West Coast Regional Council 10-Year River and Coastal Survey Strategy

Executive Summary

This paper proposes that a comprehensive 10-year strategy for conducting bed and crest level surveys, LiDAR surveys, and beach profile surveys be established across the West Coast. The program aims to ensure compliance with regulatory consent conditions, improve infrastructure management, enhance flood prevention efforts, and provide valuable data for long-term planning and informed decision-making with regards to the effects of gravel extraction on the region's rivers and coastlines. West Coast Regional Council have had a 10-year cross section survey strategy in place since 2014. This strategy provided a schedule for surveys of the rating districts where surveys were required. The current 10-year strategy finishes this year (2024) therefore a new strategy will be set in place. There is a desire to supplement the regular program of surveys with cross section surveys, Mean Bed Level (MBL) analysis, LiDAR, and Structure from Motion surveys funded via the use of gravel royalties.

Purpose

To update and enhance the next 10-year strategy for conducting bed and crest level surveys in relevant Special Rating Districts and in areas where significant volumes of gravel extraction is taking place. This strategy aims to monitor the effects of gravel extraction on rivers and coastlines, ensure compliance with consent conditions, manage the required levels of service on the West Coast, and help to ensure that all rating districts meet their outlined levels of service as noted in their Asset Management Plans (AMP).

Importance

These surveys are critical for maintaining infrastructure, preventing flooding, ensuring public safety, meeting regulatory requirements, and reducing the West Coast Regional Council's risk of negligence in managing infrastructure. Additionally, monitoring bed levels in areas of gravel

extraction is essential to ensure the correct amount of gravel is taken and not exceeded, which is why the royalty fee exists. Calculation of individual sediment budgets and analysis of average bed levels around extraction areas is necessary to prevent over-extraction and its associated impacts. Currently, Council engineers can only assess sediment budgets by calculating estimated bedload transport from suspended sediment load using NIWA's NZ Rivermaps website.

Background

Gravel extraction is a key part of managing the flood hazard on the West Coast. Aggradation can increase the flood risk if gravel build-up is not managed due to reduced freeboard to the banks as the riverbed rises, but if too much gravel is removed, this can result in increased erosion and scour and can put assets such as stopbanks, roads and other essential infrastructure at risk. In addition to direct impacts, rivers are an important source of sediment to the coast and sediment supply is a fundamental driver of coastal morphodynamics. Too much sediment (gravel) extracted from rivers may reduce sediment inputs to the coast causing increased erosion. There is currently no programme in place that monitors the effects of gravel extraction on West Coast rivers and coastlines, although two reports prepared for Council have provided advice and guidance on the effects of river gravel extraction on West Coast rivers and beaches. A report by Dr Murray Hicks of NIWA in 2017 (*Assessing the effects of river-gravel extraction on coastal erosion*) detailed methods to assess the geomorphic setting of the river with regards to its sensitivity to gravel extraction, and how to obtain a crude estimate of the mean gravel load passing an extraction site by estimating from empirical models. A subsequent report by Professor Ian Fuller and Alastair Clement of Massey University in 2020 (*Guidance for the geomorphological assessment of the effects of river gravel extraction on West Coast rivers and beaches*), built on the 2017 NIWA report to help inform Council staff on how to robustly collect and analyse data from rivers and beaches so that informed management decisions could be made about rates of gravel extraction. Recommendations from the Massey University report include setting up a new programme of cross section surveys in some rivers and beaches and extending existing surveys in others.

Regular cross-section surveys of rivers and beaches are undertaken by some West Coast Regional Council Rating Districts. Council has an extensive database of surveys completed for Rating Districts but as they are for discrete areas, and as they are not related to gravel extraction areas these surveys are unlikely to provide adequate data to properly analyse the sediment budgets of the Coast's rivers and beaches. These surveys are undertaken to monitor the bed level around scheme infrastructure assets, with a few also including a longitudinal survey of the crest level of stopbanks/coastal revetments.

Previous Surveys

WCRC have had a 10-year cross-section survey strategy in place since 2014. Historically these surveys have been funded 50% by the relevant rating district, and 50% by the General Rate. This strategy provided a schedule for cross section surveys of the rating districts where they are required (not all schemes require cross-section surveys). The current 10-year strategy finishes this year (2024) therefore a new strategy will be put in place. There is a desire to supplement the program of surveys to also include cross-section surveys, MBL analysis, LiDAR, and Structure from Motion photogrammetry (SfM) surveys of rivers where consents have been issued for gravel extraction but for which there is no monitoring of bed levels. This additional work will be funded via the use of gravel royalties.

