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REPORT

Stream Ecological Valuation: Ruahapia and Raupare Streams

Prepared for Hawke's Bay Regional Council

March 2011

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HAWKE'S BAY REGIONAL COUNCIL

Stream Ecological Valuation: Ruahapia and Raupare Streams

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Executive Summary

The Hawke's Bay Regional Council (HBRC) has engaged MWH New Zealand Limited (MWH) to design a Stream Ecological Valuation (SEV) (Rowe *et al*, 2008) monitoring programme for the Ruahapia and Raupare Streams, which are located in the lower Karamu catchment.

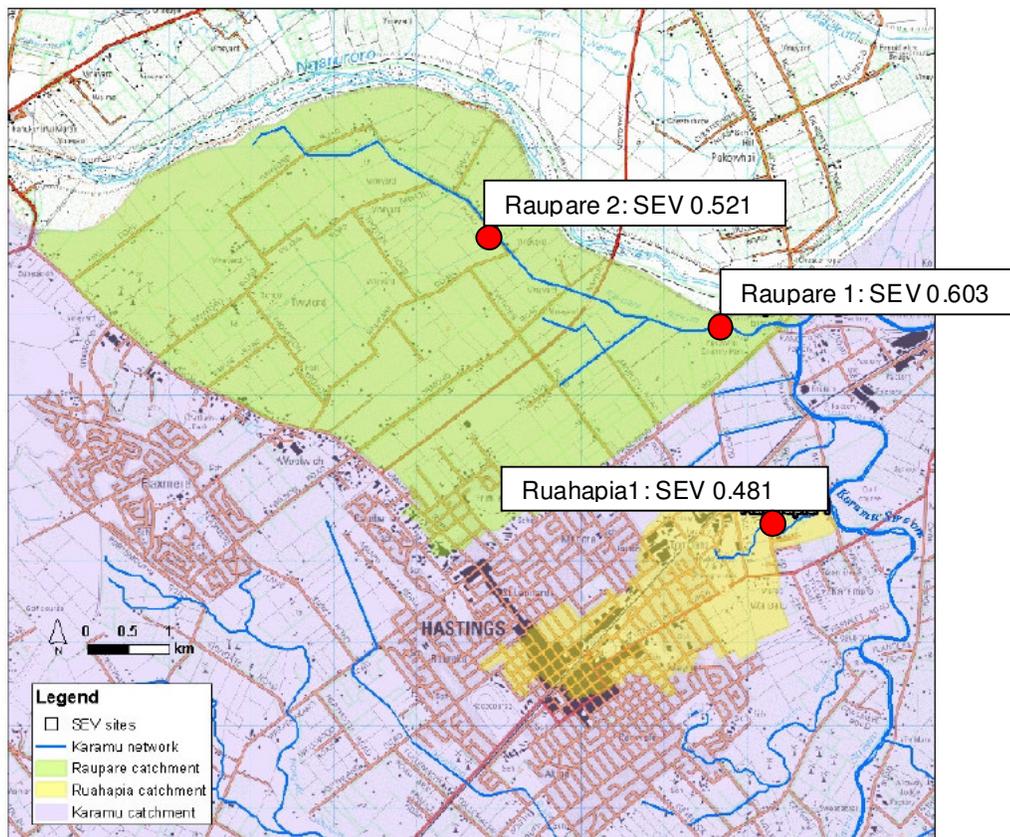
The specific objectives of this study were to (1) establish a representative network of SEV monitoring sites, which would form a baseline for future ecological monitoring; (2) determine the SEV score at representative sites of each stream; and (3) investigate scenarios for loss of ecological function resulting from water abstraction causing stream flow depletion and explore options for offsetting those effects on the Ruahapia and Raupare Streams.

The SEV baseline study included assessment of the level of ecological performance operating at three study sites, and included surveys of fish communities, macroinvertebrate communities, and in-stream, riparian and catchment conditions.

A summary of the results of the SEV baseline survey are presented spatially, below. In summary, the baseline survey determined levels of ecological functional integrity were moderate to low in the Ruahapia Stream, moderate in the upper Raupare Stream, and moderate to high in the lower Raupare Stream at the Pakowhai Country Park. The SEV score at the lower Raupare Stream site was more than one whole SEV unit above any other site measured through the Hawke's Bay baseline assessment programme to date.

After initial investigation, it was concluded that more detailed hydrological analysis of depth – velocity relationships for various drawdown scenarios would need to be progressed, in order to test the SEV calculator as a tool for prediction of ecological function loss from stream flow depletion.

Ruahapia and Raupare Streams baseline SEV results summary:



1 Introduction

1.1 Study Scope and Objectives

The Hawke's Bay Regional Council (HBRC) has engaged MWH New Zealand Limited (MWH) to undertake SEV assessment of the Ruahapia and Raupare Streams. The application of the SEV (Rowe *et al*, 2008) to these two streams forms part of a wider study programmed for the summer of 2009-2010. That project aims to establish an SEV monitoring network across a number of streams within the Karamu Catchment. The current report has been performed in isolation from the wider study, to allow separate investigation of the potential for use of the SEV to calculate off-sets for stream flow depletion effects.

The Ruahapia Stream is a low-order lowland stream, which originates within the eastern extent of urban Hastings and flows in an open channel for approximately 1.8 km to the east where it converges with the Karamu Stream. The Raupare Stream is a low to mid-order stream, which originates from groundwater springs adjacent to the Ngaruroro River near Twyford, and flows for approximately 7.5 km to the south-east, converging with the Karamu main-stem near the Pakowhai Road and Farndon Road intersection.

The location of subject streams and study reaches in relation to the wider Karamu catchment are presented in Figure 1-1 below.

