

Geotechnical structures inspection policy

NZTA S7

22 November 2022

1. Introduction

This policy document sets out the requirements for the inspection of geotechnical structures, which includes reinforced slopes, on the state highway network. For specific maintenance requirements refer to the design documentation and/or maintenance management plan for each specific structure.

Note that the requirements for the inspection of bridges and other significant highway structures is covered in *Waka Kotahi S6 Bridges and other significant highway structures inspection policy* and for tunnels in *Waka Kotahi S8 Tunnels management and inspection policy*.

2. Terms and definitions

The follow terms and definitions apply to this policy.

Asset Owner	The controlling authority of the geotechnical structure, Waka Kotahi (NZ Transport Agency)
Asset Owner Representative (AOR)	Waka Kotahi (NZ Transport Agency's) Project Manager or their representative.
'Close-Quarter' Inspection	A physical inspection from a distance close enough to determine the condition of the element. This is typically within 3m of the element.
Condition	A characteristic, or set of characteristics, that can be used to understand the state of deterioration of the structure.
Consequence of Failure	An assessment of the resulting impact to road users and the public following a failure of a structure.
Defect	A feature observed within a geotechnical structure that reduces the performance or condition of the structure.
Detailed Condition Rating	A physical close contact assessment of the condition of each element of a structure
Emergency Inspection	An inspection undertaken in response to a natural event (e.g. seismic, significant rainfall, fire), or another short-term requirement.
Geohazard	An object, feature or activity related to the natural or engineered ground (including geotechnical structures) that has the potential to have adverse effects or undesirable consequences.
Geotechnical Advisor	A suitably qualified engineering geologist or geotechnical engineer with experience defined in Section 5.1.
Geotechnical Inspector	A suitably qualified technical inspector with experience defined in Section 5.1.
Geotechnical Structure	An engineered slope above or below the highway that includes geotechnical structures as defined in Section 3.

Geotechnical Asset Database	A spatially recorded dataset that recorded the inspection and maintenance requirements of geotechnical structures, as well as inspection reports.
Geotechnical Management Consultant (GMC)	A consulting firm responsible for the operational management activities associated with the geotechnical structures.
Hazard	An object, feature or activity that has the potential to have adverse effects and undesirable consequences.
Hazard Rating	An outcome of the visual/detailed condition rating and the consequence of failure to provide an indication of the hazard exposure to road users.
Inspection (Routine)	Surveillance examination of a geotechnical structure to record the inventory and overall condition of the structure.
Inspection (Visual)	Visual examination of a geotechnical structure to record the representative characteristics of the structure, both in terms of inventory of components and their condition.
Inspection (Detailed)	Physical examination of a geotechnical structure to record the characteristics of the structure, both in terms of inventory of components and their condition.
Inspection Rating	A visual indication of the condition of each element of a structure.
Lead Geotechnical Engineer	A suitably qualified engineering geologist or geotechnical engineer with experience defined in Section 5.1.
Monitoring	The recording of quantitative information to document the changes in characteristics.
Network Criticality	The attributes of the road network at a given location and time that relate to its importance.
Network Outcome Contract (NOC)	The Waka Kotahi contract to manage the operation and maintenance of the roading networks within each region.
Observation	Characteristic (or group of characteristics) located on a geotechnical structure.
Significant Event	A natural event, such as seismic, weather, or volcanic, that is beyond the expected conditions. Thresholds for a significant event will be specific to each section of roading network.
Visual Condition Rating	A visual assessment of the condition of each element of a structure.
Triggers	A factor or event that causes a hazard to be realised.

3. Definition of geotechnical structures

“Geotechnical structures” shall include structures within the state highway corridor meeting any of the following criteria:

- **Slope Drainage System** - specialist drainage required to maintain structure stability, earthworks, and slope stability, typified by drainage blankets; counterfort, horizontal and cut-off drains; but excluding pavement sub-soil drains, side drains and culverts
- **Reinforced Slope Stabilisation** - including soil nail slopes, MSE slopes (less than 70° above horizontal), with or without facing systems, and other ground improvement and strengthening treatments that require maintenance to remain functional.

- **Retaining Structure** – retaining walls less than 1.5m in height within 1.5m of the edge line or other running surface edge that may impact the carriageway in the event of failure.
- **Rockfall and Slope Debris Control Structure** - due to the variety of control structures, these are defined as any structure intended to prevent material from reaching the carriageway through either passive protection (the capture and attenuation of material) or active support (stabilisation of source area). These structures are often termed, rockfall protection systems or rockfall protection structures (RPS).

Bridges and other significant structures are covered by the *Waka Kotahi (NZTA) Bridges and other significant highway structures inspection policy*, NZTA S6:2022⁽¹⁾ and hence are not included under this policy.

An asset owner's database for geotechnical structures shall be maintained by the Geotechnical Advisor. Changes to the database shall be agreed with the Waka Kotahi NZ Transport Agency Lead Technical Advisor - Geotechnical.

4. Standard of geotechnical structure inspections

The standard to which inspections shall be carried out is defined in the publication *Inspection manual for highway structures*⁽²⁾. This manual shall be adopted for highway structure inspections except as modified by this policy. Where there is conflict between the manual and policy, this policy shall take precedence. All references in the manual to "Supervising Engineer" and "Inspector" shall be read as "Geotechnical Advisor" and "Geotechnical Inspector" respectively.

5. Roles and responsibilities for geotechnical structure inspections

5.1 Roles

For each structures management contract, the service provider shall appoint a Geotechnical Management Consultant (GMC) who is then responsible for the related operational management activities and liaison with the AOR.

The GMC shall provide the following roles to complete the relevant geotechnical structure inspections outlined in this Section.

Geotechnical Advisor (GA) must have experience in the construction, inspection and maintenance of geotechnical structures and must be able to interpret their condition. As a minimum the GA must be a chartered member (CPEng or PEng Geol) geotechnical engineering or engineering geologist with at least 10 years of relevant experience in ground engineering and infrastructure works and shall be approved by the Waka Kotahi NZ Transport Agency Lead Technical Advisor - Geotechnical.

Lead Geotechnical Engineer (LGE), an engineering geologist or geotechnical engineering appointed by the GA who is responsible for inspections and must have at least five years' experience in the design of geotechnical structures and must be able to interpret observations in terms of structural action.

Geotechnical Inspector (GI) must be competent to identify and report on defects and faults that occur. They must be a professional engineer or a person who, from extensive practical experience, is competent to judge the condition of structures. The Geotechnical Inspector must have at least five years of experience in the maintenance of geotechnical structures along infrastructure networks.

Roped Access Contractor (RAC), competent personnel with appropriate IRATA qualification, with experience relevant to the installation of geotechnical structures and/or slope works. They must have at least five years of experience in the maintenance of geotechnical structures along infrastructure networks.

In the case of routine inspections, these shall be carried out by the network maintenance contractor by staff who are competent to identify and report on superficial faults and defects.

All personnel undertaking inspections shall have received approved training in the methods of inspection, recognition of geotechnical characteristics, assessment of observations and rating of geotechnical structure

elements, unless agreed otherwise by the Waka Kotahi NZ Transport Agency's Lead Technical Advisor - Geotechnical.

5.2 Responsibilities

An individual, within the GMC, must be designated the 'Geotechnical Advisor' for any geotechnical structure inspections.

