Queensland Government

Engineering Technology **Forum 2012**

Managing Bridge Scour

TMR's approach to evaluating bridge scour

29 Aug 2012, 12:00 – 12:30pm

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Brisbane Convention and Exhibition Centre
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- TMR and Bridge Scour
- Overview of Bridge Scour Theory
- Types Scour – General, Contraction and Local
- Summary

Hydraulics

- In house consultants
  - From KBR, AECOM, WBM, DKS, Bligh Tanner plus other government agencies
- Bridges, culverts and floodways
- Training Courses – RPD303 and RPD304
- Assess impact on community and environment
  - Afflux
- Scour
  - repair advice post flood damage
  - scour protection to prevent damage

TMR and Bridge Scour

Why is Bridge Scour important to the community?

- Scour (and flooding) causes disruption to transport, loss of value added in commerce and business interruption, legal costs associated with lawsuits.

How is Bridge Scour relevant to transport solutions?

2010 QLD Floods

I20, Texas, USA, 4/2004

Victoria, Australia, 4/2011

Northern Territory, 11/2011

Scour of Abutments

Traditional abutment protection not suitable for overtopping and high velocities

Total scour depth needs to be better understood

Loss of bridge approaches is a major cause of connectivity issues

Scour damage

Bridge Approach (2 days)

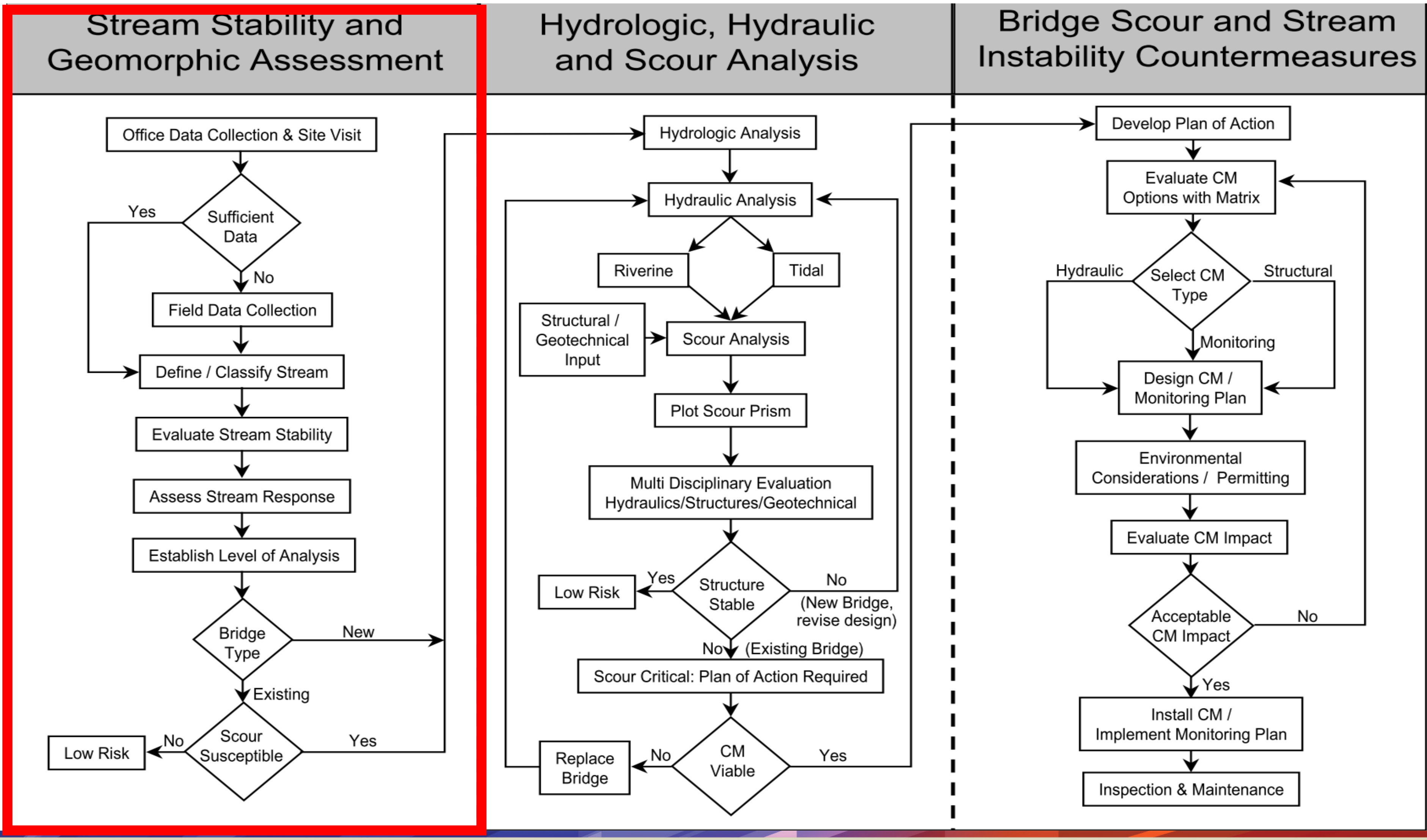
Burke & Wills Bridge – Nappa Merrie
Severe damage during flood