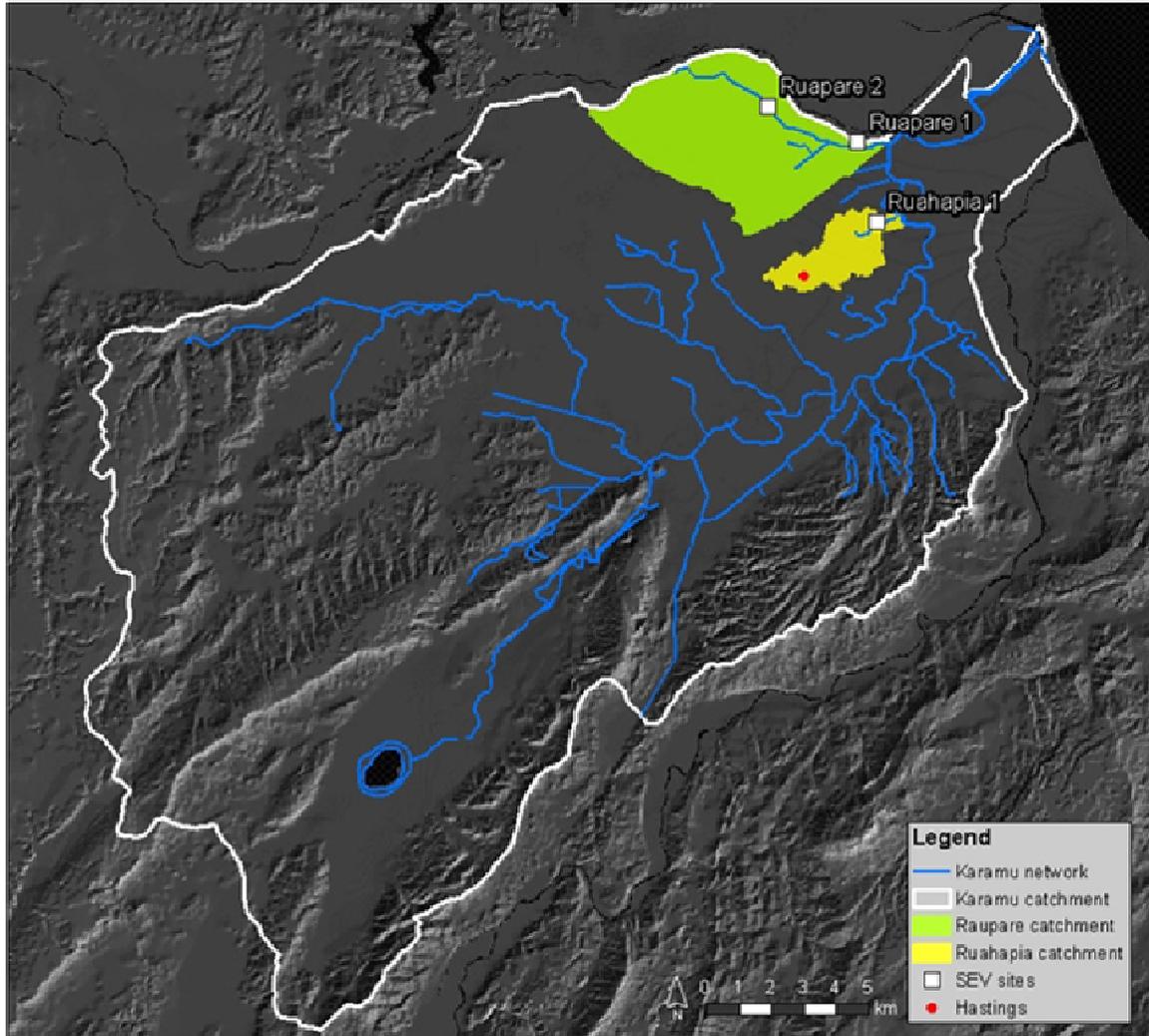
The specific objectives of the study were to:

1. Establish a representative network of SEV monitoring sites, which would form a baseline for future ecological monitoring;
2. Determine the SEV score at representative sites of each stream; and
3. Investigate scenarios for loss of ecological function from stream flow depletion and explore options for off-setting those effects on the Ruahapia and Raupare Streams.

The SEV method focuses on measurement of hydraulic, biogeochemical, habitat provision and biotic ecological functions of a given stream reach. In this case the SEV investigation included a fish survey, a macroinvertebrate survey and a range of other measurements prescribed by the SEV method to quantify the integrity of ecological functions operating at the study reach.

This report provides a description of the study reaches and methods adopted for the study. The results of the SEV calculation are presented and discussed. The utility of the SEV as a tool for calculating requirements for offsetting stream flow depletion effects is investigated.

Figure 1-1 : Ruahapia and Raupare catchments, streams and study reaches in relation to the Karamu catchment



2 Background

2.1 Ruahapia Stream Overview

2.1.1 River Environment Classification of the Ruahapia Stream

The NIWA River Environment Classification (REC) description of the Ruahapia Stream is provided in Table 2-1 below.

Table 2-1 : REC classification of the Ruahapia Stream

REC Category	Ruahapia REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Alluvium	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and groundwater infiltration. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material.
Land-cover category	Urban	Flood peaks are very 'peaky' and recessions return quickly to base flow. Base flows are very low. High concentration of many contaminants. High suspended sediment load during development and typically low afterward. Fine substrates (silts and muds) relative to natural land-cover categories.
Network position	Low-order	Headwater streams (stream order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation.
Valley-landform	Low-gradient	Low-gradient channels.

2.1.2 Catchment Land Use

The Ruahapia Stream is positioned in the lower reaches of the Karamu Catchment (See Figure 1-1). The Ruahapia Catchment has a total area of approximately 497 ha¹. Of that area, 38% is covered in industrial land use, 28 % is in residential land use. The remaining 33 % is in rural land use. Given the land use and catchment area, approximately 50 % of the catchment is covered in impervious surface.

¹ Area of catchment measured above the point of convergence with the Karamu Stream / Clive River.

2.1.3 Ruahapia SEV Study Reach Description

One SEV study reach has been established on the Ruahapia Stream - titled "*Ruahapia 1*". Ruahapia 1 is 150 meters in length and the top of the study reach is located a short distance below the Bennett Road crossing of the Ruahapia Stream. The reference details for the Ruahapia 1 SEV reach are presented in Table 2-1 below.

Table 2-2 : Reference details of Ruahapia 1 SEV reach

Reach Name	Location Description	GPS Coordinates	
		Top of SEV Reach (Easting/Northing)	Bottom of SEV Reach (Easting/Northing)
Ruahapia 1	Downstream of Bennett Road	E2842258 N6168473	E2842322 N6168372

2.1.4 Ruahapia 1 General Character

The land surrounding Ruahapia 1 is rural in character. Riparian vegetation is predominantly short pasture. Occasional exotic trees are present within the riparian zone. Stock has free access to the stream.

The stream channel is entrenched within the surrounding plain to a depth of several meters. Bank slumping is common.

The Ruahapia 1 study reach has an average wetted width of 1.78 metres, and an average depth of 0.11 metres.

Figure 2-1 : Typical character of the Ruahapia 1 SEV study reach, August 2009



2.2 Raupare Stream Overview

2.2.1 River Environment Classification of the Raupare Stream

The NIWA River Environment Classification (REC) description of the Raupare Stream is provided in Table 2-3 below.

Table 2-3 : REC classification of the Raupare Stream

REC Category	Raupare REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Alluvium	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and groundwater infiltration. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silts and muds) compared to natural land cover.
Network position	Low-order and Middle-order	Low-order: Headwater streams (Stream Order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation. Middle-order: Tributaries (Stream Orders 3 to 4).
Valley-landform	Low-gradient	Low-gradient channels.

2.2.2 Catchment Land Use

The Raupare Stream is positioned in the lower reaches of the Karamu Catchment (See Figure 1-1). The Raupare Catchment has a total area of approximately 2566 ha². Of that area less than 5 % is covered in residential land use with the remainder in rural land use. On that basis less than 5 % of the catchment area features impervious cover. The upper reach of the Raupare Stream does not have significant area of impervious cover within its catchment.