Out of the 23 West Coast Regional Council rating districts, 16 locations have regular cross-section surveys. Cross-profiles of the riverbed morphology are measured at locations along the length of channels of the Waiho, Waitangitaona, Wanganui, Hokitika, Taramakau, Grey, Buller, and Karamea Rivers, as well as smaller waterways Red Jacks Creek, Nelson Creek, and Vine Creek, plus annual beach profiles at Punakaiki and Hokitika (*refer Appendix B for list of cross-sectional survey data currently held by Council*[1]). The main purpose is to check that riverbed levels have not risen significantly, ensuring that the minimum level of service for the schemes is maintained, or for coastal structures - that beach levels are not dropping significantly; and to monitor the crest height

[1] Please note that some recently completed surveys including LiDAR of the Waiho and Wanganui are not included in this list.

of stopbanks and rock revetments. Recently, LiDAR surveys have also been used to detect geomorphic change in channels of two rivers (Waiho and Wanganui Rivers) supplementing the cross-section surveys. Additional cross-sections from historic schemes are also available for areas such as Poerua River, Whataroa River, Orowaiti River and Kokatahi River. The data has been systematically filed and archived to enhance accessibility and historical reference.

Data related to beach and riverbed surveys undertaken and supplied by non-council consent holders (to meet their conditions of consent) is a valuable resource that will contribute to the objectives of the survey programme. That information will assist with analysis on the effects of gravel extraction.

Survey Proposal

A combination of traditional cross-sectional surveys, SfM photogrammetry, and LiDAR (Light Detection and Ranging) technology could be employed to capture accurate bed and crest level data, assisted by hydraulic modelling where appropriate. Cross-sectional surveys provide precise measurements of river and coastal profiles but are by definition two-dimensional, and large areas of the riverbed and active channel are left unmonitored. The most reliable way of monitoring gravel budgets is arguably via three-dimensional mapping and modelling of the riverbed because this captures the holistic behaviour of the riverbed as it responds to bedload flux. LiDAR technology offers high-resolution three-dimensional topographic data but due to the higher cost of LiDAR, it will not be feasible to employ it in every area, and it will often have to be accompanied by routine channel cross section surveys as conventional LiDAR does not produce reliable bathymetric surveys (unless using calibrated Green Light LiDAR).

It may be feasible to employ the use of drones to provide SfM photogrammetry which could be a more cost-effective way of obtaining three-dimensional maps, but there are disadvantages such as the requirement to mask out vegetation in analysis of aerial photos as SfM photogrammetry produces a digital surface model and the priority is to assess changes to the elevation of the active channel bed, not vegetation. Instead, if the yearly budget allows the programme will aim to have

LiDAR flown in selected areas, SfM used where appropriate, while other areas will rely on cross-sectional surveys done in line with the rotational survey programme. For detailed information on survey methods, hydraulic modelling and technology use please refer to Appendix A.

Programme for Crest and Bed Level Surveys

To ensure monitoring and management of our infrastructure, we will carry out crest and bed level surveys as necessary. Noting that not all WCRC Rating District schemes require bed or crest level survey. An updated programme for the 2025-2035 period is included as Appendix C.

The crest and bed level data will enable the Catchment Management team to monitor changes in riverbed level, and stopbank crest height but will not provide enough data to adequately monitor and report on the condition and performance of assets.

A programme for bed level surveys of rivers and coastlines impacted by gravel extraction will be dependent on extraction pressures. Information regarding where extraction is occurring will be provided to the Catchment Management team by the Policy & Regulatory team, so we will be able to develop a detailed programme. An indicative/draft programme of surveys for the 2024-2030 period is included as Appendix D

Data Analysis

Although useful to know what the change in volume has been from the last survey undertaken, it would be of more use to report on mean bed level (MBL) for the purpose of reporting on the level of service. MBL is a measurement at a particular cross-section location of the average topographic elevation of the 'active channel' which includes the wetted channel and any actively re-worked (non-vegetated) alluvial surfaces. Conceptually this is represented as a horizontal straight line across the channel, positioned so there is as much bed above the line as below it. The volume of bed material stored within the active channel is calculated by the change in MBL at adjacent cross-sections and the distance between those cross sections. Area is calculated by change in MBL

multiplied by the active channel width (ACW). The two areas are added, divided by two, then multiplied by the distance between cross sections. MBL's are used throughout New Zealand to determine trends of aggradation and degradation in rivers. A standardized approach for measuring MBL in the context of gravel extraction for monitoring purposes is available from Environment Canterbury, and Greater Wellington Regional Council have produced an excellent memo for determining appropriate MBL's and gravel volumes for river gravel extraction.