The Geotechnical Advisor shall:

- a. maintain overall management and technical supervision of the geotechnical structure inspection and maintenance programme for those structures scheduled by the AOR
- b. take responsibility for the technical competence of all personnel involved in all non-routine inspections
- c. take responsibility for the stability of all geotechnical structures advised by the AOR
- d. take responsibility for consulting with specialist staff when necessary
- e. ensure that the schedule of structures and the inspection requirements are appropriate and comply with this policy
- f. appoint a Lead Geotechnical Engineer to review all inspection reports
- g. approve all inspection reports
- h. undertake an on-site review and reconciliation of at least three visual inspection reports and at least three detailed inspection reports representative of the inspections being carried out by each Geotechnical Inspector in that year (but no less than a total of 2% of all structures in the annual inspection programme) for each inspector annually unless agreed otherwise with the Waka Kotahi NZ Transport Agency's Lead Technical Advisor - Geotechnical. A summary of the results of all reviews shall be submitted to the AOR.

The Geotechnical Advisor may delegate to the following roles to complete inspections:

- i. Geotechnical Inspector
- ii. Lead Geotechnical Engineer
- iii. Other specialist staff

In any situation where identification of faults in the particular material or geotechnical structure is considered by the Geotechnical Advisor to be outside the competence of the normal inspection staff, outlined in Section 5.1, a specialist must be engaged to advise them. Specialist staff must be used for the following situations, but shall not be limited to them:

- geotechnical structures showing significant breakdown of protective coatings, and/or significant corrosion of elements.
- geotechnical structures showing significant decay of timber elements
- geotechnical structures and/or supporting foundations showing alkali/aggregate reaction, chloride attack, significant spalling of concrete, corrosion of concrete reinforcement steel, or other significant concrete defects
- geotechnical structures which incorporate uncommon materials, such as fibre composite materials

geotechnical structures requiring roped or other specialist access, see the Roped Access Contractors (RAC) role description in Section 5.1.

6. Categories and frequencies of inspections

The various categories of inspection and the frequency with which they are to be undertaken for geotechnical structures are listed in Table 1 and described below. Where specific personnel are referred to, they shall be as defined in Section 5.

Table 1: Geotechnical structure inspection requirements

Category of inspection	Minimum frequency of inspection	Personnel involved (minimum requirements)	Reporting
Routine Inspection	3 monthly or following significant event (seismic, rainfall, wind, vehicle incident)	Network Maintenance Contractor (NOC)	Geotechnical Routine Inspection report (see Appendix A for example Pro Forma)
Visual inspection			
Slope drainage, retaining structures, MSE, earthworks and slopes	3 years*	Geotechnical Inspector	Geotechnical Inspection report (see Appendix A for example Pro Forma)
Slope stabilisation, ground improvement and strengthening, rockfall and slope debris control structures	2 years*	Geotechnical Inspector	Geotechnical inspection report (see Appendix A for example Pro Forma)
Detailed inspection			
Slope drainage, retaining structures, MSE, earthworks and slopes; rockfall and slope debris control structures; slope stabilisation, ground improvement and strengthening	6 years*	Geotechnical Inspector or Lead Geotechnical Engineer	Geotechnical Detailed Inspection report (see Appendix A for example Pro Forma) and engineering report as necessary
Special inspections:			
Acceptance inspection	Changeover of responsibility	Lead Geotechnical Engineer	As required
Earthquake event inspection	Immediately following an earthquake likely to have caused damage	Geotechnical Inspector	As agreed with Lead Technical Advisor - Geotechnical
Flood event inspection	Immediately following a flood event likely to have caused damage	Geotechnical Inspector	As agreed with Lead Technical Advisor - Geotechnical
Fire or chemical spillage, or vehicle impact inspection	Immediately following the event	Geotechnical Inspector	As agreed with Lead Technical Advisor - Geotechnical

* Period may vary as detailed in the geotechnical structure list provided by AOR

For the purposes of scheduling inspections, a visual inspection shall substitute for NOC routine inspection and a detailed inspection shall substitute for a visual inspection, such that, multiple inspections are not required each year as long as the most comprehensive inspection is completed out of those required.

6.1 Inspection frequencies

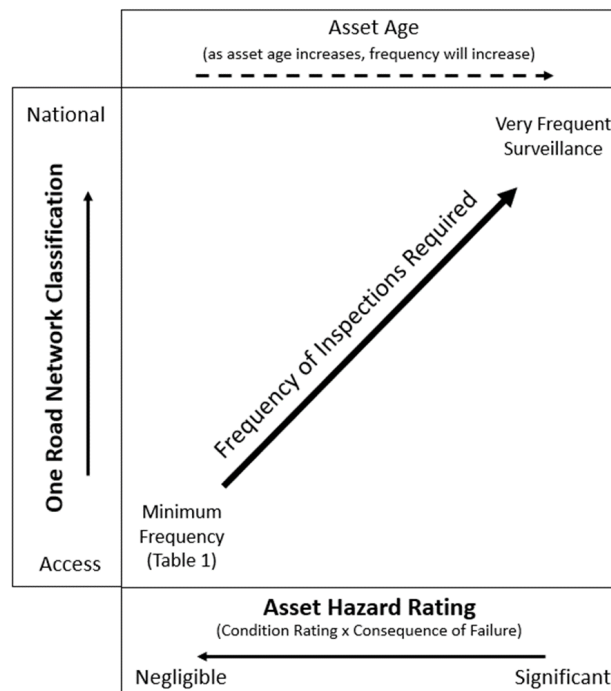
Suitable guidance for determining which structures require increased or reduced inspection frequencies can be obtained from Chapter 4 of *CS 450 Inspection of highway structures*⁽³⁾.

The specific inspection frequency for each structure shall be assessed by the Geotechnical Advisor and agreed with the Waka Kotahi Lead Technical Advisor - Geotechnical and recorded within the Geotechnical Asset Database. The minimum frequency for inspection is defined in Table 1 above. Where a Structure Specific Maintenance Plan (SSMP) has been developed during design and construction of a geotechnical structure, the recommended inspection frequencies therein shall be taken into account.

An increase in inspection frequency can be guided by Figure 1 below and where structures display any of the following attributes:

- located in a very high / severe corrosion (marine) environment
- at moderate/high risk of scour/undermining
- at moderate/high risk of inundation during flooding (storm/weather events)
- condition is poor or unknown
- rockfall protection structure in a highly active location where damage or frequent maintenance is likely
- signs of foundation or structural deterioration (e.g. concrete alkali aggregate reaction, chloride attack)
- failure of the geotechnical structure would affect the highway, risk to road users, and/or adjacent infrastructure (e.g. railway, third party property, etc.)
- structures with fire hazards or a history or evidence of fire damage.

As outlined in Figure 1 below, the frequency of inspections will be determined by the network importance identified by the One Road Network Classification, and the hazard ratings relating to condition assessments and consequences to the road.



6.2 Routine inspection (NOC/network maintenance contractor)

Routine inspections shall be carried out in accordance with the relevant requirements of the *Inspection manual for highway structures*⁽²⁾ and *State highway maintenance contract proforma manual* (SM032)⁽⁴⁾. These routine surveillance inspections are intended to be completed regularly by the network maintenance contractors (NOC) to identify any obvious defect which may affect the safety of highway users or anything else needing urgent attention, such as those items listed below:

- impact from debris or seismic / weather events, especially to structural elements. For Rockfall and Debris Control Structures the Early Response Inspection Cards (attached in Appendix B), will assist in the identification of defects in these structures
- build-up of debris
- erosion damage
- drainage function, i.e. ponding, overflow and scouring
- water seepage from the hillside
- movement or cracking of foundations, rockfall barriers, and retaining walls
- structures involved in a major accident, vehicle impact, chemical spillage or fire.