2.2.3 Raupare SEV Study Reach Description

Two SEV study reaches have been established on the Raupare Stream. "*Raupare 1*" is the downstream most reach and is located on the Raupare Stream at the Pakowhai Country Park. "*Raupare 2*" is positioned on the upper reaches of the Raupare Stream, adjacent to Nicholl Road. Both SEV study

² Area of catchment above the point of confluence with the Karamu Stream.

reaches are 150 meters in length. The reference details for the Raupare 1 and Raupare 2 SEV reaches are presented in Table 2-4 below.

Table 2-4 : Reference details of Ruahapia 1 and Raupare 2 SEV reaches

Reach Name	Location Description	GPS Coordinates	
		Top of SEV Reach (Easting/Northing)	Bottom of SEV Reach (Easting/Northing)
Raupare 1	Upstream end of Pakowhai Country Park	E2841678 N6170915	E2841815 N6170854
Raupare 2	Nicholl Road, on Raupare Stream between convergence points of "Burns Drain" and "Walker Drain"	E2838906 N6172028	E2839002 N6171912

2.2.4 Raupare 1 General Character

Land use in the vicinity of Raupare 1 is reserved parkland, with expansive areas of mown grass (particularly on the true left) and mixed native and exotic tree-land on the true right of the stream. To the true right of the stream is a relatively³ expansive floodplain.

The stream alignment is artificially channelised, although it retains natural substrate and earth banks. Bank erosion is common along the steeper true left bank.

The Raupare 1 study reach has an average wetted width of 7.1 metres, and an average depth of 0.3 metres.

Figure 2-2 : Typical character of the Raupare 1 SEV study reach, September 2009



³ Relative to the wetted width of the stream at this point.

2.2.5 Raupare 2 General Character

Land use in the vicinity of Raupare 2 is agricultural, in particular orchards and vineyards. The Raupare Stream is separated from Nicholl Road on the true right by a 7.5 metre grass verge.

The channel is straightened and incised. The stream is set within near vertical banks, which are vegetated with exotic grasses and periodically mown.

The Raupare 2 study reach has an average wetted width of 4.3 metres, and an average depth of 0.57 metres. Macrophyte growth is abundant. The stream substrate is predominantly silt and clay.

Figure 2-3 : Typical character of the Raupare 2 SEV study reach, August 2009



3 Methods

3.1 The SEV Method

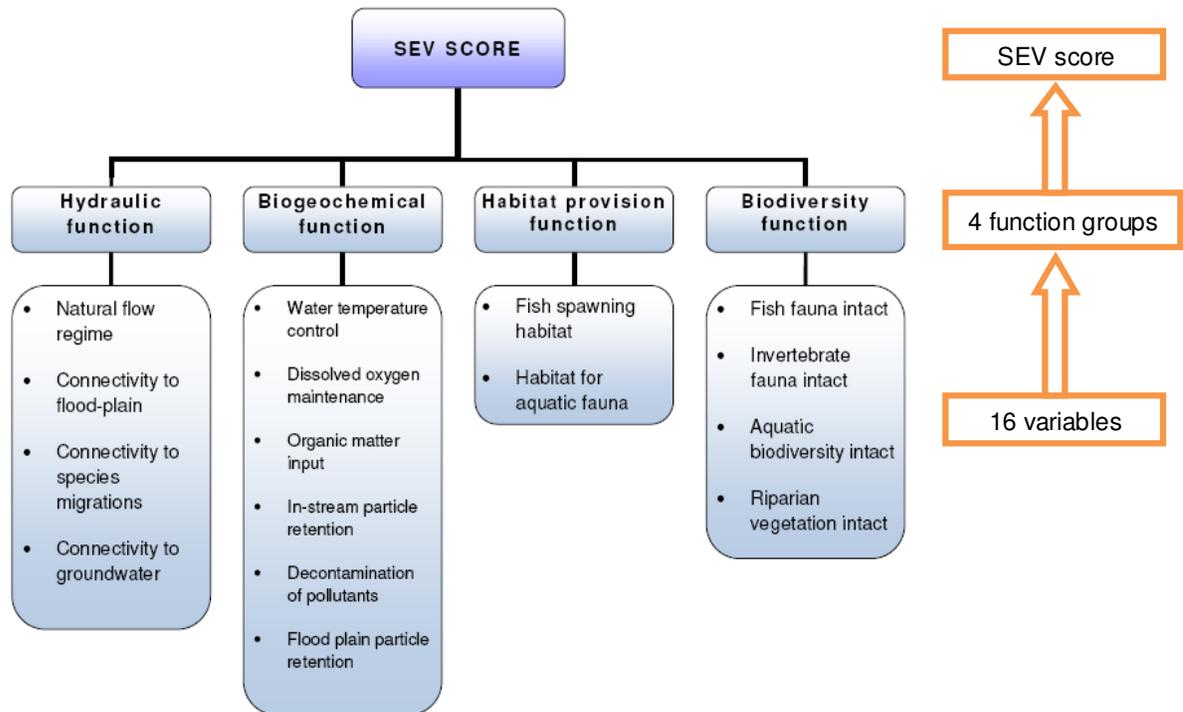
The SEV method was developed to provide a method of assigning values to stream ecology attributes and calculating the required amount of restoration to off-set loss of ecological value at an impact site.

In this study the SEV method is applied as a valuation tool for establishment of a baseline state, against which future change can be measured against.

3.1.1 SEV Structure

The SEV score is generated by collection of data relating to 16 variable scores. Those variable scores contribute to one or more function group scores. The SEV score is the average of those four function group scores.

Figure 3-1 : SEV general structure



3.1.2 Function Group Definitions

The four function groups relate to the following ecological function qualities (see Table 3-1).

Table 3-1 : Explanation of function group definitions

Function Group Title	Function has Reference to these Matters
Hydraulic functions	Processes associated with water storage, movement and transport
Biogeochemical functions	Related to the processing of minerals, particulates and water chemistry
Habitat provision functions	Types, amounts and quality of habitats that the stream reach provides for flora and fauna
Biotic provision functions	The occurrence of diverse populations of indigenous native plants and animals that would normally be associated with the stream reach

3.2 Study Site Selection Methods

The three SEV study reaches were located according to stream and surrounding land use characteristics. Aerial photographs, topographical maps and the National Institute of Water and Atmosphere's (NIWA) River Environment Classification (REC) were used to derive preliminary locations for study reaches. Those locations were then investigated in the field to confirm representativeness of the surrounding environment and site access.

3.3 Application of the SEV Method

The standard SEV method (Rowe *et al*, 2008) was adhered to. Survey reaches were defined and marked on the ground using spray paint. All study reaches were 150 metres in total length, with ten 15 metre transects. This arrangement aligned with the transect design required for the fish survey, as outlined below.

3.3.1 Field Surveys

3.3.1.1 Fish fauna survey

All fish surveys were undertaken in general accordance with the Draft Standardised Fish Sampling Protocols for New Zealand Wadable Streams (Bruno, 2009).