With regards to coastal surveys, cross-shore beach profiles of beach topography are collected to monitor trends in beach behaviour. Volumes of sediment at each beach profile are calculated as the area underneath each profile down to the lowest elevation common to all profiles surveyed. Volumes of beach sediment are expressed as cubic metres of sediment per metre of longshore beach width.

Frequency of Survey

When considering the necessary frequency of survey, it would be worth considering the nature of the individual river system (or beach) when determining the appropriate frequency. This frequency balances the need for up-to-date data, the geomorphology of the area, budget constraints, ensuring the program's financial sustainability.

Standard practice elsewhere in New Zealand is to repeat channel cross sections at 5 yearly intervals. In addition to these regular surveys, it is important to capture changes to channels following significant flood events (suggested 10-year ARI).

The frequency of surveys should consider the nature of the river system. For instance, rivers like the Waiho, which change bed levels rapidly, require regular monitoring (currently annual surveys are undertaken here), while more stable rivers like the Buller may need less frequent surveys.

It has been suggested that all West Coast rivers included in the survey strategy should be scheduled into regular 5-yearly surveys. A standardized approach to cross section surveys on West Coast rivers could be set as a nominal 5 yearly frequency but there will be location-specific factors

influencing individual rivers/beaches and the nature of the river system should be considered when determining the appropriate measurement frequency for each river. Gravel movement only occurs when the flow entrainment thresholds are exceeded. This means that unlike suspended load, it is not moving continuously, and sediment may be stored for indefinite periods of time. Note though that Resource Consent conditions may dictate survey frequency.

A qualified assessment of the local river/beach morphology, sensitivity, and MBL analysis can help inform what an appropriate location-specific survey strategy. In some cases, river cross-sections for rating district schemes have been deferred for several years as there was little obvious change in the river profile, nor any significant flood events. Others have increased survey frequency to monitor aggradation or the passage of sediment waves down-river. Note that to make reasonable inferences about trends in bed levels and gravel extraction impacts, multiple sets of data over many years will be necessary; therefore this strategy needs to be forward thinking, setting in place future benchmarks.

Trends in river MBL's

MBL's in the four main rivers for which cross sections are routinely surveyed, Hokitika, Grey, Buller and Karamea, (excluding Waiho) suggest substantial variability in location and volume of sediment stored in the channel. This variability is to be expected where sediment passes down-river as a series of sediment waves or sheets - this is typical of large-scale bedload transport in gravel-bed rivers. It should be noted that it will take some time before detailed analysis can be completed on any new rivers included in a survey programme, as long periods of surveys are required to make clear inferences. It is recommended that Council seek specialist advice on relevant river sediment budgets, and the provision of regular (triennial) reports on bed level changes and implications thereof.

Additional survey data

As noted above, regular surveys, over long periods of time, and volumes of consented gravel extracted in those periods are required before any clear inference can be made between gravel

extraction and changes in river behaviour. It is difficult to make reasonable inferences about trends in bed level and sediment storage on the basis of a small number of cross sections. If increasing the number of channel cross sections in the reach of either an already surveyed river or setting up new cross sections (permanent monumented transects), then spacing between sections should reflect channel morphology and be scaled to reflect channel size. For example, careful attention needs to be made when assessing the spacing of cross sections as different river forms will have different requirements. The fundamental unit of a wandering or single thread river channel is the pool-riffle unit and spacing between successive pools is approximately 5-7 times channel width. Ideally cross sections should aim to bisect the channel at an equivalent interval capturing information from each key bar-riffle (noting that bar migration will occur, but a dense network of sections will ensure adequate data capture).

Work is also needed to link the gravel extraction returns to specific cross-sections and time periods to better understand the impact of extraction on MBL and change in MBL, and ultimately changes to volume of sediment stored in the channel and what an appropriate maximum gravel extraction rate that aligns with the rivers sediment budget.