Each item must be given an Inspection Rating based on the observed condition of each inspected item. The Inspection Ratings are included on the Pro Forma in Appendix A and summarised in Table 2 below.

Table 2: Inspection Rating

Inspection Rating	Description
0	Not Inspected / Observed
1	Satisfactory / Good Condition
2	Monitor next inspection
3	Needs Further Inspection by GMC (Visual or Detailed)
4	Need Maintenance
5	Emergency Works Required
N/A	Not Applicable

An Inspection Rating of 3 or higher, must be reported immediately to the Geotechnical Advisor.

6.3 Visual inspection

The procedures required are described in *Inspection manual for highway structures*⁽²⁾. During a visual inspection, personnel shall verify that the descriptive data recorded for each geotechnical element in the asset owner's database is correct or note any necessary changes.

This type of inspection may also include aerial imagery captured using a UAV/drone supervised on site by a Geotechnical Inspector with the subsequent imagery reviewed by the Lead Geotechnical Engineer.

For Visual Inspections, each item must be given a *Visual Condition Rating* based on the observed condition of each inspected item, and an indication of *Consequence of Failure* of the specific item. The Visual Condition Ratings and Consequence of Failure categories are included on the example Pro Forma in Appendix A and summarised in Tables 3 and 4 below.

Table 3: Visual Condition Rating

Visual Condition Rating	Description
N/A	Not Applicable
0	Not Inspected / Observed
A	Good Condition
B	Acceptable Condition
C	Poor Condition, Requires Detailed Inspection
D	Very Poor Condition, Requires Maintenance
E	Emergency Works Required

Table 4: Consequence of Failure

Consequence of Failure Rating	Description
N/A	Not Applicable
Minor	No direct impact to risk to road users
Moderate	Increased risk to road users
Major	Impact to road outside of live lanes, with increased risk to road users
Critical	Directly impacts live lane – Life Safety considerations

These two assessment criteria combine within the below matrix (Table 5) to provide a hazard rating for each inspection element, indicating its urgency and prioritisation for action (maintenance, repair, replacement).

Table 5: Hazard Rating Matrix

Consequence of Failure	Visual Condition Rating					
	0	A	B	C	D	E
Minor	Low	Negligible	Low	Low	Medium	High
Moderate	Medium	Negligible	Low	Medium	Medium	High
Major	High	Low	Low	Medium	High	Significant
Critical	High	Low	Medium	High	Significant	Significant

A Hazard Rating of High or Significant, requires immediate notification to the Geotechnical Advisor and Waka Kotahi Asset Owner Representative.

6.4 Detailed inspection

The purpose of a detailed inspection is to provide specific information on the physical condition of all inspectable parts of a structure. It is more comprehensive than a visual inspection. The detailed inspection requires a review of the previous Routine and Visual Inspections as well as any associated design documentation, and/or any available maintenance management plans (eg SSMPs). Any resulting amendments to structure specific maintenance plans (SSMPs) should be reviewed and approved by the Lead Geotechnical Engineer or Geotechnical Advisor.

The procedures described in *Inspection manual for highway structures*⁽²⁾ shall be followed. The inspection shall be carried out at 'close quarters' of all inspectable parts of the geotechnical structure and include

adjacent earthworks and waterways where they may affect the behaviour or stability of the geotechnical structure.

Where it is not possible to inspect all elements at close quarters, a representative portion of all elements, as determined appropriate by the Geotechnical Advisor, shall be inspected at close quarters and the condition of the remaining elements shall be visually compared (using UAV/drone, binoculars, or other optical equipment) to confirm condition is similar to those elements inspected at close quarters. Elements not inspected within close quarters must be inspected at close quarters during a subsequent detailed inspection.

The Condition Rating, Consequence of Failure and Hazard Rating in the attached example Pro Forma in Appendix A and outlined in Tables 3 to 5 shall be updated during the detailed inspection and recorded.

Where specific access requirements or features requiring specific or unusual inspection or specialist staff are identified, they shall be recorded as a 'detailed inspection – special access' in the asset owner's database. Such structures are likely to have one or more of the following features or conditions (noting that this list is not exhaustive):

- elevated work platforms or specialised industrial rope access are required to achieve close-quarter inspection
- confined space entry is required to enter structures such as box girders and culverts
- the structure crosses or is adjacent to a third party's property or asset that makes access to the structure difficult (e.g. structures over railway lines or shared corridor)
- boat access is required to inspect elements in close quarters
- there are components requiring specialist inspection.

The Geotechnical Advisor on agreement from the AOR may use alternative means of access for areas of difficult or dangerous access, e.g. obscured parts of a geotechnical structure, high-risk sites and/or confined spaces. See Section 8 for more details.

6.5 Special inspection

The procedures required are described in *Inspection manual for highway structures*⁽²⁾. Special inspections involve particular types of geotechnical structures or particular circumstances (i.e. post-event). The Geotechnical Advisor shall identify geotechnical structures requiring special inspections, document them in the asset owner's database and maintain a schedule of structures requiring regular special inspections, which define the specific inspection requirements, the inspection frequency and access requirements.

6.5.1 Acceptance Inspection

The purpose of these inspections is to provide a formal mechanism for recording and agreeing the current status, or outstanding work required, to a geotechnical structure prior to changeover of responsibility. Typical examples include but are not limited to; pre-opening, the end of a defect liabilities period, transfer and handover inspections.

It is good practice to programme these inspections one month prior to changeover of responsibility and whenever possible the opportunity to make use of existing access arrangements shall be utilised.

The criteria and the extent of the inspection shall be as agreed between the Geotechnical Advisor and the Asset Owner Representative (AOR) in conjunction with Waka Kotahi NZ Transport Agency Lead Technical Advisor - Geotechnical

The inspection shall be carried out by a Lead Geotechnical Engineer and/or such other specialist staff as the Geotechnical Advisor may direct.

6.5.2 Earthquake Event Inspection

This shall be carried out following an earthquake which is likely to have caused damage to geotechnical structures in the affected area. The inspection shall be carried out as for a visual inspection, on those elements susceptible to earthquake damage.

The criteria and the extent of the inspection shall be agreed between the Geotechnical Advisor and the Asset Owner Representative (AOR).

The inspection shall be carried out by a Geotechnical Inspector and/or such other specialist staff as the Geotechnical Advisor may direct.

The use of drones and other aerial devices may be used subject to prior agreement with the Waka Kotahi NZ Transport Agency's Lead Technical Advisor - Geotechnical.

6.5.3 Post-Significant Rainfall or Flood Event Inspection

This shall be carried out following a significant rainfall or flooding event which is likely to have caused damage to geotechnical structures at sites known to have a history of instability or are likely to have been at significant risk from high-intensity or high-duration rainfall. The criteria and the extent of the inspection shall be agreed between the Geotechnical Advisor and the Asset Owner Representative (AOR).