The Ruahapia 1 and Raupare 2 study reaches were night spotlighted. One 30W Lightforce spotlight was used per person.

The Raupare 1 study reach was electric fished using a back pack unit, at 100-200 volts and with a pulse rate of 70Hz.

All fish surveys were carried out by Adam Forbes (MWH) and Fiona Cameron (HBRC), in tandem.

3.3.1.2 Macroinvertebrate survey

Macroinvertebrate surveys were undertaken in accordance with the MfE (2001) Protocols for Sampling Macroinvertebrates in Wadeable Streams.

Ruahapia 1 and Raupare 2 were surveyed according to the soft-bottomed semi-quantitative protocol "C2". Raupare 1 was surveyed according to the hard-bottomed semi-quantitative protocol "C1".

A macroinvertebrate kick-net with 0.5mm mesh aperture was used for sample collection. Samples were preserved with c. 70 : 30 isopropyl alcohol : water solution in the field and shipped to Landcare Research (Auckland) for species level, species presence, identification.

3.3.2 Desktop Analyses

3.3.2.1 Reference site rationale

In the context of the SEV method, a reference site should be un-impacted by development or other human disturbance. A reference stream should be of a similar stream order, underlying geology, gradient and substrate type, and should have an intact native forest riparian zone. Such conditions represent the original or 'best case' scenario for a given test site.

Due to the highly modified nature of riparian conditions associated with lowland streams on the Heretaunga Plains, no pristine reference site is available for inclusion in the Karamu Catchment SEV calculations. The National Institute of Water and Air (NIWA) have provided an opinion that Auckland reference stream data can be applied to streams in Hawke's Bay⁴. On that basis, specific reference values for each variable score have been developed with consideration of (1) the test score returned from field analysis; (2) NIWA endorsed reference scores; and (3) experience gathered from application of the SEV method at other sites on the Heretaunga Plains (Forbes, 2008; 2009).

It is known that during pre-Polynesian times (i.e. more than 800yrs BP) Hawke's Bay was covered in woody vegetation (Fromont and Walls, 1988). Charred wood fragments have been found at locations across the Heretaunga Plains (Grant, 1996), suggesting that the area would once have supported a tall native forest community. On this basis it is assumed that before human settlement the Ruahapia and Raupare Streams would have benefited from a riparian zone with full native forest cover. This assumption has consequently been adopted in the compilation of the reference SEV data.

3.3.2.2 Specific reference score details

With regard to reference macroinvertebrate scores, it is potentially problematic to determine accurately what macroinvertebrate community structure would have been present in reference conditions. On that basis macroinvertebrate data from the Auckland reference site, West Hoe (Albany) has been adopted across all sites.

Reference scores for the variables *Vtrans* and *Vretain* were calculated using the average of six Auckland reference score results.

Given the absence of fish fauna records for reference sites, Index of Biotic Integrity ('IBI') scores of 59 ("excellent") were applied to all reference sites.

Hypothesised reference scores, along with measured test scores, are enclosed in Appendix A of this report.

3.3.2.3 Various desktop techniques

Delineation and measurement of catchment boundaries and the proportion of the catchment above each study reach in impervious cover were calculated using HBRC spatial data and GIS (ArcGIS 9.3).

Fish survey data was input into the IBI calculator to generate IBI scores. Those scores were imported into the SEV calculator.

SEV scores were calculated using Version 8 of the spreadsheet calculator.

⁴ This confirmation has been provided in the letter dated 22nd May 2008 from Stephanie Parkyn (NIWA) to Graham Sevicke-Jones (HBRC).

3.4 Limitations

3.4.1 Reference Scores

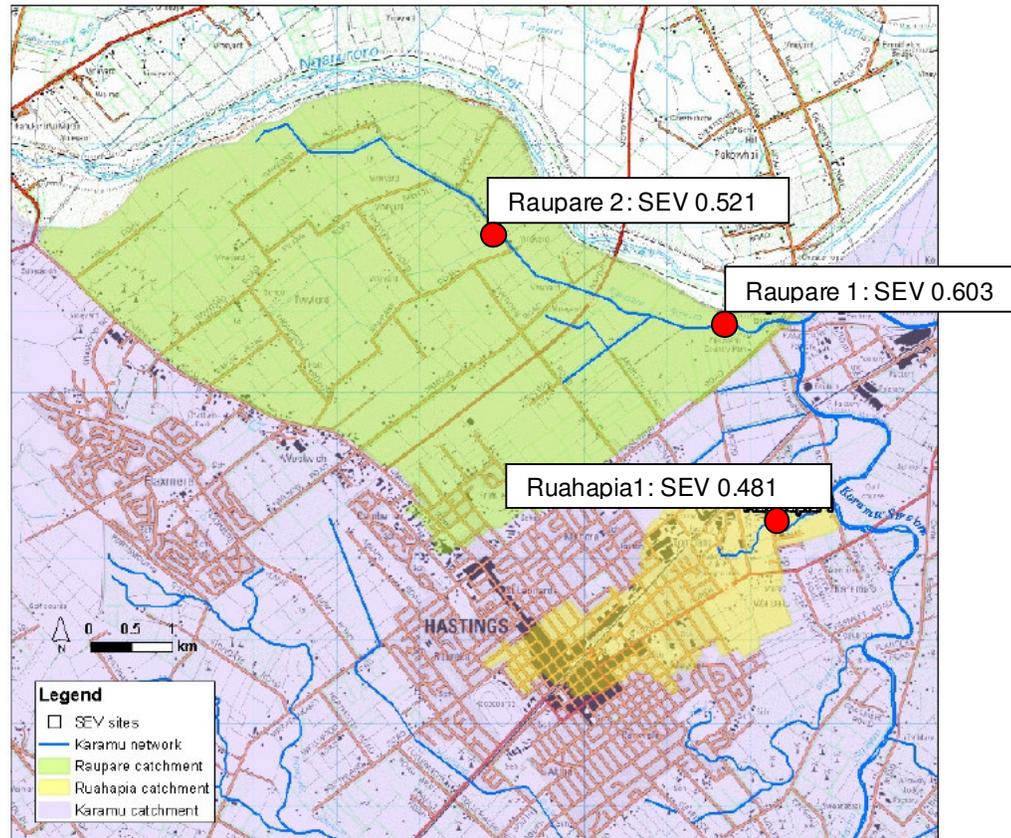
No actual reference site is available on the Heretaunga Plains for the Ruahapia and Raupare Streams SEV study. On that basis previously developed reference data for Auckland and Hawke's Bay, and from the Author's experience and opinion were relied upon to compile representative reference scores.

4 Results

4.1 Overview of SEV Scores

Test scores returned from SEV analysis of the representative reaches of the Raupare and Ruahapia Streams are presented in Figure 4-1 below. Moderate SEV scores were returned from the Ruahapia 1 and Raupare 2 study reaches. A moderate to high score was returned from Raupare 1, at the Pakowhai Country Park.