With regards to assessing the impacts of gravel extraction on nearby coastlines, the spacing of any new beach profiles must reflect the need to balance financial constraints, survey workload, the type of beach, and the reason for monitoring. Beach profiles should be placed closely at spits and adjacent to river mouths. On the open coast profiles can be up to 1000m spacing. Beach profiles should be measured at least annually and remeasured after significant storm events. West Coast beaches are highly dynamic landforms and graphs of the beach profiles do not necessarily make good outputs for directly informing coastal management. It is recommended that beach profiles be regularly analysed to produce derivative indicators of the health and status of the beach. Possible indicators include: changes in the landward condition of the beach, changes in the elevation of the crest, changes in the volume of sand and gravel stored in the beach, changes in the width of the beach, and determination of the ‘envelope’ within which the beach changes. An alternative method is to use SfM photogrammetry for monitoring of the coastal zone.

Personnel and Resources

A decision needs to be made regarding whether surveying stopbank crests, carrying out cross sections & long sections, and other survey work such as SfM photogrammetry should be done in-house or externally - although certain rivers require a jetboat to safely and accurately determine bathymetric bed level therefore these surveys will not be done in-house (eg, Hokitika, Grey, Buller, and Karamea Rivers).

An estimated 1-2 full time (FTE) staff members would be required to undertake this work in-house, with additional assistance for physical surveys of river and beach cross sections. Aside from fieldwork, this work will include post-processing of the survey data, MBL analysis, GIS analysis, beach health and status analysis, collating and digitising historic data from engineering and consent files, linking of gravel extraction returns to specific cross sections and time periods, and input of cross section surveys from WCRC consent holders. New IT systems and support to provide for post-processing of data are also likely to be required.

The alternative option is to engage external consultants and contractors to carry out this work, either on a term service contract, or on an as-and-when required basis.

Budget and Funding

The budget for this program must first ensure it covers the initial purpose for which the gravel royalty is earmarked. Cross sections, and sediment/bed load analysis should be done for all areas where major gravel extraction is taking place. The funds from gravel royalties must first cover these analyses to ensure compliance with the primary purpose of the royalty. Only after these primary objectives are met can the remaining funds be allocated to the rating districts.

The budget included in the LTP for this program is $206,800 for the 24/25 FY. This will be funded through anticipated gravel royalties paid by contractors extracting gravel from rivers, and supplemented by the General Rate. For illustrative purposes these royalties netted $172k in 2022-

2023 (not including administrative and assessment costs). The sustainability of this funding model will be evaluated over the first 1-2 years of the programme, and if necessary, scope and cost will be adjusted via the Annual Planning process.

Importance of Meeting Consent Conditions

Ensuring compliance with consent conditions is crucial for the management of our rating districts. Several consents mandate that surveys be conducted at specific frequencies to monitor and maintain the health of our waterways and infrastructure. Failure to meet these conditions could result in regulatory penalties and jeopardize the safety and functionality of our flood management systems. Specific conditions in WCRC Resource Consents related to survey are shown in Appendix E. Regular surveys will provide the necessary data to comply with these requirements.

Auditor- General Comments on LTP

The Auditor-General has emphasised the importance of regular and systematic surveys to ensure compliance with consent conditions and effective infrastructure management. To address these comments, the following measures are recommended:

1. Strengthening Financial Management: Implementing a robust financial strategy that includes detailed budgeting for survey activities and exploring alternative funding sources to ensure sustainability.
2. Enhancing Data and Document Management: Investing in new data and document management systems, core financial systems, reporting tools, a fit-for-purpose spatial platform for GIS and aerial imagery, and asset management systems for the management of rating district asset information.
3. Improving Asset Condition Information: Addressing the current gaps in asset condition data through process and technological improvements, ensuring timely maintenance and renewal decisions.
4. Regular Monitoring and Reporting: Establishing a systematic approach to monitor and report on the condition and performance of assets, aligning with the Auditor-General's standards for information quality and accessibility.

The survey programme will assist with Council achieving the recommended measure related to regular monitoring and reporting on Council assets and infrastructure, but survey of bed levels and beach profiles is just one small part of any strategy to monitor and report on asset condition and performance of assets. The information will be used to help inform any future asset management system but must be supplemented by on-the-ground condition assessment of individual assets, and hydraulic modelling to determine a schemes current 'level of service'.