The inspection shall be as for a visual inspection of the geotechnical structure, associated waterways and all structure elements susceptible to surface water run-off, slope saturation or flood damage.

The inspection shall be carried out by a Geotechnical Inspector and/or such other specialist staff as the Geotechnical Advisor may direct.

The Geotechnical Advisor shall maintain details of structures with known significant waterway or surface run-off, slope saturation vulnerabilities requiring rainfall / flood event inspections in the asset owner's database.

6.5.4 Vehicle Impact, Fire or Chemical Spillage Inspection

This shall be carried out on any structure that has been involved in a vehicle impact, fire, or chemical spillage. The criteria and the extent of the inspection shall be determined, by the Geotechnical Advisor and the Asset Owner Representative (AOR), case-by-case based on the severity of incident and affect geotechnical structure.

6.5.5 Vulnerable Structure Inspection

Inspections are required for geotechnical structures which are known from previous performance to be at higher than normal risk of failure, that have known potential defects, or require specialist inspection, where the frequency or the scope of the visual or detailed inspections are not appropriate.

Examples:

- steel and mesh structures susceptible to fatigue and corrosion
- geotechnical structures subjected to scour or exposure of shallow foundations
- concrete elements with corroded reinforcement
- concrete steel and mesh structures or foundations in a saline wetting/drying environment that have been identified as potentially having excessive chloride contamination.

The Geotechnical Advisor shall prepare a specific inspection brief outlining the inspection requirements. The inspection shall be carried out by the Geotechnical Advisor and/or the Lead Geotechnical Engineer. The Geotechnical Advisor shall maintain details of structures requiring a vulnerable structures inspection in the asset owner's database.

6.5.6 Uncommon Material Inspection

This is required for geotechnical structures that incorporate uncommon materials, such as laminated timber or fibre composite materials, where specialist knowledge and experience of those materials and mechanisms of deterioration is required. The inspection shall be carried out by specialist staff as directed by the Geotechnical Advisor.

7. Reporting and records

The management of geotechnical asset information should be aligned to the Principals requirements.

The Geotechnical Advisor is responsible for the management of information relating to the geotechnical asset inspections (Routine, Visual, Detailed and Special).

7.1 Geotechnical Structure Inspections

Each inspection (routine, visual and detailed) shall be reported on an agreed inspection report for each specific structure accompanied by a written engineering report as necessary to describe specific defects. Maintenance work, further detailed investigation or changes to the inspection regime shall be recommended as appropriate.

Appendix A presents example Pro Forma: the GMC shall develop forms suitable for adoption in their inspection process for acceptance by Waka Kotahi NZ Transport Agency's Lead Technical Advisor – Geotechnical.

Each report and recommendations must be sent to the AOR. Submitted inspections shall be acknowledge and accepted by the Asset Owner Representative (AOR), unless agreed otherwise with the Waka Kotahi NZ Transport Agency's Lead Technical Advisor - Geotechnical. If the results of any inspection show that emergency action is required, the Geotechnical Advisor must immediately advise the AOR, who shall implement appropriate action as necessary.

7.2 Geotechnical Asset Database

Changes required to the asset owner's database, including the addition of geotechnical structures, shall be reported to the AOR on the necessary input forms. The AOR shall be responsible for approving the addition of geotechnical structures to the database. Inspections may be used to verify the data fields in the geotechnical asset database are correct and/or to complete any missing data fields.

The Geotechnical Advisor shall be responsible for the publishing and/or uploading inspection data to the asset owner's database. Inspection data shall be collated in a standardised format relating to the Asset Management Database Standard (AMDS). The Geotechnical Advisor shall also maintain records of inspections and maintenance in the asset owner's database, so that a continuous history of each geotechnical structure is available, as well as the particular inspection requirements, including special needs (specific access requirements and temporary traffic management requirements).

8. Alternative means of access

There is provision in 6.3 and 6.4 for the use of alternative means of access for areas of difficult or hazardous access with the prior agreement of the AOR.

Equipment and methods that may provide acceptable alternatives to close quarter inspection, provided they are suitable for the proposed use, and only with the recommendations of the Geotechnical Advisor, include:

- Unmanned Aerial Vehicles (UAV) / Drone
- cameras on long reach poles
- binoculars
- high resolution and telephoto photography from ground level
- thermal imaging
- remote controlled vehicles (or propelled by winch) with mounted video equipment
- unmanned underwater vehicles (UUV)
- Other options that may not be available at the time of writing this policy, that can be demonstrated to be suitable and agreed between the Geotechnical Advisor and Waka Kotahi NZ Transport Agency's Lead Technical Advisor - Geotechnical.

While remote systems can be useful tools in the range of inspection techniques available to inspectors, they can have some shortfalls and therefore any proposal to use them must address their limitations as compared to a close-quarter inspection undertaken by an inspector or geotechnical engineer. As such, alternative means of access and inspection must not be proposed to replace close-quarter inspections carried out under a detailed inspection unless it eliminates a significant safety hazard, while mitigating the shortfalls of remote inspection.

9. Verification of maintenance

A system shall be instituted to verify that approved maintenance work has been carried out as programmed. The cost, description, quantity and timing of the completed work, other than routine maintenance, shall be recorded in the asset owner's database.

10. Traffic control


At all times during the work or activities associated with or arising from the exercise of this specification, the Structure Inspection Engineer shall take responsibility to ensure all traffic control is carried out in accordance with the *Code of practice for temporary traffic management (CoPTTM)*⁽⁵⁾.

11. References

- (1) NZ Transport Agency (2022) *NZTA S6 Bridges and other significant structures inspection policy*. Wellington.
- (2) Highways England (2007) *Inspection manual for highway structures*. TSO, London, United Kingdom.
- (3) Highways England (2021) *CS 450 Inspection of highway structures*. TSO, London, United Kingdom.
- (4) NZ Transport Agency (2015) *SM032 State highway maintenance contract proforma manual*. Wellington.
- (5) NZ Transport Agency (2012) *Code of practice for temporary traffic management (CoPTTM): Part 8 of the Traffic control devices manual (TCD manual)*. Wellington.

Appendix A

Example Pro Forma

		Slope Drainage Systems Routine Observation Report		<i>Supplier Logo</i>		
Network Area:		Structure Name:	Highway:	RP:	OSN:	
Inspection Rating 0 = Not Inspected / Observed 1 = Satisfactory 2 = Monitor next inspection (<i>comment & photo</i>) 3 = Needs Further (Visual/Detailed) Inspection (<i>comment & photo</i>) 4 = Needs Maintenance (<i>comment & photo</i>) 5 = Emergency Works Required (<i>comment & photo</i>) NA = Not Applicable		Structure Type:	Map ref. (easting):			
		Length:	Map ref. (northing):			
		Max Height:	Owner:			
		Average Height:	RCA:			
Inspector:		Reviewer:				
Date:		Date:				
Item	Description	Observations Notes		Needs Maintenance	Needs Inspection	Inspection Rating
1	Surface Matting (eg erosion control)			Y/N	Y/N	
2	Stormwater Drain Outlets, Drainage Ditch, Weep Holes					
3	Carriageway: Top of wall					
4	Carriageway: Foot of wall					
5	Maintenance/ inspection access					
6	Guardrail/ handrail/ safety fences					
7	Erosion					
8	Debris Accumulation					
9	Vegetation					
10	Signs/ signals					
11	General Appearance					
12	Other Defects (Specify)					