Figure 4-1 : SEV scores for the Raupare and Ruahapia Stream study reaches



4.2 Macroinvertebrate Communities

Macroinvertebrate community index (MCI) scores all returned low results. It is possible that scores returned from the Raupare Stream may reflect deep water, lack of significant shading and limited stable habitat for macroinvertebrate colonisation. Potential causative factors associated with the extremely low MCI score returned from the Ruahapia Stream are worthy of investigation.

Table 4-1 : Macroinvertebrate index results

Macroinvertebrate Index by Study Reach				MCI Ranked Order	
Reach reference	MCI value	# of EPT	Richness	Reach reference	MCI Value
Ruahapia 1	31.6	0	16	Raupare 2	84.4
Raupare 1	69.2	4	19	Raupare 1	69.2
Raupare 2	84.4	7	18	Ruahapia 1	31.6

4.3 Fish Communities

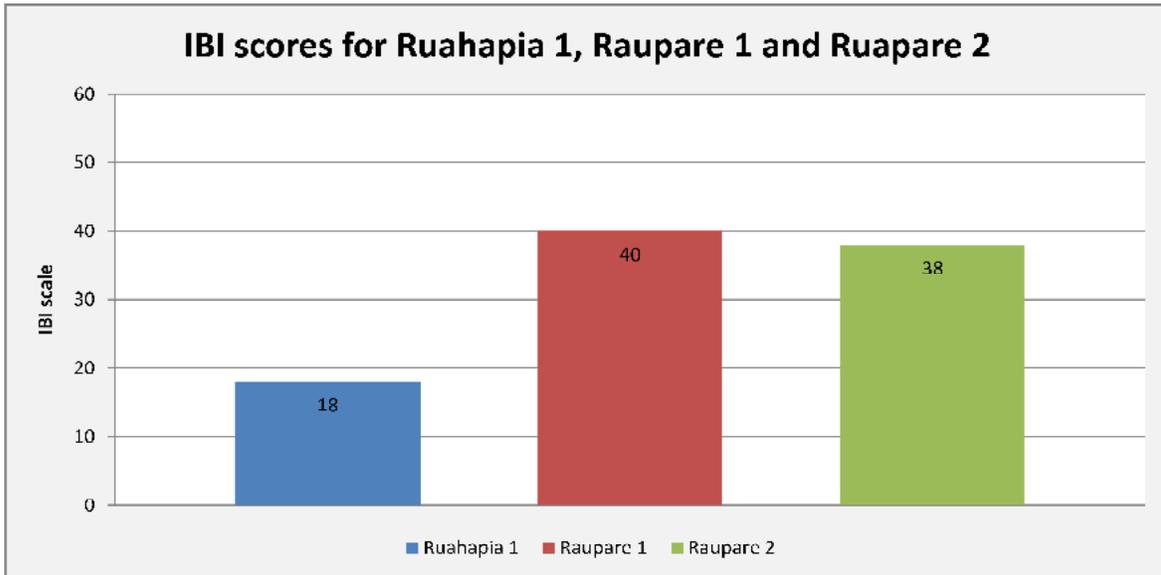
The fish survey results for the Ruahapia and Raupare Streams is presented in Table 4-2 below.

Table 4-2 : Fish survey presence data from Ruahapia and Raupare Streams

Site Code or Name	Ruahapia 1	Raupare 1	Raupare 2
Altitude (metres above sea level)	14.0	12.0	15.0
Distance from Coast (km)	12.4	9.1	12.3

Scientific Name	Common Name	Ruahapia 1	Raupare 1	Raupare 2
<i>Anguilla australis</i>	Shortfin Eel	✓	✓	✓
<i>Anguilla dieffenbachii</i>	Longfin Eel		✓	
<i>Carassius auratus</i>	Goldfish		✓	
<i>Cheimarrichthys fosteri</i>	Torrent Fish		✓	✓
<i>Galaxias maculatus</i>	Inanga		✓	
<i>Gambusia affinis</i>	Mosquito Fish	✓		
<i>Oncorhynchus mykiss</i>	Rainbow Trout			✓

Index of Biotic Integrity scores for the Ruahapia and Raupare Streams are presented in Figure 4-2 below.

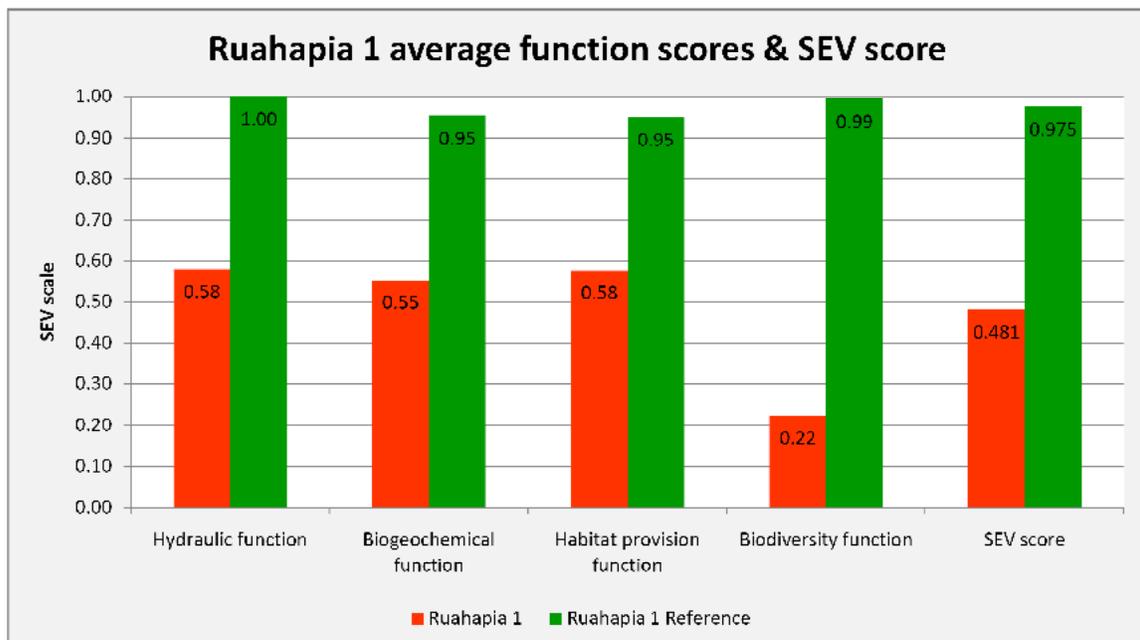
Figure 4-2 : IBI scores for the Raupare and Ruahapia Stream study reaches


4.4 Ruahapia Stream

4.4.1 Ruahapia 1 SEV Function Scores

4.4.1.1 Ruahapia 1 (SEV: Test = 0.481, Reference = 0.975)

The Ruahapia 1 study reach returned moderate hydraulic, biogeochemical and habitat provision scores (0.58, 0.55 and 0.58 respectively). The overall SEV score was reduced by the poor biodiversity variable scores (biodiversity function score of 0.22). In particular the impaired fish and macroinvertebrate community structures, and highly degraded riparian condition contributed to the poor biodiversity function score.

