assessment, is an attempt to have a no-net-loss (and preferably net gain) in the Ecological District. This will require that similar features (which are not currently protected and are degraded, but that have the potential to be restored by management) are available in the ecological district. Alternatively, areas not like for like of high potential or current ecological value (under-represented habitats or sites supporting rare species) that are under threat and not protected could be considered. While this scenario may not represent a "like-for-like" situation, areas of high conservation priority may be of more value than "like-for-like" alternatives.

Vegetation communities and habitats for which offset mitigation will be necessary include 367 ha of vegetation communities and terrestrial habitats comprise:

- 223 ha of significant vegetation communities and habitat comprised of wetlands, riverbed turflands and *Ozothamnus* shrubland in the valley bottom and lower river terraces of the South Branch and 7km of main river.
- 144 ha of other vegetation community and habitat types, including matagouri / *Copromsa* scrub / shrublands, grassland with matagouri shrublands, and a small area of mountain beech forest, but not grasslands.

The offsetting for loss of vegetation communities also offsets the associated loss of habitat for fauna.

5.1.1 Current potential offset options

The following lists areas we currently know of and see as part of the possible offsetting portfolio based on their type and location. To a large extent these may suffice to offset the various lower and middle slope habitats of the South Branch that will be inundated and the smaller, middle and lower hill toe wetlands and Ozothamnus heath.

- The remaining slopes and any upper terraces above the lake on the north side
- Any terraces or lower slopes with existing shrub/wetland not inundated on the southern side
- Bell knoll and saddle
- River and river terraces up stream of the inundation (past masons confluence) to the property boundary– this includes the river and its turfs as well as a large hill fan on the south side of the river
- Homestead Creek and riparian wetland edges
- Red tussock wetlands
- Lower Valley shrublands
- Upper valley heathland

Total habitat which could be "returned" from grazing, present on site and with current values approximating those lost are listed in the table below (Table 4).

Table 4: Potential areas (ha) of habitat for offsetting

Vegetation community Type	Quantity (ha)
Red tussock wetland	81
River (Homestead Creek)	22
Sub-alpine shrub (Bell knoll)	50
Shrubland/mixed grassland	620
Main River and river turf	263 (4.5km of river)
Heathland	131
Total	1167

These features are shown on Figure 1.

However, the areas listed in Table 4 do not entirely offset the braided river turf lands or the schoenus wetlands which will be lost. This significant component of the project may have no suitable offset option.

5.2 Upland braided River habitat

To examine the possibilities for offsetting the 3.5 km of braided river lost that has no compensation potential on site, we undertook an initial desk top search to find other similar habitat. We identified a small number of potential river valley areas, only one of which we consider viable.

A weed management and habitat improvement plan will need to be developed for those offset areas for the purpose of improving breeding habitat for the At Risk and Threatened bird species.

There are a range of issues to overcome in the possible use of offset areas (both on and off site), including philosophical ones of off-setting and appropriateness of "simply" protecting an area not under particular threat.

5.3 Salmon

While it remains debated as to the significance of the loss of passage on the South Branch, the current proposal is to develop a salmon hatchery near the Hurunui River mouth. This location (before the first gorge and perhaps at around the Domett distance inland) is favoured by anglers as it is more likely to be successful than upstream hatcheries.

5.4 River habitats of the Upper South Branch and particular migratory native fish

As discussed the dam is likely to result in the loss of passage for trout, salmon, banded kokopu, eel, koaro and any other fish moving up stream. Trout and salmon aside, which we do not believe "need" passage, the native species do need passage to maintain viable upland river populations. While the current abundances of these species are low in the main braided section above the gorge, in the smaller forested sections of the head waters much larger populations are expected to occur and these habitats may be diminished significantly over time.

While there are a wide range of fish pass studies and methods, to our knowledge none demonstrate the ability to successfully maintain or attain passage over a height of 75m.

Dams such as the Arnold (around 20m high) have elver passes which appear to work and areas lateral to the dam that allow the formation of acceptable gradient channels to be made. The box-step type passes seen on the Branch River are not proven to work and that is only for a small concrete weir situation. The Patea Dam (a TrustPower hydro dam) is 80m high and debate continues over whether fish passage has been achieved on that river, but it appears to be the case. “Passage” for elver at the Patea is reported to be achieved by NIWA through trap and transfer. Dr Joy (Massey University) however, suggests that trap and transfer, while partially successful for eel (and without knowledge of the sufficiency for population maintenance of that transfer) is only “effective” for eels and no other native fish.

There remains a potential to create a climbing fish passage using the gorge sides to raise an artificial path up to the southern dam edge (at around a 3:1 gradient) and use the majority of the residual discharge water down this path so as to make the dominant flow this path. With innovative design and focus on climbing native fish, such a passage could be built. However, its effectiveness cannot be guaranteed and using a dominant flow down the path will leave around 200-300m from the dam downstream with little or no flow.