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant (GMC) where the defect is structural in nature. **In the event a Inspection Rating of 5, immediate notification is required to the GMC**

EXAMPLE ONLY - FOR DEVELOPMENT

Network Area:		Structure Name:	Highway:	RP:	OSN:
Structure Type:		Year Constructed:	Inspection Type:		<i>Visual / Detailed</i>
Condition Rating 0 = Not Inspected / Observed A = Good Condition B = Acceptable Condition C = Poor Condition, Req's Detailed Insp. D = Very Poor Condition, Req's Maintenance E = Emergency Works Required N/A = Not Applicable	Consequence of Failure Critical= Directly Impacts Live Lane Major = Impacts Road outside Live Lane Moderate = Increased Risk to Road Minor = No direct impact to Road N/A = Not Applicable	Length:	Map ref (easting):		
		Max Height:	Map ref (northing):		
		Owner:	Structure location (in relation to highway):		
		RCA:	Offset distance from highway centre line:		
Network Area:		Next Inspection Type:	Previous Inspection Type:		
Date:		Next Inspection Date:	Previous Inspection Date:		
Inspector:		Reviewer:			
Date:		Date:			

Inspection Reason (e.g. Scheduled, Post Event, Special - Handover, Special - Vulnerable Geotechnical Structure)

Element:		Description	Condition Rating	Consequence	Hazard	Brief description of defect and comments	Photo ID
Set	No						
Main Elements	1	Foundations	B	Moderate	Low		
	2	Surface Matting (eg erosion control)	A	Minor	Negligible		
	3	Slope Face Condition	0	Major	High	Unable to inspect, needs urgent drone inspection Post damaged beyond acceptable range	
	4	Guardrail Beam	D	Critical	Significant		
Durability Elements	5	Stormwater Drain Outlets, Drainage Ditch and Weep Holes					
	6						
Safety Elements	7	Carriageway: Top of wall					
	8	Carriageway: Foot of wall					
	9	Footway/ shoulder: Top of Structure					
	10	Footway/ shoulder: Foot of Structure					
	11	Maintenance/ inspection access					
	12						
Slope Elements	14	Scour					
	15	Erosion					
	16	Slope Deformation (bulging, slumping, cracks)					
	17	Debris Accumulation					
	18						
	19						
Ancillary Elements	20	Signs/ signals					
	21	General Appearance					
	22	Monitoring System					
	23	Adjacent River Bed					
	24						
	25						
	26						
	27	Other Defects (Specify)					

Comments and recommendations for maintenance/repairs

Item No.	Element No.	Suggested remedial Works	Priority (H/M/L)	Estimated Cost
1				
2				
Total Cost \$				-

Reason remedial structural work recommended in last inspection has not been completed

Database changes required	Consequence	Condition Rating					
		0	A	B	C	D	E
	Minor	Low	Negligible	Low	Low	Medium	High
Maintenance strategy	Moderate	Medium	Negligible	Low	Medium	Medium	High
General comments and recommendations relating to future management	Major	High	Low	Low	Medium	High	Significant
	Critical	High	Low	Medium	High	Significant	Significant

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant where the defect is structural in nature.



**Reinforced Slope Stabilisation
Routine Observation Report**

Supplier Logo

Network Area:		Structure Name:	Highway:	RP:	OSN:
Inspection Rating 0 = Not Inspected / Observed 1 = Satisfactory 2 = Monitor next inspection (<i>comment & photo</i>) 3 = Needs Further (Visual/Detailed) Inspection (<i>comment & photo</i>) 4 = Needs Maintenance (<i>comment & photo</i>) 5 = Emergency Works Required (<i>comment & photo</i>) NA = Not Applicable		Structure Type:		Map ref. (easting):	
		Length:		Map ref. (northing):	
		Max Height:		Owner:	
		Average Height:		RCA:	
Inspector:		Reviewer:			
Date:		Date:			

Item	Description	Observations Notes	Needs Maintenance	Needs Inspection	Inspection Rating
1	Mesh		Y/N	Y/N	
2	Surface Matting (eg erosion control)				
3	Geotextiles (if visible)				
4	Stormwater Drain Outlets, Drainage Ditch and Weep Holes				
5	Carriageway: Top of wall				
6	Carriageway: Foot of wall				
7	Maintenance/ inspection access				
8	Guardrail/ handrail/ safety fences				
9	Erosion				
10	Debris Accumulation				
11	Vegetation				
12	Signs/ signals				
13	General Appearance				
14	Other Defects (Specify)				

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant (GMC) where the defect is structural in nature. **In the event a Inspection Rating of 5, immediate notification is required to the GMC**

EXAMPLE ONLY - FOR DEVELOPMENT

Network Area:		Structure Name:	Highway:	RP:	OSN:
Structure Type:		Year Constructed:	Inspection Type:		<i>Visual / Detailed</i>
Condition Rating 0 = Not Inspected / Observed A = Good Condition B = Acceptable Condition C = Poor Condition, Req's Detailed Insp. D = Very Poor Condition, Req's Maintenance E = Emergency Works Required N/A = Not Applicable	Consequence of Failure Critical= Directly Impacts Live Lane Major = Impacts Road outside Live Lane Moderate = Increased Risk to Road Minor = No direct impact to Road N/A = Not Applicable	Length:	Map ref (easting):		
		Max Height:	Map ref (northing):		
		Owner:	Structure location (in relation to highway):		
		RCA:	Offset distance from highway centre line:		
Network Area:		Next Inspection Type:	Previous Inspection Type:		
Date:		Next Inspection Date:	Previous Inspection Date:		
Inspector:		Reviewer:			
Date:		Date:			

Element:		Condition Rating	Consequence	Hazard	Brief description of defect and comments	Photo ID
Main Elements	1 Mesh	B	Moderate	Low		
	2 Surface Matting (eg erosion control)	A	Minor	Negligible		
	3 Slope Coverings (e.g. Shotcrete, Cracking and Deformation)	0	Major	High	Unable to inspect, needs urgent drone inspection Post damaged beyond acceptable range	
	4 Primary Structure Elements	D	Critical	Significant		
	5 Secondary Structure Elements (e.g lateral cables)					
	6 Slope Face Condition					
	7 Guardrail Beam					
	8 Anchors and Soil Nails					
	9 Wire Ropes					
	10					
	11					
	12					
Durability Elements	13 Stormwater Drain Outlets, Drainage Ditch and Weep Holes					
	14 Corrosion Surface Finishes					
	15					
	16					
Safety Elements	18 Carriageway: Top of wall					
	19 Carriageway: Foot of wall					
	20 Footway/ shoulder: Top of Structure					
	21 Footway/ shoulder: Foot of Structure					
	22 Maintenance/ inspection access					
	23					
Slope Elements	25 Erosion					
	26 Slope Deformation (bulging, slumping, tensions cracks)					
	27 Debris Accumulation					
	28 Surrounding Slope/ Transition Area Condition					
	29 Vegetation					
	30					
Ancillary Elements	31 Signs/ signals					
	32 Monitoring System					
	33 Adjacent River Bed					
	34 Adjacent Embankments					
	35					
	36					
	37 Other Defects (Specify)					

Comments and recommendations for maintenance/repairs				
Item No.	Element No.	Suggested remedial Works	Priority (H/M/L)	Estimated Cost
1				
2				
Total Cost \$				-

Reason remedial structural work recommended in last inspection has not been completed

Database changes required	Consequence	Condition Rating					
		0	A	B	C	D	E
	Minor	Low	Negligible	Low	Low	Medium	High
Maintenance strategy	Moderate	Medium	Negligible	Low	Medium	Medium	High
	Major	High	Low	Low	Medium	High	Significant
General comments and recommendations relating to future management	Critical	High	Low	Medium	High	Significant	Significant

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant where the defect is structural in nature.