Figure 4-3 : Average function scores and overall SEV score for the Ruahapia 1 study reach


4.5 Raupare Stream

4.5.1 Raupare 1 and Raupare 2 SEV Function Scores

4.5.1.1 Raupare 1 (SEV : Test = 0.603, Reference = 0.956)

The Raupare 1 study reach returned moderate to high scores for hydraulic and biogeochemical function groups (0.67 and 0.65 respectively). Scores returned for habitat provision and biodiversity function groups resulted in moderate and moderate to low scores for those function groups (0.54 and 0.43 respectively).

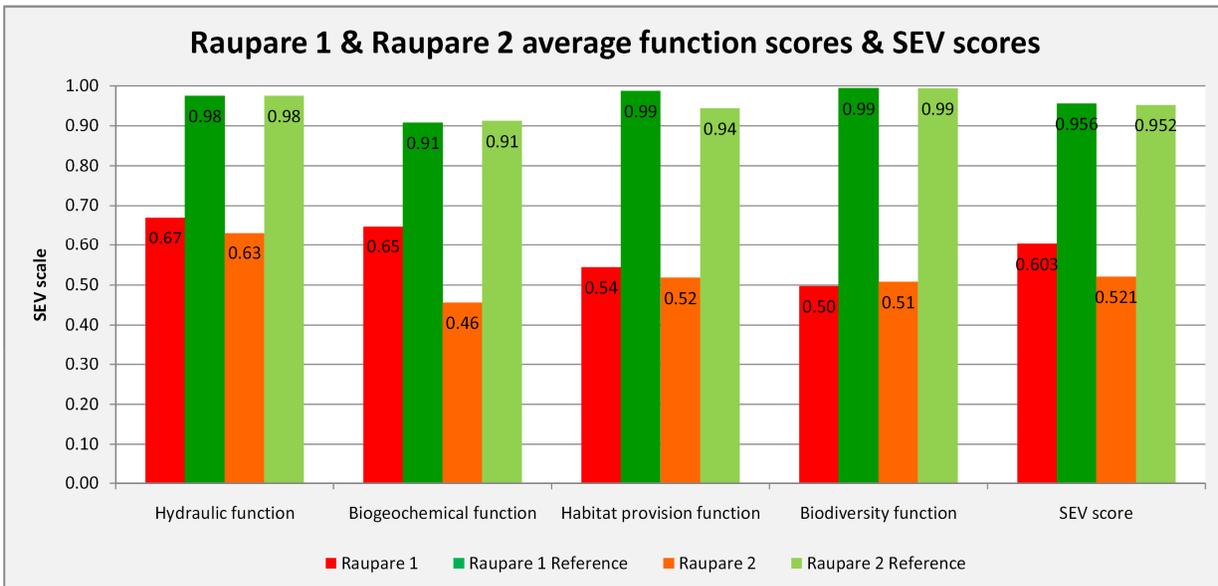
Poor shading of the water column and limited integrity of the riparian zone were the dominant factors restricting the overall SEV score of Raupare 1.

4.5.1.2 Raupare 2 (SEV : Test = 0.521, Reference = 0.952)

The absence of significant areas of impervious surface upstream of the study reach was found to benefit the hydraulic function group score (0.63). The absence of floodplains at the Raupare 2 study reach restricted both the hydraulic and, in particular, the biogeochemical function group score 0.46.

Poor or absent habitat for native fish spawning and poor upstream shading moderated the habitat provision function score (0.52). Despite the excellent EPT variable score (1.0), the highly modified and degraded riparian conditions limited the biodiversity function score (0.51).

Figure 4-4 : Average function scores and overall SEV score for the Raupare 1 and 2 study reaches



5 Discussion

5.1 Interpretation of SEV Baseline Results

5.1.1 Ruahapia Stream

The Ruahapia Stream retains a natural channel bed, although deposition of fine sediment appears to be an issue for the stream. Relative to its size, the stream has good water depths.

The stream features a considerable amount of surface / substrates suitable for hosting biological decontamination processes. It is also considered that some of the substrate present would provide suitable sites for bully spawning.

The upper Ruahapia Stream catchment features a high proportion of impervious cover. The upper catchment is utilised for urban land use, and significant areas of that land use are industrial in nature. This factor presents the potential for changes to the natural hydrograph, and potential impacts to water quality by industrial spills and discharges of contaminated urban stormwater.

The stream features bank slumping, and a highly impacted macroinvertebrate structure. The bank slumping could well be the symptom of pastoral riparian vegetation, colonising sediments and narrowing the stream channel, in combination with increased peak flows from impervious run-off eroding the banks of the narrowing stream during larger flow events. The highly impacted macroinvertebrate community structure is notable and worthy of further investigation. Macroinvertebrates are secondary producers in a stream ecosystem and are therefore an important component in the aquatic food web.

The fish community structure is impacted, with only shortfin eel and mosquito fish being present.

The stream benefits from areas of developed floodplains, although those landforms are often vegetated in grazed pasture or bare earth and therefore present low roughness in times of flood flows.

The riparian zone is highly modified and is currently in pastoral land use. This provides minimal shading or canopy cover of the water column. The shading or canopy cover which is present tends to be provided by deciduous trees. The benefit to stream environments by deciduous riparian cover is limited in comparison to the potential benefits derived from a riparian zone featuring native vegetation.

The Ruahapia 1 study reach returned an SEV score of 0.481. This is a moderate score which suggests good potential for aquatic ecological enhancement. Three obvious key actions for enhancement of the Ruahapia Stream are (1) enhancement of the riparian zone; (2) remediation of the significant fish passage barrier at the confluence of the Ruahapia and Karamu Streams (where the Ruahapia Stream cascades from a perched and overhanging culvert); and (3) investigation into the cause(s) of the severely impaired macroinvertebrate community structure, with a focus on remedying those impacts.

5.1.1.1 Aspects requiring attention in subsequent SEV monitoring of the Ruahapia 1 study reach

From the baseline SEV, in particular the following aspects should be given attention during the interpretation of future SEV assessments:

- Trends in biodiversity functions, in particular macroinvertebrate community structure;
- Trends in substrate particle size composition; and
- Changes in channel and bank morphology.

5.1.2 Lower Raupare Stream

The lower Raupare Stream at the Pakowhai Country Park benefits from good floodplain width relative to the streams wetted width. Although any finer scale bends have been lost through straightening of the streams alignment, at the reach scale the channelised alignment still features some gentle sinuosity. The stream has a natural bed and substrate.

During the leaf analogue test, the stream showed a good ability to retain organic matter (leaf litter). Hard stable substrate is abundant, which provides good potential for facilitation of organic decomposition processes. The hard substrate was also identified as providing suitable habitat for bully spawning.