Benefits

1. Regular surveys will provide up-to-date information on bed and beach levels, enabling better maintenance and timely interventions to protect assets and infrastructure.
2. Early detection of changes in bed and crest levels will allow for proactive measures to prevent flooding.
3. Meeting all consent conditions to avoid penalties and ensure legal compliance.
4. Regular monitoring and comprehensive data collection will help reduce the risk of the West Coast Regional Council not meeting its obligations in the management of flood and coastal protection infrastructure.
5. Data-driven decisions on appropriate extraction rates for rivers impacted by gravel extraction.
6. Council will gain greater certainty about how to manage gravel extraction in rivers so that the benefits of using the resource can continue at a rate that ensures adverse effects are managed.
7. Access to accurate and current data will facilitate more informed decision-making by WCRC. Gravel extraction data and survey data received by the Policy & Regulatory team from WCRC consent holders will be provided to the Catchment Management Group to enhance the current survey programme
8. Utilising the latest data to generate new and improved models for predicting and managing waterway behaviours and risks. This will provide a scientific basis for infrastructure development and risk management.

9. In-house survey staff would enable the council to meet existing consent conditions which involve survey, currently fulfilled by externals.
10. In-house survey staff could also be used for capital projects (capturing data for design, culvert invert levels, drain long sections and cross sections, + many other aspects for design), capturing existing asset geospatial data

Issues

1. Limited in-house capacity for cross-section surveys and SfM photogrammetry.
2. Limited in-house staff capacity for Mean Bed Level Analysis and reporting.
3. Larger and deeper rivers will need the use of a boat, which will need to be done by externals.

Climate Change Impact

Climate change is expected to increase the frequency and magnitude of flood events on the West Coast. This will likely result in accelerated catchment erosion and consequential changes in bed levels. Regular monitoring through surveys is essential to adapt to these changes and implement effective flood management strategies.

Recommendations

1. The strategy should be implemented in each annual plan throughout the term of the Long-Term Plan (LTP). This includes:
    - Regular updates and adjustments based on survey findings.
    - Continuous funding through gravel royalties.

2. Seek specialist advice on the linking of gravel extraction returns to specific cross-sections and time periods to better understand the impact of extraction on river MBL, and coastal erosion.
3. Seek specialist advice on relevant river sediment budgets, and the provision of regular (triennial) reports on bed level changes and implications thereof.

4. Seek specialist advice on recommended methodology for site monumented cross sections and undertake assessment of any new sites or extensions of current sites requiring monitoring and management.
5. Survey data and gravel extraction returns received by WCRC consent holders is made available to Catchment Management team.
6. Report on MBL changes for relevant rating district schemes. This includes monitoring trends, hydrological changes, and river alignment changes to determine if the current protection system remains appropriate.
7. Undertake an assessment of the feasibility of enabling survey and associated works to be completed by in-house staff.
8. Include a nominal percentage of the annual gravel royalty return to undertaking LiDAR and hydraulic modelling of West Coast rivers, and provision of specialist advice and triennial reporting.

Appendices

Appendix A: Survey Methods and Technology Use.

LiDAR Surveys

LiDAR technology provides high-resolution topographic data by emitting laser pulses from an aircraft or drone and measuring the time it takes for the pulses to return. This method is highly accurate and efficient for capturing large areas and generates three-dimensional information about the shape of the Earth and its surface characteristics. LiDAR is valued for its precision and ability to penetrate vegetation, making it especially useful in areas where traditional surveying methods are challenging.

Beach Profile Surveys

Beach profile surveys involve measuring the cross-sectional shape of the beach from the dune to the low water mark. This data helps in understanding beach erosion and accretion patterns.

Cross-section survey

A cross section is a method used to measure the shape and characteristics of a river channel at specific points along its course. It involves creating transects, which are straight lines that run perpendicular to the river flow. This type of survey provides detailed information on the depth, width, and profile of the riverbed.

Long section survey

A long section survey is a surveying method used to create a detailed profile along the length of a particular feature, such as a stopbank. This type of survey captures the vertical alignment of the feature relative to a reference point or datum, allowing for the assessment of its slope, gradient, and elevation changes over distance.

Hydraulic modelling

Hydraulic modelling is a computational process used to simulate the movement and behaviour of water within rivers, streams, and coastal systems. It helps to predict how water will flow, how it will interact with surrounding structures, and the potential effects of changes in the landscape, such as sediment transport or erosion. Hydraulic models can be used to assess flood risks, design flood protection systems, and plan for the impact of environmental changes like gravel extraction or climate change.

