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# Road Controlling Authorities Forum

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Development of a National Bridge  
Scour Risk Screening Procedure

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# Presentation Outline

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- ✓ Background
- ✓ Overview
- ✓ Study Methodology
- ✓ Pilot Study
- ✓ Implementation
- ✓ Summary
- ✓ Questions



# Background

## Drivers for Study

- ✓ Asset/Risk Management.
- ✓ Maximise SH Network availability.
- ✓ CDEM Act requires:
  - Identify and understand hazards and risks
  - Prepare plans to manage hazards and risks
- ✓ Global Warming.



# Background

## Natural Hazards

- ✓ Earthquakes.
- ✓ Lahar.
- ✓ Tsunamis.
- ✓ Floods.



# Overview

## ✓ Study Objectives

- Simple, robust, rapid screening process
- Don't re-invent the wheel
- Identify high priority at-risk bridges

## ✓ LTNZ Research Report No.196

- Dr. Coleman & Prof. Melville

## ✓ Ontrack Erosion Study 2003

- Identify/mitigate key risk sites



# Study Methodology

- ✓ Review Existing Studies/Procedures
- ✓ Develop Exclusion Criteria
  - Bridge on replacement programme
  - Bridge Closed
  - Bridge built in last 20 years
- ✓ Develop Inspection Forms
  - Identify Hazard Categories
  - Hazard Rating (1 to 5)
- ✓ Complete Pilot Study



## SCOUR / AGGRADATION RISK SCREENING FORM FOR MULTISPAN BRIDGES

|                             |                           |        |
|-----------------------------|---------------------------|--------|
| <b>BRIDGE NAME:</b> _____   |                           | page 1 |
| <b>OBSERVER NAME:</b> _____ | <b>DATE / TIME:</b> _____ |        |

### OFFICE REVIEW / BRIDGE DETAILS

N = No, U = Unknown, Y = Yes

| <b>BRIDGE IDENTIFICATION</b>  |  |                              |   |   |   |
|---|--|------------------------------|---|---|---|
| Bridge Authority / Region:  |  | Bridge not over waterway:    | N | U | Y |
| Highway:  |  | Bridge closed:               | N | U | Y |
| Bridge ID   |  | Bridge sched for replacement | N | U | Y |
| Construction date:  |  |                              |   |   |   |
| Note 1: If any of the above responses are 'Y' then do not continue with the scour / aggradation hazard assessment |  |                              |   |   |   |

| <b>CATCHMENT AND WATERWAY</b>     |        |          |                |            |       |
|-----------------------------------|--------|----------|----------------|------------|-------|
| Waterway crossed:                 |        |          |                |            |       |
| Regional Council:                 |        |          |                |            |       |
| NZMS 260 Sheet No:                |        |          | NZMG Grid Ref: |            |       |
| Catchment area (km <sup>2</sup> ) | 1 - 10 | 10 - 100 | 100 - 500      | 500 - 1000 | >1000 |

| <b>OBSERVATIONS ON SCOUR / AGGRADATION HISTORY AT BRIDGE SITE</b> |  |
|---|--|
| Regional Bridge Engineer:   |  |
| Transit NZ Regional Engineer                                      |  |
| Regional Network Consultant                                       |  |
| Regional Network Contractor                                       |  |
| Regional Council Staff:   |  |

| <b>BRIDGE STRUCTURE AND FOUNDATION DETAILS (BASED ON SITE OBSERVATION)</b> |  |
|--|--|
| No. spans / superstructure description                                     |  |
| Foundation type / material (piles, piles with cap, cylinder, other):       |  |
| Pier type / shape (circular, wall, inclined pier, other):                  |  |
| Abutment type / material (vertical wall, wing wall, spill through, other): |  |
| Bed materials (rock, boulders, cobbles, gravels, sands, silts, clays):     |  |
| Bank materials (rock, boulders, cobbles, gravels, sands, silts, clays):    |  |