The upstream catchment features a low proportion of impervious cover; the effect of that on functional processes in the stream at this point is likely to be small. The Raupare Stream benefits from high quality⁵ fish community structure and has good fish passage to the Karamu Stream, and beyond to the sea.

Two factors constraining the SEV score in the lower reaches of the Raupare Stream are poor riparian condition, contributing little to shading of organic matter inputs to the stream ecosystem, and poor riparian landforms suitable for galaxiid spawning.

The protected status of land surrounding the Raupare Stream at the Pakowhai Country Park presents good opportunity for further enhancement of the riparian zone.

Potential threats to the integrity of ecological functioning of the lower Raupare Stream are considered to be presented by stream depletion from water takes and effects from changes of land use in the upper catchment.

5.1.3 Upper Raupare Stream

The Raupare Stream benefits from a minimal area of impervious cover in the upper catchment. What impervious cover is present is generally un-reticulated and is, therefore, poorly connected to the stream which would help mitigate effects to the hydrograph and impacts to stream water quality.

As with the lower reaches, the upper reaches benefit from good fish passage and good water depths. Quantities of stable substrate present are suitable for provision of decontamination process, and potential bully spawning habitat is present.

The upper Raupare Stream features no floodplains, and a straightened alignment. Elevated water velocities and an impaired ability of the stream to retain organic matter inputs depressed the SEV score. As with the other sites of this study, the riparian conditions at the upper Raupare Stream are poor, which impairs a number of biogeochemical, habitat and biodiversity function variables.

The upper Raupare Stream flows within a drainage corridor, from which surrounding land use is setback. This attribute present an opportunity for the enhancement of the riparian zone.

Potential threats to the functional integrity of the upper Raupare Stream are effects by stream flow depletion and discharges of sediment and other contaminant discharges from surrounding land use.

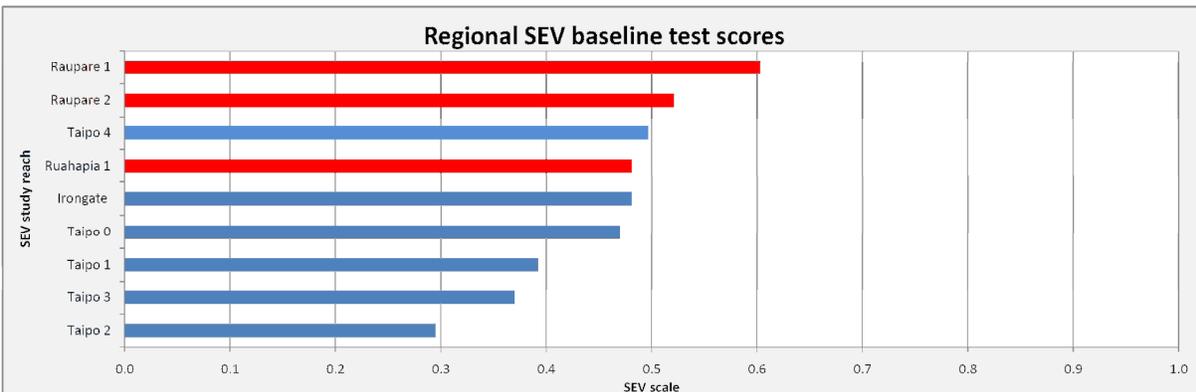
5.2 Comparison of Scores with Other Regional Baseline SEV Test Scores

Baseline SEV test scores returned from assessments of 'natural' streams during the 2008-2009 periods are presented in Table 5-1 below. The results returned from the current study are represented with red bars, while test scores from Taipo Stream (Forbes, 2009) and Irongate Stream (Forbes, 2008) are shown in blue.

The comparison shows that the Ruahapia Stream (Ruahapia 1) and upper Raupare Stream (Raupare 2) are comparable with the highest scoring Napier urban site, Taipo 4. The lower Raupare Stream returned the highest score of all 'natural stream' test sites measured though the Hawke's Bay baseline study to date, being more than one whole SEV unit above the next highest scoring site.

It should be noted that during 2009 the SEV was applied to a number of Napier's' urban waterways, and scores from those assessments ranged from 0.204 (Plantation 2) to 0.497 (OTRB1).

⁵ According to the qualitative assessment criteria specified by the IBI (Joy and Death, 2004)

Figure 5-1 : Regional comparison of baseline SEV test scores


5.3 Utility of the SEV Method in Assessing Ecological Function Loss from Stream Flow Depletion

The utility of the SEV method in identifying changes in ecological function integrity from stream flow depletion has been investigated below. In summary, it was found that a reasonably accurate average velocity value would be required for each given draw-down scenario. Due to the interrelatedness of some variables, the absence of that velocity information compounded across variable scores, resulting in misleading SEV predictions for stream flow depletion scenarios.

5.3.1 SEV Variables Relevant to Water Depth and Flow

For a scenario where stream water depths are reduced, the immediately affected SEV variable types are:

- *Vdepth*: Depth at distances of 0, 25, 50, 75, 100% of channel width at 10 transects represent mean depth
- *Vveloc*: Mean velocity by gauging the flow at one point within the reach, and the cross sectional areas at each of the 10 transects
- *Vdod*: $\text{Mean velocity} / \text{mean depth}^{0.25} (S/Z)^{0.25}$
- *Vwaterqual*: $\text{DOM} \times (\text{Vshade} + \text{extent of upstream shading})/2$

5.3.2 Sensitivity of 'Vdepth' Variable to Reduction in Average Depth

The SEV calculator recognises and allows scoring of five categories of average water depth (see first column of Table 5-1 below). Application of the average depths measured in the Ruahapia and Raupare Streams (during winter flows) to the SEV calculator, and in particular the *Vdepth* variable shows that a reduction in average depth of 0.1 metres would not affect *Vdepth* at Raupare 1 and Raupare 2.