Appendix B. List of cross-sectional survey data held by Council

(Please note that recent Waiho, Wanganui and Waitangitaona River and Hokitika Beach surveys are not included in the list below)

Summary of WCRC Cross Section Data

(updated 2024)

(note some cross sections listed have been provided from others such as WSP)

Rivers

Buller River	1972	1983	1994	1999	2020	2014	2017	2019	2021		
Orowaiti Buller	1999										
Grey River (Coal Creek)	2007	2009	2011	2016	2019	2021	2023				
Grey River (mouth to bridges)	2000	2007	2009	2011	2016	2019	2021	2023			
Hokitika River at Kowhitirangi	2007	2010	2013								
Hokitika River Kaniere to mouth	1993	2002	2004	2007	2010	2013					
Karamea River	1984	1993	1999	2002	2006	2009	2012	2023			
Kokatahi River	2003										
Nelson Creek	2002	2006	2010	2013	2023						
Poerua River	1983	1985	1987	1992	1997	1999	2000	2001	2003	2005	
Redjacks Creek	1985	1993	2012	2023							
Taramakau River Inchbonnie	1991	2000	2004	2006	2009	2012	2020				
Taramakau River Settlement	1977	1991	2000	2004	2006	2009	2011	2013	2020		
Vine Creek	2007	2010									
Waiho River	1983	1992	1993	1999	2002	2008	2011	2012	2014	2015	2016
Waitangitaona River	1982	1992	1998	2000	2002	2006	2008	2011	2013	2017	
Wanganui River	1982	1992	2000	2003	2007	2009	2012				
Whataroa River	1993	2012									

Beaches

Punakaiki Beach	2008	2009	2010	2011	2012	2013	2014	2015	2016	2018	2019	2020	2021	2022	2023	2024
Hokitika Beach	2000	2002	2003	2004	2005	2006	2009	2011	2013	2020						

Appendix C: Proposed Programme of surveys: RD schemes.

Surveys for 2024-2025 FY			
Survey	Cost (50%)	Frequency	Reason
Buller River	15,000	3 Yearly	
Orowaiti River	0	3 Yearly	
Waitangitaona River	0	3 Yearly	Completed
Hokitika River	10,000	3 Yearly	
Wanganui River	0	2 Yearly	Completed
Matainui	0	2 Yearly	Long sections In-house
Neils Beach	0	Yearly	In-house
Waiho River	10,000	Yearly	
Punakaiki Beach	1,500	Yearly	
Hokitika Beach	10,000	Quarterly	
Vine Creek	0	(as needed)	
Subtotal	46,500		
Contingency for emergency survey work	4,650		
TOTAL	51,150		

Surveys for 2025 -2026 FY			
Survey	Cost	Frequency	Reason
Hokitika River at Kowhitirangi	$ -	3 Yearly	Combine with survey of the lower reach
Whataroa River	$ 4,000	3 Yearly	
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 10,000	Yearly	
Punakaiki Beach	$ 1,600	Yearly	
Hokitika Beach	$ 10,000	Quarterly	
Subtotal	$ 25,600		
Contingency for emergency survey work	$ 2,560		
TOTAL	$ 28,160		

Surveys for 2026 -2027 FY			
Survey	Cost	Frequency	Reason
Grey River (Coal Creek to mouth)	$ 7,500.00	3 Yearly	
Taramakau River Inchbonnie	$ 3,500.00	3 Yearly	
Taramakau River Settlement	$ 5,000.00	3 Yearly	
Wanganui River	$ 12,000.00	2 Yearly	Needs checking
Matainui	$ -	2 Yearly	Long sections In-house
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 10,000.00	Yearly	
Punakaiki Beach	$ 1,700.00	Yearly	
Hokitika Beach	$ 10,500.00	Quarterly	
Subtotal	$ 22,200.00		
Contingency for emergency survey work	$ 2,220.00		
TOTAL	$ 24,420.00		

Surveys for 2027 - 2028 FY			
Survey	Cost	Frequency	Reason
Okuru	$ 4,000.00	5 Yearly	
Buller River	$ 16,000.00	3 Yearly	
Orowaiti River	$ -	3 Yearly	
Waitangitaona River	$ 2,500.00	3 Yearly	
Hokitika River	$ 10,000.00	3 Yearly	
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 11,000.00	Yearly	
Punakaiki Beach	$ 1,750.00	Yearly	
Hokitika Beach	$ 10,500.00	Quarterly	
Subtotal	$ 55,750.00		
Contingency for emergency survey work	$ 5,575.00		
TOTAL	$ 61,325.00		