**Retaining Structure
Routine Observation Report**

Supplier Logo

Network Area:	Structure Name:	Highway:	RP:	OSN:
Inspection Rating 0 = Not Inspected / Observed 1 = Satisfactory 2 = Monitor next inspection (<i>comment & photo</i>) 3 = Needs Further (Visual/Detailed) Inspection (<i>comment & photo</i>) 4 = Needs Maintenance (<i>comment & photo</i>) 5 = Emergency Works Required (<i>comment & photo</i>) NA = Not Applicable	Structure Type:		Map ref. (easting):	
	Length:		Map ref. (northing):	
	Max Height:		Owner:	
	Average Height:		RCA:	
Inspector:		Reviewer:		
Date:		Date:		

Item	Description	Observations Notes	Needs Maintenance	Needs Inspection	Inspection Rating
1	Stormwater Drain Inlets, Outlets, Drainage Ditch, Weep Holes		Y/N	Y/N	0 - 5
2	Carriageway: Top of wall				
3	Carriageway: Foot of wall				
4	Maintenance/ inspection access				
5	Guardrail/ handrail/ safety fences				
6	Erosion				
7	Vegetation				
8	Signs/ signals				
9	General Appearance				
9a	Cracking				
9b	Deformation				
9c	Rotation				
9d	Settlement				
10	Other Defects (Specify)				

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant (GMC) where the defect is structural in nature. **In the event a Inspection Rating of 5, immediate notification is required to the GMC**

EXAMPLE ONLY - FOR DEVELOPMENT

Network Area:		Structure Name:	Highway:	RP:	OSN:
Structure Type:		Year Constructed:	Inspection Type:		<i>Visual / Detailed</i>
Condition Rating 0 = Not Inspected / Observed A = Good Condition B = Acceptable Condition C = Poor Condition, Req's Detailed Insp. D = Very Poor Condition, Req's Maintenance E = Emergency Works Required N/A = Not Applicable		Consequence of Failure Critical= Directly Impacts Live Lane Major = Impacts Road outside Live Lane Moderate = Increased Risk to Road Minor = No direct impact to Road N/A = Not Applicable		Length:	Map ref (easting):
		Max Height:	Map ref (northing):		
		Owner:	Structure location (in relation to highway):		
		RCA:	Offset distance from highway centre line:		

Network Area:	Next Inspection Type:	Previous Inspection Type:
Date:	Next Inspection Date:	Previous Inspection Date:
Inspector:	Reviewer:	
Date:	Date:	

Element:			Condition Rating	Consequence	Hazard	Brief description of defect and comments	Photo ID
Set	No	Description					
Main Elements	1	Foundations	B	Moderate	Low		
	2	Geosynthetics (if visible)	A	Minor	Negligible		
	3	Retaining Wall Primary Elements (eg posts)	0	Major	High	Unable to inspect, needs urgent drone inspection Post damaged beyond acceptable range	
	4	Retaining Wall Secondary Elements (eg lagging)	D	Critical	Significant		
	5	Structure Face Condition (incl. concrete blocks, gabion facing etc)					
	6	Guardrail Beam					
	7	Anchor Heads and Face Plates					
	8	Anchors					
	9						
	10						
Durability Elements	11	Stormwater Drain Outlets, Drainage Ditch and Weep Holes					
	12	Movement/ expansion joints					
	13	Corrosion Surface Finishes					
	14	Carriageway: Top of wall					
	15	Carriageway: Foot of wall					
Safety Elements	16						
	17	Footway/ shoulder: Top of Structure					
	18	Footway/ shoulder: Foot of Structure					
	19	Maintenance/ inspection access					
Slope Elements	20						
	21	Erosion					
	22	Slope Deformation above / below wall					
	23	Surrounding Slope/ Transition Area Condition					
	24						
Ancillary	25						
	26	Signs/ signals					
	27	General Appearance					
	28	Monitoring System					
	29	Adjacent River Bed					
	30	Adjacent Slopes					
	31						
	32						
	33						
	34	Other Defects (Specify)					

Comments and recommendations for maintenance/repairs				
Item No.	Element No.	Suggested remedial Works	Priority (H/M/L)	Estimated Cost
1				
2				
Total Cost \$				-

Reason remedial structural work recommended in last inspection has not been completed

Database changes required	Consequence	Condition Rating					
		0	A	B	C	D	E
	Minor	Low	Negligible	Low	Low	Medium	High
Maintenance strategy	Moderate	Medium	Negligible	Low	Medium	Medium	High
General comments and recommendations relating to future management	Major	High	Low	Low	Medium	High	Significant
	Critical	High	Low	Medium	High	Significant	Significant

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant where the defect is structural in nature.



**Rockfall and Slope Debris
Control Structures
Routine Observation Report**


Supplier Logo

Network Area:		Structure Name:	Highway:	RP:	OSN:
Inspection Rating 0 = Not Inspected / Observed 1 = Satisfactory 2 = Monitor next inspection (<i>comment & photo</i>) 3 = Needs Further (Visual/Detailed) Inspection (<i>comment & photo</i>) 4 = Needs Maintenance (<i>comment & photo</i>) 5 = Emergency Works Required (<i>comment & photo</i>) NA = Not Applicable		Structure Type:		Map ref. (easting):	
		Length:		Map ref. (northing):	
		Max Height:		Owner:	
		Average Height:		RCA:	
Inspector:		Reviewer:			
Date:		Date:			

Item	Description	Observations Notes	Needs Maintenance	Needs Inspection	Inspection Rating
1	Debris Accumulation		Y/N	Y/N	
2	Stormwater Drain Inlets, Outlets, Drainage Ditch, Weep Holes				
3	Maintenance/ inspection access				
4	Guardrail/ handrail/ safety fences				
5	Erosion				
6	Vegetation				
7	Signs/ signals				
8	General Appearance				
9	Other Defects (Specify)				

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant (GMC) where the defect is structural in nature. **In the event a Inspection Rating of 5, immediate notification is required to the GMC**