5.5 Flushes for sediment release and algae control

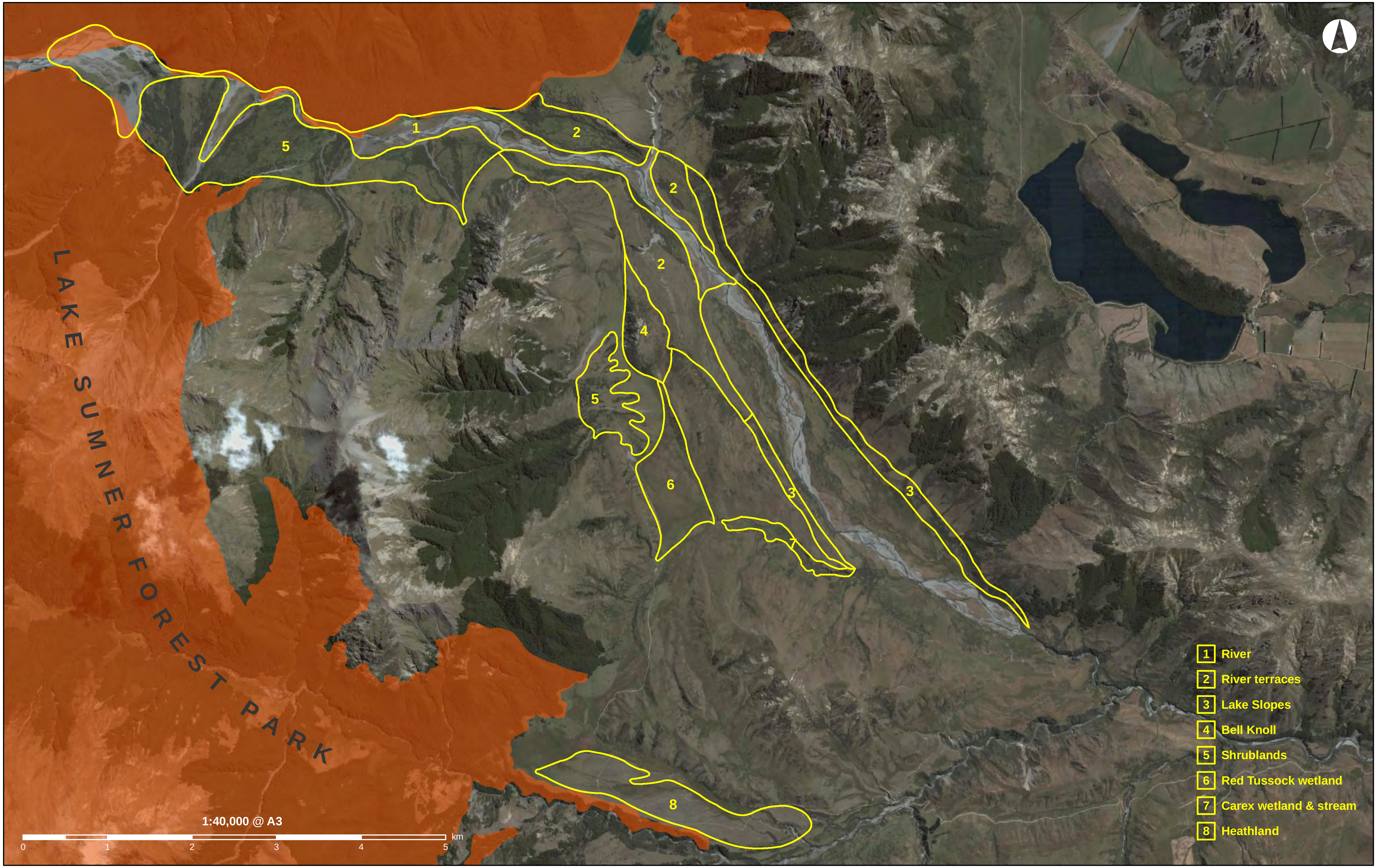
Sediment re-introduction will have to be at the time of a natural flush (where the storage is full and a heavy rain event occurs) or at a programmed flush. To manage periphyton build up, especially in late summer, a periphyton monitoring programme will trigger a flush from the dam. The quantity and duration of a flush to remove or limit nuisance algae is specific to each river but there are a range of heuristic parameters. Largely the river flush to mitigate algae levels will require an adaptive management programme but our current opinion is that around 30 cumecs will need to be released for 2 to 3 hours to remove nuisance algae in the South Branch. In addition 90 cumecs could be released over 6 hours to assit issues in the main stem of the Hurunui.

6.0 Conclusion

Around 520 ha of terrestrial and riverine habitat will be adversely affected (lost) to the proposed inundation behind a 75 m dam on the South Branch. Around 223 ha of that area is ecologically significant and a further 140ha with some indigenous values. Breeding habitat for around 50 pairs of banded dotterel will be lost. Some 35km of upland river system may lose its migratory native fish due to passage issues created by the Dam. Downstream potential aquatic effects relating to water quality, sediment loading, algae and general low flows are all potential adverse effects but are also effects that can be avoided by appropriate management regimes and adherence to thresholds established by methods such as IFIM. Lake management will be important in avoiding draw down effects on establishing aquatic communities.

Several of the habitat types affected, especially the Scheonus wetlands, currently have no “like for like” offsetting options. The replacement of braided river turf and braided river bird habitat currently remains problematic.

The concept of offsetting does require acceptance of loss and an ability to compensate that loss, typically with protection and management of other systems perhaps of greater conservation value or under immediate threat of loss. In part the compensation ratio of around 3:1 is targeted in recognition that protection and management of existing areas of value is not replacement for systems lost (in terms of physical area or quantity of habitat) and that recreation of large areas of indigenous systems is largely not feasible (due to time, land and cost constraints). The 3:1 ratio suggested here has no scientific basis other than that ratio has been used in other cases (Arnold Hydro scheme) and is a common Stream Ecological Valuation (Rowe et al 2008) system ratio.



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INDICATIVE

HURUNUI INUNDATION OFFSETTING CONCEPTS

POTENTIAL AREAS FOR OFFSETTING ECOLOGICAL EFFECTS OF INUNDATION

1