Surveys for 2028 -2029 FY			
Survey	Cost	Frequency	Reason
Karamea River	$ 3,200.00	5 Yearly	
Nelson Creek	$ 2,000.00	5 Yearly	
Redjacks Creek	$ 2,000.00	5 Yearly	
Whataroa River	$ 4,500.00	3 Yearly	
Wanganui River	$ 13,000.00	2 Yearly	Check and update
Matainui	$ -	2 Yearly	Long sections In-house
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 11,000.00	Yearly	
Punakaiki Beach	$ 1,800.00	Yearly	
Hokitika Beach	$ 10,500.00	Quarterly	
Subtotal	$ 48,000.00		
Contingency for emergency survey work	$ 4,800.00		
TOTAL	$ 52,800.00		

Surveys for 2029 -2030 FY			
Survey	Cost	Frequency	Reason
Grey River (Coal Creek to mouth)	$ 8,000.00	3 Yearly	
Taramakau River Inchbonnie	$ 3,500.00	3 Yearly	
Taramakau River Settlement	$ 5,000.00	3 Yearly	
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 11,000.00	Yearly	
Punakaiki Beach	$ 1,800.00	Yearly	
Hokitika Beach	$ 10,500.00	Quarterly	
Subtotal	$ 31,800.00		
Contingency for emergency survey work	$ 3,180.00		
TOTAL	$ 34,980.00		

Surveys for 2030 -2031 FY			
Survey	Cost	Frequency	Reason
Buller River	$ 17,000.00	3 Yearly	
Orowaiti River	$ -	3 Yearly	Combined with the Buller River
Waitangitaona River	$ 2,750.00	3 Yearly	
Hokitika River	$ 11,000.00	3 Yearly	
Wanganui River	$ 14,000.00	2 Yearly	Check and update
Matainui	$ -	2 Yearly	Long sections In-house
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 12,000.00	Yearly	
Punakaiki Beach	$ 1,850.00	Yearly	
Hokitika Beach	$ 11,000.00	Quarterly	
Subtotal	$ 69,600.00		
Contingency for emergency survey work	$ 6,960.00		
TOTAL	$ 76,560.00		

Surveys for 2031 -2032 FY			
Survey	Cost	Frequency	Reason
Whataroa River	$ 5,000.00	3 Yearly	
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 12,000.00	Yearly	
Punakaiki Beach	$ 1,900.00	Yearly	
Hokitika Beach	$ 11,000.00	Quarterly	
Subtotal	$ 29,900.00		
Contingency for emergency survey work	$ 2,990.00		
TOTAL	$ 32,890.00		

Surveys for 2032 -2033 FY			
Survey	Cost	Frequency	Reason
Okuru	$ 4,500.00	5 Yearly	
Grey River (Coal Creek to mouth)	$ 8,000.00	3 Yearly	
Taramakau River Inchbonnie	$ 3,750.00	3 Yearly	
Taramakau River Settlement	$ 5,500.00	3 Yearly	
Wanganui River	$ 14,000.00	2 Yearly	Check and update
Matainui	$ -	2 Yearly	Long sections In-house
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 12,000.00	Yearly	
Punakaiki Beach	$ 1,950.00	Yearly	
Hokitika Beach	$ 11,000.00	Quarterly	
Subtotal	$ 60,700.00		
Contingency for emergency survey work	$ 6,070.00		
TOTAL	$ 66,770.00		

Surveys for 2033 -2034 FY			
Survey	Cost	Frequency	Reason
Karamea River	$ 3,500.00	5 Yearly	
Nelson Creek	$ 2,500.00	5 Yearly	
Redjacks Creek	$ 2,500.00	5 Yearly	
Buller River	$ 18,000.00	3 Yearly	
Orowaiti River	$ -	3 Yearly	Combined with Buller River
Waitangitaona River	$ 2,750.00	3 Yearly	
Hokitika River	$ 12,000.00	3 Yearly	
Neils Beach	$ -	Yearly	In-house
Waiho River	$ 12,000.00	Yearly	
Punakaiki Beach	$ 2,000.00	Yearly	
Hokitika Beach	$ 11,000.00	Quarterly	
Subtotal	$ 57,750.00		
Contingency for emergency survey work	$ 5,775.00		
TOTAL	$ 63,525.00		