Abutment Repairs

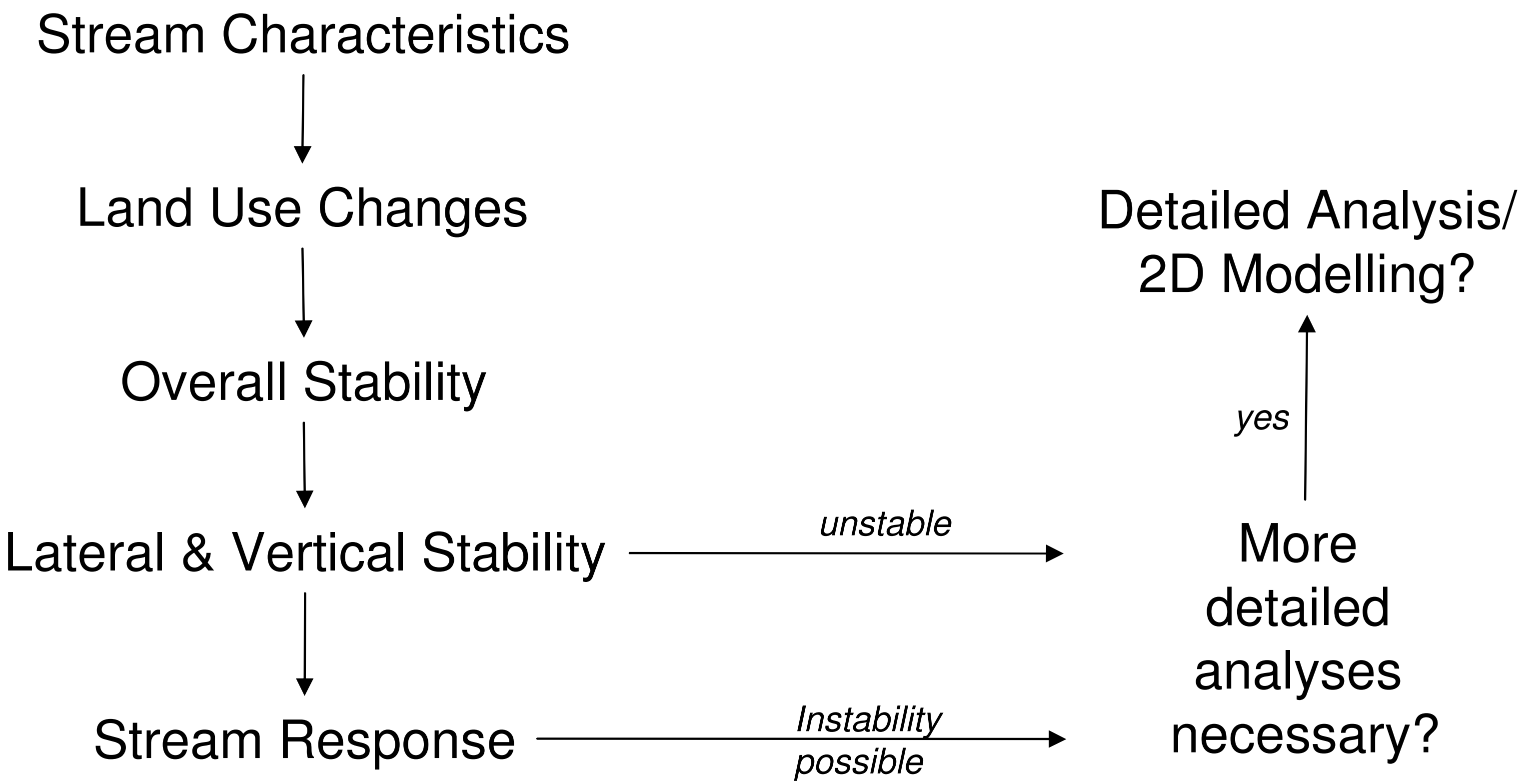
Is the problem fixed?