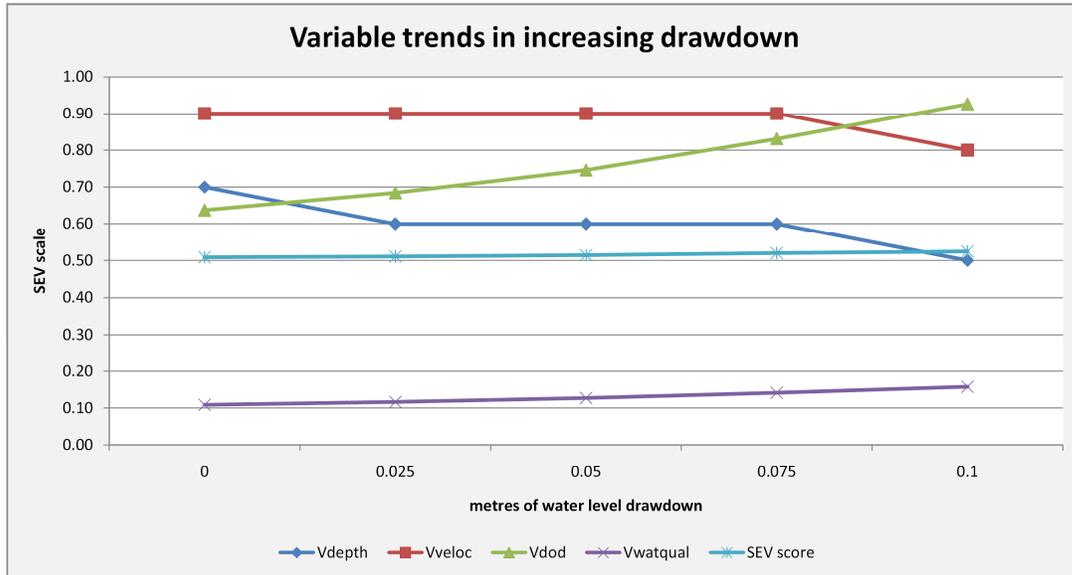
The shallower depth of Ruahapia 1 is within the range of the *Vdepth* thresholds, and a change in *Vdepth* from 0.7 to 0.5 could be expected for a 0.1 metres decrease in average depth.

Table 5-1 : Sensitivity of Vdepth to reduction in average depth in Ruahapia and Raupare Streams

Winter Flow Scenarios					
Ruahapia 1					
Vdepth thresholds	drawdown depth	mean depth	Δ mean depth	Δ Vdepth?	Vdepth
	(m)	(m)	(m)	(Yes/No)	
$\geq 0.41 = 1.0$	0.000	0.118	0	-	0.7
$\geq 0.21 = 0.8$	0.025	0.103	0.015	yes	0.6
$\geq 0.11 = 0.7$	0.050	0.087	0.031	no	0.6
$\geq 0.06 = 0.6$	0.075	0.070	0.048	no	0.6
$< 0.06 = 0.5$	0.100	0.057	0.060	yes	0.5
Raupare 1					
Vdepth thresholds	drawdown depth	mean depth	Δ mean depth	Δ Vdepth?	Vdepth
	(m)	(m)	(m)	(Yes/No)	
$\geq 0.41 = 1.0$	0.000	0.305	0	-	0.8
$\geq 0.21 = 0.8$	0.025	0.290	0.015	no	0.8
$\geq 0.11 = 0.7$	0.050	0.275	0.030	no	0.8
$\geq 0.06 = 0.6$	0.075	0.260	0.045	no	0.8
$< 0.06 = 0.5$	0.100	0.245	0.060	no	0.8
Raupare 2					
Vdepth thresholds	drawdown depth	mean depth	Δ mean depth	Δ Vdepth?	Vdepth
	(m)	(m)	(m)	(Yes/No)	
$\geq 0.41 = 1.0$	0.000	0.574	0	-	1.0
$\geq 0.21 = 0.8$	0.025	0.549	0.025	no	1.0
$\geq 0.11 = 0.7$	0.050	0.524	0.050	no	1.0
$\geq 0.06 = 0.6$	0.075	0.499	0.075	no	1.0
$< 0.06 = 0.5$	0.100	0.474	0.100	no	1.0

5.3.3 Interrelationship of Vdepth with Other Variable Scores

If only mean depth (i.e. Vdepth) is adjusted in the SEV calculator, incorrect results are returned. For example, when mean depth of the Ruahapia 1 study site was reduced by 0.025 metres, 0.05 metres, 0.075 metres and 0.1 metres the following trends in variable and SEV scores resulted (see Figure 5-2).

Figure 5-2 : Trends in SEV variable scores with reducing average water depth (Vdepth)


With the declining Vdepth variable score, Vdod increased. The increase in Vdod consequentially caused an increase in Vwaterqual. The aggregate of these variable changes effect a steady increase in SEV score with increasing stream flow depletion.

For the SEV to provide a prediction of the effects of stream flow depletion on ecological function, the results from a reasonably accurate velocity – depth prediction would be needed by the SEV calculator for each drawdown scenario. If that could be obtained, variables affected by stream flow depletion would be adjusted in a relative manner, and a more reasoned SEV result could be expected.

6 Conclusions

The following conclusions are drawn from the results of the baseline SEV assessments of the Ruahapia and Raupare Streams, and from the investigations for use of the SEV in assessing stream flow depletion effects:

1. A representative SEV monitoring network has been established for the Ruahapia and Raupare Streams. That network consists of one study reach located in the middle-reaches of the Ruahapia Stream and one study reach located on the lower, and one on the upper reach of the Raupare Stream.
2. Test SEV scores from the baseline assessment returned the following results:

Study Reach Reference	Stream	SEV Test Score
Raupare 1	Raupare Stream	0.603
Raupare 2	Raupare Stream	0.521
Ruahapia 1	Ruahapia Stream	0.481

Comparison of the results of the current study with other baseline SEV test scores calculated during 2009 shows that the Ruahapia Stream (Ruahapia 1) and upper Raupare Stream (Raupare 2) are comparable with the highest scoring Napier urban site, Taipo 4. The lower Raupare Stream (Raupare 1) returned the highest score of all test sites measured through the Hawke's Bay baseline study to date, being more than one whole SEV unit above the next highest scoring site.

3. The SEV calculator provides broad categories for assessing changes in average depth. The winter water levels of the Raupare Stream fall within the 'deepest' category, and the Vdepth variable score remained unaffected by up to a 0.1 metre reduction in average depth. The shallower average depth of the Ruahapia Stream is more susceptible to reduction in average depth, and a reduction in Vdepth from 0.7 to 0.5 was observed.
4. For the SEV to provide a prediction of ecological function effects of stream flow depletion, the results from a reasonably accurate velocity – depth prediction would be needed by the SEV calculator for each drawdown scenario. If that could be obtained, SEV variables affected by stream flow depletion would be adjusted in a relative manner, and a more reasoned SEV result could be expected.

7 Recommendations

From the work carried out to date the following recommendations are made:

1. Potential factors responsible for the highly impaired MCI score returned from the Ruahapia Stream should be investigated with the aim of resolving those matters as far as practicable.
2. Options for remediation of the severe fish passage barrier at the point of convergence between the Ruahapia and Karamu Streams should be investigated, with the aim of improving fish passage for the Ruahapia Stream.
3. From the baseline SEV, in particular the following aspects should be given attention during the interpretation of future SEV assessments of the Ruahapia Stream:
 - a. Trends in biodiversity functions, in particular macroinvertebrate community structure;
 - b. Trends in substrate particle size composition; and
 - c. Changes in channel and bank morphology.
4. A more detailed hydrological analysis of depth – velocity relationships for various drawdown scenarios be progressed, with the aim of testing the SEV calculator as a tool for prediction of ecological function loss from stream flow depletion.
5. The SEV programme should be repeated at five year intervals.

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Appendix A: SEV Test and Reference Scores

Appendix B: SEV Field Results

Appendix C: Fish Survey Results