**SITE INSPECTION OBSERVATIONS**

N = No, U = Unknown, Y = Yes

| <b>CATCHMENT / CHANNEL CHARACTERISTICS</b>  | N | U | Y | <b>Hazard Rating<br/>1 - 5<br/>( 1 = low<br/>5 = high )</b> |
|---|---|---|---|---|
| Significant changes in catchment vegetation / forestry operations   | N | U | Y |   |
| Evidence of widespread catchment erosion  | N | U | Y |   |
| Upstream dam / storage reservoir cutting off sediment supply  | N | U | Y |   |
| Sediment mining / dredging  | N | U | Y |   |
| Historic channel straightening / channelisation   | N | U | Y |   |
| Historic channel diversion  | N | U | Y |   |
| Channel banks lined with vegetation (willows, native bush, scrub, other)  | N | U | Y |   |
| Channel bed infested with vegetation (willows, native bush, scrub, other)   | N | U | Y |   |
| Sea or downstream lake affecting flow conditions at bridge site   | N | U | Y |   |
| Other downstream feature affecting flow conditions at bridge site (identify: gravel barrier at outlet to sea, waterfall, weir, other) | N | U | Y |   |

| <b>BRIDGE LOCATION / WATERWAY ADEQUACY</b>   | N | U | Y | <b>Hazard Rating<br/>1 - 5<br/>( 1 = low<br/>5 = high )</b> |
|--|---|---|---|---|
| Bridge on steep or active alluvial fan / delta   | N | U | Y |   |
| Bridge on braided / semi-braided river   | N | U | Y |   |
| Bridge on meandering channel (identify degree: high, medium, low)  | N | U | Y |   |
| Bridge on bend (identify bend sharpness: high, medium, low)  | N | U | Y |   |
| Sediment bar affecting flow behaviour at bridge site   | N | U | Y |   |
| Bridge approaches blocking floodplain (identify bank: left, right)   | N | U | Y |   |
| Bridge sited at significant channel constriction   | N | U | Y |   |
| Channel significantly constricted by bridge span / number of piers   | N | U | Y |   |
| Waterway significantly blocked (identify source: accumulated woody debris, sediment bar, vegetation, foundations, stopbank, guide bank, other) | N | U | Y |   |
| Floodplain significantly blocked other than by bridge approaches (identify source: vegetation, other)  | N | U | Y |   |
| Flood relief feature present upstream (identify: overflow channel / bridge, flood storage basin, other)  | N | U | Y |   |

## SITE INSPECTION OBSERVATIONS

N = No, U = Unknown, Y = Yes

**CHANNEL CROSS-SECTION SHAPE / BED DEGRADATION AND AGGRADATION**

|  |   |   |   |   |
|--|---|---|---|---|
| Evidence of channel degradation - exposed piles / abutment foundations   | N | U | Y | <b>Hazard Rating<br/>1 - 5<br/>( 1 = low<br/>5 = high )</b> |
| Evidence of channel degradation downstream   | N | U | Y |   |
| Locally increased flow depths affecting bridge pier foundations<br>(identify location: outside of bend, confluence of two braid channels, other) | N | U | Y |   |
| Locally increased flow depths affecting bridge abutments<br>(identify location: outside of bend, other)  | N | U | Y |   |
| Channel degradation countermeasures present downstream (identify: erosion resistant bedrock, weir, other)  | N | U | Y |   |
| Evidence of recent sediment buildup under bridge / bed aggradation<br>(identify location: across whole of bed, on sediment bar, other)           | N | U | Y |   |
| Evidence of sediment / flood debris on bridge superstructure<br>(identify location)  | N | U | Y |   |
| Channel aggradation countermeasures present upstream (identify: sediment dam, weir, other)   | N | U | Y |   |

**BANK STABILITY / APPROACH EMBANKMENT INTEGRITY**

|  |   |   |   |   |
|--|---|---|---|---|
| Evidence of bank erosion in vicinity of bridge crossing<br>(identify bank, nature of failure and location)                                   | N | U | Y | <b>Hazard Rating<br/>1 - 5<br/>( 1 = low<br/>5 = high )</b> |
| Evidence of bank erosion / failure affecting bridge pier foundations<br>(identify bank and nature of failure)                                | N | U | Y |   |
| Evidence of bank erosion / failure affecting bridge approach embankments<br>(identify bank and nature of failure)                            | N | U | Y |   |
| Evidence of bridge abutment / approach embankment erosion  | N | U | Y |   |
| Evidence of bridge approach embankment fill movement   | N | U | Y |   |
| Channel bank erosion countermeasures present (identify: riprap rock groynes, gabions, concrete blocks, planted vegetation, other)            | N | U | Y |   |
| Abutment erosion countermeasures present (identify: rip rap, other)  | N | U | Y |   |
| Bridge approach embankment erosion counter measures present (identify: concrete wall, concrete slab face, riprap, planted vegetation, other) | N | U | Y |   |