EXAMPLE ONLY - FOR DEVELOPMENT

		Rockfall and Slope Debris Control Structures Inspection Report		<i>Supplier Logo</i>					
Network Area:		Structure Name:		Highway:		RP:	OSN:		
Structure Type:		Year Constructed:		Inspection Type:		<i>Visual / Detailed</i>			
Condition Rating 0 = Not Inspected / Observed A = Good Condition B = Acceptable Condition C = Poor Condition, Req's Detailed Insp. D = Very Poor Condition, Req's Maintenance E = Emergency Works Required N/A = Not Applicable		Consequence of Failure Critical= Directly Impacts Live Lane Major = Impacts Road outside Live Lane Moderate = Increased Risk to Road Minor = No direct impact to Road N/A = Not Applicable		Length:		Map ref (easting):			
				Max Height:		Map ref (northing):			
				Owner:		Structure location (in relation to highway):			
				RCA:		Offset distance from highway centre line:			
Network Area:		Next Inspection Type:		Previous Inspection Type:					
Date:		Next Inspection Date:		Previous Inspection Date:					
Inspector:		Reviewer:							
Date:		Date:							
Element:									
Set	No	Description	Condition Rating	Consequence	Hazard	Brief description of defect and comments	Photo ID		
Main Elements	1	Foundations	B	Moderate	Low	Unable to inspect, needs urgent drone inspection Post damaged beyond acceptable range			
	2	Mesh	A	Minor	Negligible				
	3	Bund Facing	0	Major	High				
	4	Primary Structure Elements (e.g posts)	D	Critical	Significant				
	5	Secondary Structure Elements (e.g lateral cables)							
	6	Slope Face Condition							
	7	Anchors							
	8	Wire Ropes							
	9	Wire Rope Clamps							
	10								
	11								
Durability Elements	12	Shackles							
	13	Anchor Head (inc. Flexible Anchor Heads)							
	14	Base Plates							
	15	Energy Dissapators							
	16	Other (e.g spike plates, steel pins)							
	17	Stormwater Drain Inlets, Outlets, Drainage Ditch, Weep Holes							
	18								
Safety Elements	21	Corrosion Surface Finishes: Primary							
	22	Maintenance/ inspection access							
	23	Guardrail/ handrail/ safety fences							
Slope Elements	24	Erosion							
	25	Slope Deformation (bulging, slumping, cracks)							
	26	Debris Accumulation(2)							
	27	Upslope Condition							
	28								
	29								
Ancillary Elements	30	Vegetation							
	31	Signs/ signals							
	32	General Appearance							
	33	Monitoring System							
	34	Adjacent Slopes							
	35	Aprons							
	36	Lighting							
	37	Services							
	38								
	39								
	40	Other Defects (Specify)							
Comments and recommendations for maintenance/repairs									
Item No.	Element No.	Suggested remedial Works	Priority (H/M/L)			Estimated Cost			
1									
2									
						Total Cost \$	-		
Reason remedial structural work recommended in last inspection has not been completed									
Database changes required									
			Consequence	Condition Rating					
			Minor	Low	Negligible	Low	Low	Medium	High
Maintenance strategy			Moderate	Medium	Negligible	Low	Medium	Medium	High
General comments and recommendations relating to future management			Major	High	Low	Low	Medium	High	Significant
			Critical	High	Low	Medium	High	Significant	Significant

NOTE: In addition to the categories above, routine surveillance inspections shall identify any obvious defects which may affect the safety of road users or anything else needing urgent attention (as required by NZTA S7). Photographs of key defects should be taken. These shall be supplied to the Geotechnical Management Consultant where the defect is structural in nature.



EXAMPLE ONLY - FOR DEVELOPMENT

Appendix B



Example Early Response Indicator Cards

(for Rockfall and Slope Debris Control Measures)



Rockfall Fence Inspection Card

Example	Things to Look For	Actions	
	<ul style="list-style-type: none"> • Fence is fully loaded. • Rocks may be on the road. • Some posts are bent and leaning over. • The mesh is bulging for the full height, and may be ripped. • Damage is clearly visible. • Steel ropes may have snapped. • Some of the fence that hasn't been hit may look ok. 	<ul style="list-style-type: none"> • Do not approach the fence. • CALL GEOTECHNICAL ADVISOR (A. Smith: 021 XXX XXXX) AND ASSET OWNER REPRESENTATIVE (B. Wilson: 021 YYY YYYY) IMMEDIATELY • Affected transport corridor should be closed. 	IMMEDIATE ACTION
	<ul style="list-style-type: none"> • Fence is over a quarter full. • One or two posts may be leaning more than the others. • Debris is causing mesh to bulge. • The steel rope at the top of the mesh looks to be sagging under the load. • Large rocks may be caught in the mesh. 	<ul style="list-style-type: none"> • Fence needs urgent maintenance (within XXX weeks of inspection). • During working hours contact Asset Owner Representative (B. Wilson: 021 YYY YYYY) • Geotechnical Advisor should be contacted for maintenance support and asset inspection. 	URGENT MAINTENANCE



Rockfall Fence Inspection Card

Example	Things to Look For	Actions	
	<ul style="list-style-type: none"> • Fence is less than a quarter full. • Debris can be seen piling up behind the mesh. • The mesh may be bulging slightly where the debris is piling up. • Posts are all leaning at the same angle. • The bottom of one or more posts may be buried by the debris. • The top rope is NOT sagging and the height of the mesh approx. in line with the post height. 	<ul style="list-style-type: none"> • No immediate action required. • Notify Geotechnical Advisor. • Fence should be monitored if heavy rain is forecasted. • Clearance of debris should be undertaken within next X months. 	MONITOR
	<ul style="list-style-type: none"> • Fence has a small amount of debris that can be seen through the mesh. • The ropes look tight. • All the posts should be leaning at the same angle. • The bottom of the posts may be covered by debris. • Debris may have collected in the area behind the fence. 	<ul style="list-style-type: none"> • No action required. • Fence is designed to have some debris within the catchment area. <i>(Note the maximum height of permitted debris for information)</i> • If concerned or unsure notify Geotechnical Advisor. 	NO ACTION NEEDED



Rockfall Active/Drape Mesh Inspection Card

Example	Things to Look For	Actions	
	<ul style="list-style-type: none"> • Mesh is heavily loaded and material may have broken through. • Debris may be on the road. • Some ropes may have snapped • The mesh is bulging for a height greater than 2m, and the mesh may be ripped. • Damage is clearly visible. • Some of the mesh that hasn't been hit may look ok. 	<ul style="list-style-type: none"> • Do not approach the fence. • CALL GEOTECHNICAL ADVISOR (A. Smith: 021 XXX XXXX) AND ASSET OWNER REPRESENTATIVE (B. Wilson: 021 YYY YYYY) IMMEDIATELY • Affected transport corridor should be closed. 	IMMEDIATE ACTION
	<ul style="list-style-type: none"> • Mesh is bulging under the load of debris. • Some material may be on the road. • The steel rope along the bottom of the mesh looks to be stretched under the load. • Large rocks may be caught in the mesh. 	<ul style="list-style-type: none"> • Mesh needs urgent maintenance (within XXX weeks of inspection). • During working hours contact Asset Owner Representative (B. Wilson: 021 YYY YYYY) • Geotechnical Advisor should be contacted for maintenance support and asset inspection. 	URGENT MAINTENANCE

Rockfall Active/Drape Mesh Inspection Card

Example	Things to Look For	Actions	
	<ul style="list-style-type: none"> • Debris can be seen piling up behind the mesh <2m in height. • The mesh may be bulging slightly where the debris is piling up. • The bottom rope may look right and be buried by the debris. 	<ul style="list-style-type: none"> • No immediate action required. • Notify Geotechnical Advisor. • Mesh should be monitored if heavy rain is forecasted. • Clearance of debris should be undertaken within next X months. 	MONITOR
	<ul style="list-style-type: none"> • Mesh has a small amount of debris and some boulders that can be seen through the mesh. • The ropes may look tight. • Small fine debris may have collected in the area at the bottom of the mesh. 	<ul style="list-style-type: none"> • No action required. • Mesh is designed to have some debris within the mesh and catchment area. <i>(Note the maximum height of permitted debris for information)</i> • If concerned or unsure notify Geotechnical Advisor. 	NO ACTION NEEDED