Appendix D. Indicative 5-6 year programme of surveys: gravel extraction

Surveys for 2024-2025 FY			
Survey	Cost	Frequency	Reason
Taramakau River (lower)	$25,000	5 Yearly	Monitoring of gravel extraction pressure
Mokihinui River	$13,000	3 Yearly	Monitoring of gravel extraction impacts
Extend Hokitika River xsecs	$25,000	3 Yearly	Monitoring of sediment to track changes in gravel budget
Cobden Beach profiles (set-up)	$6,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$135,500		
Contingency for emergency survey work	$13,550		
TOTAL	$149,050		

Surveys for 2025 -2026 FY			
Survey	Cost	Frequency	Reason
Extend Grey River survey upstream	$25,000	3 Yearly	Monitoring of gravel extraction pressure
Inangahua River	$40,000	3 Yearly	Monitoring of sediment to assess gravel budget
Cobden Beach profiles	$5,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$136,500		
Contingency for emergency survey work	$13,650		
TOTAL	$150,150		

Surveys for 2026 -2027 FY			
Survey	Cost	Frequency	Reason
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Cobden Beach profiles	$5,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$71,500		
Contingency for emergency survey work	$7,150		
TOTAL	$78,650		

Surveys for 2027 - 2028 FY			
Survey	Cost	Frequency	Reason
Extend Hokitika River xsecs	$30,000	3 Yearly	Monitoring of sediment to track changes in gravel budget
Mokihinui River	$13,000	3 Yearly	Monitoring of gravel extraction impacts
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
Cobden Beach profiles	$5,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$114,500		
Contingency for emergency survey work	$11,450		
TOTAL	125,950		

Surveys for 2028 -2029 FY			
Survey	Cost	Frequency	Reason
Extend Grey River survey upstream	$25,000	3 Yearly	Monitoring of gravel extraction pressure
Inangahua River	$40,000	3 Yearly	Monitoring of sediment to assess gravel budget
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
Cobden Beach profiles	$5,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$136,500		
Contingency for emergency survey work	$13,650		
TOTAL	$150,150		

Surveys for 2029 -2030 FY			
Survey	Cost	Frequency	Reason
Taramakau River (lower)	$33,000	5 Yearly	Monitoring of gravel extraction pressure
North Beach Westport	$7,500	Yearly	Monitoring of coastline. Related to gravel extraction in the Buller River
Mokihinui Beach	$9,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Mokihinui River
Cobden Beach profiles	$5,000	Yearly	Monitoring of coastline. Related to gravel extraction in the Grey River
LiDAR/Hydraulic Modelling/Reporting	$50,000	Yearly	Nominal sum
Subtotal	$104,500		
Contingency for emergency survey work	$10,450		
TOTAL	$114,950		
Costs for this 5 year strategy have not been inflation adjusted			

Appendix E: West Coast Regional Council held resource consents requiring survey data.

RC01243-V1 Lower Waiho Gravel Extraction

Provide accurate records of gravel volumes taken, based on loose measure, at 6-monthly intervals to the consent authority.

RC 06134 Punakaiki

Conduct annual photographic monitoring and beach profile surveys, recording locations using GPS equipment.

RC 13131 Hokitika

Annual cross section surveys, photographic monitoring, and 6-monthly inspections.

RC12015 Whataroa River

Perform surveying and maintenance of rock groynes, avoid sediment losses, and ensure no exacerbation of erosion or flood risks.

RC-2021-0158 Waiho River

Conduct surveying and maintenance for river protection works, avoid sediment losses, and restore site post-works.

RC-2023-0030 Waiho River

Perform river diversion works, consult with river engineers, and ensure no erosion or sedimentation impacts.

RC12030 Karamea River

Construct relocated sections of stopbanks, ensure sediment losses are minimized, and avoid exacerbating erosion.

RC12158 Kongahu Swamp

Construct stopbanks, establish transects for monitoring wetland impacts, and ensure no adverse effects on vegetation and ecology.

RCN98225 Taramakau River

Construct and maintain rock spurs, use existing access routes, and minimize damage to riverbank vegetation.

RCN98269 Raft Creek

Clean out and maintain existing drains and creeks, use existing access routes, and minimize damage to creek bank vegetation.