## SITE INSPECTION OBSERVATIONS

N = No, U = Unknown, Y = Yes

| LOCAL SCOUR AT PIERS / ABUTMENTS  |   |   |   | Hazard Rating<br>1 - 5<br>(1 = low<br>5 = high) |
|---|---|---|---|---|
| Evidence of woody debris accumulation on piers<br>(identify location of debris accumulation)    | N | U | Y |   |
| Evidence of pier scour<br>(identify location of scour)  | N | U | Y |   |
| Evidence of pier foundation tilt / movement<br>(identify location of tilt / movement)           | N | U | Y |   |
| Piers skewed at angle to direction of river flow<br>(estimate angle of skew)                    | N | U | Y |   |
| One or more piers sited in deepest part of channel  | N | U | Y |   |
| One or more piers sited close to confluence of two braid channels                               | N | U | Y |   |
| Evidence of woody debris accumulation on abutment<br>(identify location of debris accumulation) | N | U | Y |   |
| Evidence of abutment scour<br>(identify location and nature of scour)                           | N | U | Y |   |
| Abutments skewed to direction of river flow<br>(estimate angle of skew)                         | N | U | Y |   |

| HAZARD SUMMARY   |               |                   |
|--|---------------|-------------------|
| Hazard Category  | Hazard Rating | Key Hazard Factor |
| Catchment / channel characteristics  |               |                   |
| Bridge location / waterway adequacy  |               |                   |
| Channel cross-section shape / bed degradation & aggradation                            |               |                   |
| Bank stability / approach embankment integrity   |               |                   |
| Local scour at piers / abutments   |               |                   |
| <b>Summation of hazard ratings</b>   |               |                   |
| <b>Hazard rating summation as percentage</b><br>(summation of risk ratings x 100 / 25) |               |                   |
| <b>Maximum hazard rating</b>   |               |                   |