Rockfall Bund Inspection Card

Example	Things to Look For	Actions	
	<ul style="list-style-type: none"> • The catch area behind the bund is over half full with debris and/or the material is touching the toe of the bund. • Debris and rocks may be on the road. • A significant slope failure is clearly visible. • Some concrete blocks may have moved. • There may be bulges on the road-side face of the bund. • Large boulders may be visible on the surface of the debris cone or within the catch area. 	<ul style="list-style-type: none"> • Do not approach the bund. • CALL GEOTECHNICAL ADVISOR (A. Smith: 021 XXX XXXX) AND ASSET OWNER REPRESENTATIVE (B. Wilson: 021 YYY YYYY) IMMEDIATELY • Bund needs urgent maintenance (within XXX weeks of inspection). 	IMMEDIATE MAINTENANCE
	<ul style="list-style-type: none"> • Catch area behind bund is less than a half full with debris and there is greater than 3m catch width remaining. • Several larger boulders may be leaning against the bund or in the catchment area. • Debris may have accumulated within the catchment area. 	<ul style="list-style-type: none"> • No immediate action required. • Notify Geotechnical Advisor of any new material. • Bund should be monitored if heavy rain is forecasted. • Clearance of debris in contact with bund should be undertaken within next XXX months and before the next winter. 	MONITOR

Appendix C

Regional Trigger Events

Trigger events will relate to a number of factors including the location of the geotechnical structure. Details of expected trigger events for structures should be included in the geotechnical asset database.

If there are no site-specific trigger events identified in the geotechnical asset database or design report/information, then Figure C.1 and Table C.1 below can be used to guide expected trigger events with a regional perspective. They are provided for guidance only as there will be large variability of triggering events across regions. Expected trigger events shall be determined by the GMC using local experience, analysis of High Intensity Rainfall Design System (HIRDS) data, Waka Kotahi’s Bridge Manual and the GNS National Seismic Hazard model. Site specific triggers, such as snow, ice, volcanic ash or scour shall also be considered.

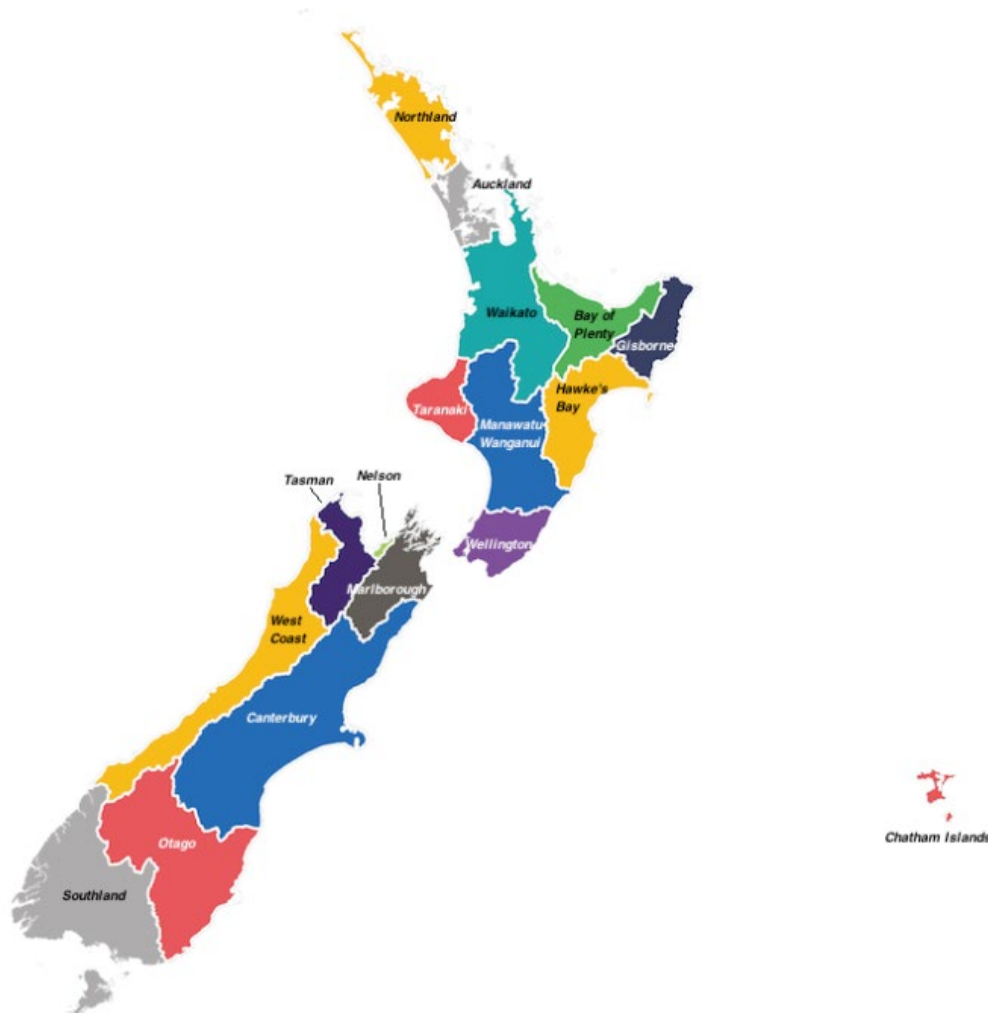


Figure C.1: Map of Regions considered for Trigger Events

Table C.1: The Regional Trigger Events for Post-Event Inspection

Region	Rainfall Duration*	Rainfall Intensity**	Earthquake*** (MMI)
Northland	48 - 72hrs	25mm/hr	V
Auckland	48 – 72 hrs	25mm/hr	VI
Waikato	72hrs +	20mm/hr	VI
Bay of Plenty	72hrs +	30mm/hr	VII
Gisborne	48 – 72 hrs	15mm/hr	VII

Hawke's Bay	48 – 72 hrs	15mm/hr	VII
Taranaki	48 – 72 hrs	25mm/hr	VI
Manawatu Wanganui	48 – 72 hrs	15mm/hr	VII
Wellington	48 – 72 hrs	15mm/hr	VII
Tasman	72hrs +	25mm/hr	VI
Nelson	48 – 72 hrs	20mm/hr	VII
Marlborough	48 – 72 hrs	10mm/hour	VII
Canterbury	48 – 72 hrs	10mm/hour	VII
West Coast	72hrs +	25mm/hr	VII
Otago	48 - 72 hrs	15mm/hr	VI
Southland	48 - 72 hrs	15mm/hr	VII

*Rainfall duration triggers are based on NIWA's general annual moisture deficient for each region and used to determine the general frequency of long period rain events.

**Rainfall Intensity is based on the data from HIRDS for a 1h intensity for a 2-yr average reoccurrence interval (ARI) for the main metropolitan centres in each region.

***Seismic triggers are based on Figure 6.2(f) from the *Bridge manual*.

Fire within the source area and/or location of geotechnical structure will also trigger the need for a post-event inspection (routine inspection – or as directed by the Geotechnical Advisor).

The Post-Event assessments undertaken by the GMC will require notification to the AOR to inform of any engineering input and specify the works required to maintain or reinstate the geotechnical structure to the intended design capacity.