## GENERAL COMMENTS / RECOMMENDATIONS FOR MONITORING / MAINTENANCE ETC.

|  |
|--|
|  |
|--|



**Table A1** Summary of guidelines for definition of hazard ratings

| Hazard rating | Catchment / Channel Characteristics   | Bridge location / Waterway adequacy   | Channel Cross-section shape / Bed Degradation and Aggradation  | Bank Stability / Approach Embankment Integrity   | Local Scour at Piers / Abutments  |
|---------------|---|---|--|--|---|
| 5             | <p>Widespread deforestation of catchment.</p> <p>Widespread catchment erosion.</p> <p>Dam located upstream cutting off sediment supply.</p>   | <p>Bridge sited on extremely sharp bend.</p> <p>Bridge sited on very steep alluvial fan.</p> <p>Waterway significantly blocked.</p> <p>Bridge sited at severe channel constriction.</p> <p>Large sediment bar blocking waterway.</p>  | <p>Extreme degradation of bed.</p> <p>Highly exposed piles / abutment foundations.</p> <p>Channel shape highly asymmetric<br/>- much deeper on one side<br/>- affecting pier or abutment.</p> <p>Extreme aggradation of bed.</p> | <p>Extreme bank erosion upstream impinging on bridge abutment or piers.</p> <p>Extreme abutment / approach embankment erosion.</p>   | <p>Extensive debris raft on piers / abutments.</p> <p>Evidence of extreme scour at piers / abutments.</p> <p>Evidence of pier tilt / movement.</p> <p>One or more piers sited close to confluence of two braid channels.</p> <p>Piers / abutment skewed at more than 45 degrees to direction of river flow.</p> |
| 4             |   | <p>Bridge sited on lower gradient section of alluvial fan.</p> <p>Bridge sited on highly meandering channel.</p> <p>Bridge approaches severely blocking floodplain.</p> <p>Channel significantly blocked by bridge span / No. of piers.</p>   |  | <p>Severe bank erosion upstream impinging on bridge abutment or piers.</p> <p>Severe abutment / approach embankment erosion.</p>   | <p>Piers / abutments skewed at more than 30 degrees to direction of flow.</p> <p>Severe debris raft formation on piers / abutments.</p> <p>Severe scour at piers / abutments.</p>   |
| 3             | <p>Partial deforestation of catchment.</p> <p>Moderate landslide activity in catchment.</p> <p>Channel bed infested with large willow trees or other vegetation.</p> <p>Severe straightening and channelisation of river / stream.</p>            | <p>Bridge sited on moderate bend.</p> <p>Bridge sited on moderately meandering channel.</p> <p>Bridge sited at moderate channel constriction.</p> <p>Waterway partially blocked.</p> <p>Sediment partially blocking waterway.</p> <p>Bridge approaches partially blocking floodplain.</p> | <p>Moderate degradation of bed.</p> <p>Moderately exposed piles / abutment foundations.</p> <p>Channel shape slightly asymmetric<br/>- slightly deeper to one side.</p> <p>Moderate aggradation of bed.</p>                      | <p>Moderate bank erosion.</p> <p>Moderate abutment / approach embankment erosion.</p> <p>Movement of abutment / approach embankment fill.</p> <p>Displacement of abutment rock protection.</p> | <p>Piers skewed at more than 15 degrees to direction of flow.</p> <p>Moderate debris raft formation on piers / abutments.</p> <p>Moderate scour at piers / abutments.</p>   |
| 2             | <p>Catchment extensively vegetated.</p> <p>Occasional landslide occurrences.</p> <p>Natural alpine processes in catchment.</p> <p>Moderate straightening and channelisation of river / stream.</p> <p>Channel extensively lined with willows.</p> | <p>Bridge sited on slight bend.</p> <p>Bridge sited on slightly meandering channel.</p> <p>Bridge sited at slight channel constriction.</p>   |  | <p>Minor displacement of abutment protection.</p> <p>Minor bank erosion.</p> <p>Minor damage to bank protection measures.</p>  | <p>Piers skewed at more than 5 degrees to direction of flow.</p> <p>Minor debris raft capture by piers / abutments.</p> <p>Minor scour at piers / abutments.</p>  |
| 1             | <p>Catchment geologically stable.</p> <p>Channel stable in geomorphic sense.</p> <p>Extensive bank vegetation with good root structure.</p> <p>Low gradient river / stream.</p> <p>Tidal or lake influence on water levels.</p>                   | <p>Flood relief feature upstream of bridge.</p> <p>Good waterway capacity.</p> <p>No sediment or vegetation blocking waterway.</p>  | <p>Effective channel degradation countermeasures downstream.</p> <p>Effective channel aggradation countermeasures upstream.</p>  | <p>Abutments / approach embankments well protected.</p> <p>Banks well protected.</p>   | <p>No debris raft capture.</p> <p>Piers / abutment not skewed.</p> <p>No scour evident at piers / abutments.</p>  |

# Study Methodology

## ✓ Pilot Study

✓ SH 2, SH 6, SH 54, SH 57

➤ Total inspected - 53

## ✓ Identification of known risks

➤ TNZ Regional staff

➤ Bridge & Network Consultants

➤ Regional Council staff

## ✓ Calibration

✓ Melling Bridge

✓ Ava River Bridge



# Study Methodology

- ✓ Peer Reviews Completed
  - Coleman & Melville
  - Regional Bridge Consultant
  - Positive feedback
- ✓ Inspection Form Updated
- ✓ Implementation
  - Prioritise at-risk bridges
  - Detail Assessments
  - Physical Works



# Screening Implementation

- ✓ Training of inspection staff
  - Done by experts involved in project
  - Ensure consistency
- ✓ Inspections and Screening
  - Complete Forms & Photos
- ✓ Review of results by experts
  - Identify inconsistencies
  - Confirm results



# Summary

- ✓ Screening Procedure completed
- ✓ Relatively easy process
- ✓ Cost-effective method
- ✓ Enable TNZ to develop risk profiles for bridges on the Network
- ✓ Assist TNZ in planning forward work programmes



# QUESTIONS

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