Overview of Bridge Scour Theory

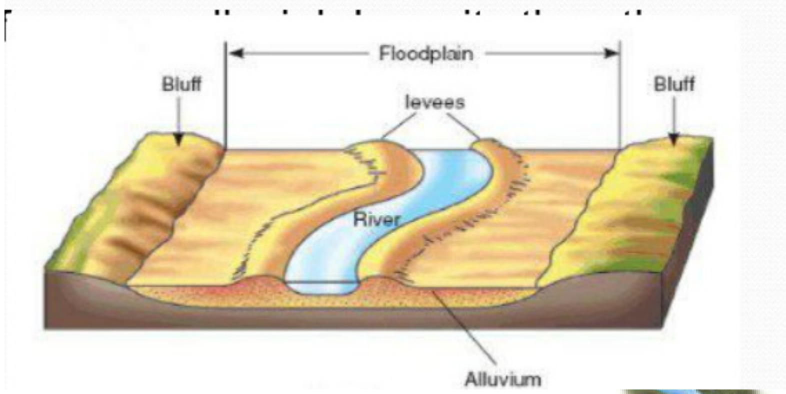
Step 1 – General Scour Analysis

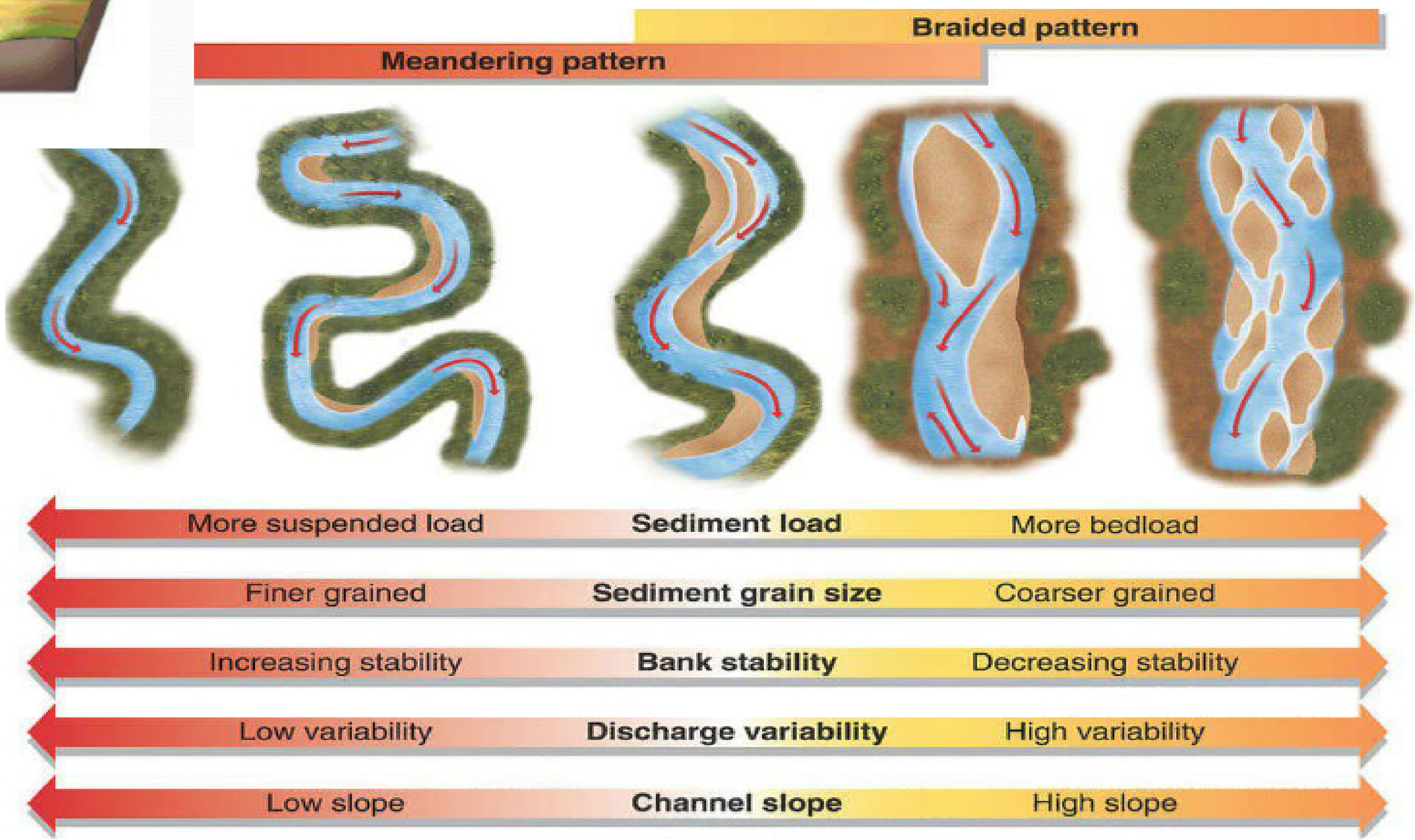


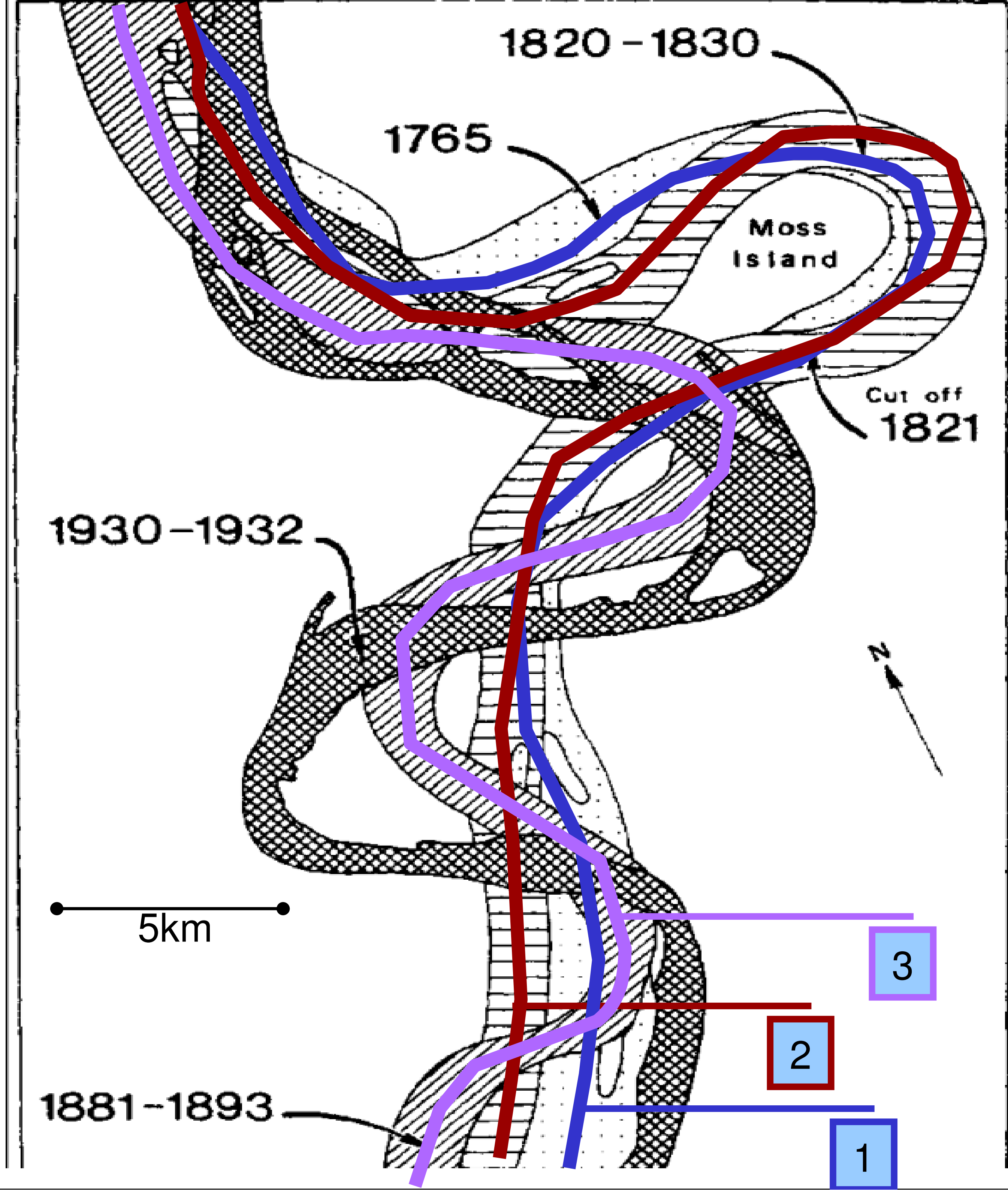
Geomorphic Assessment



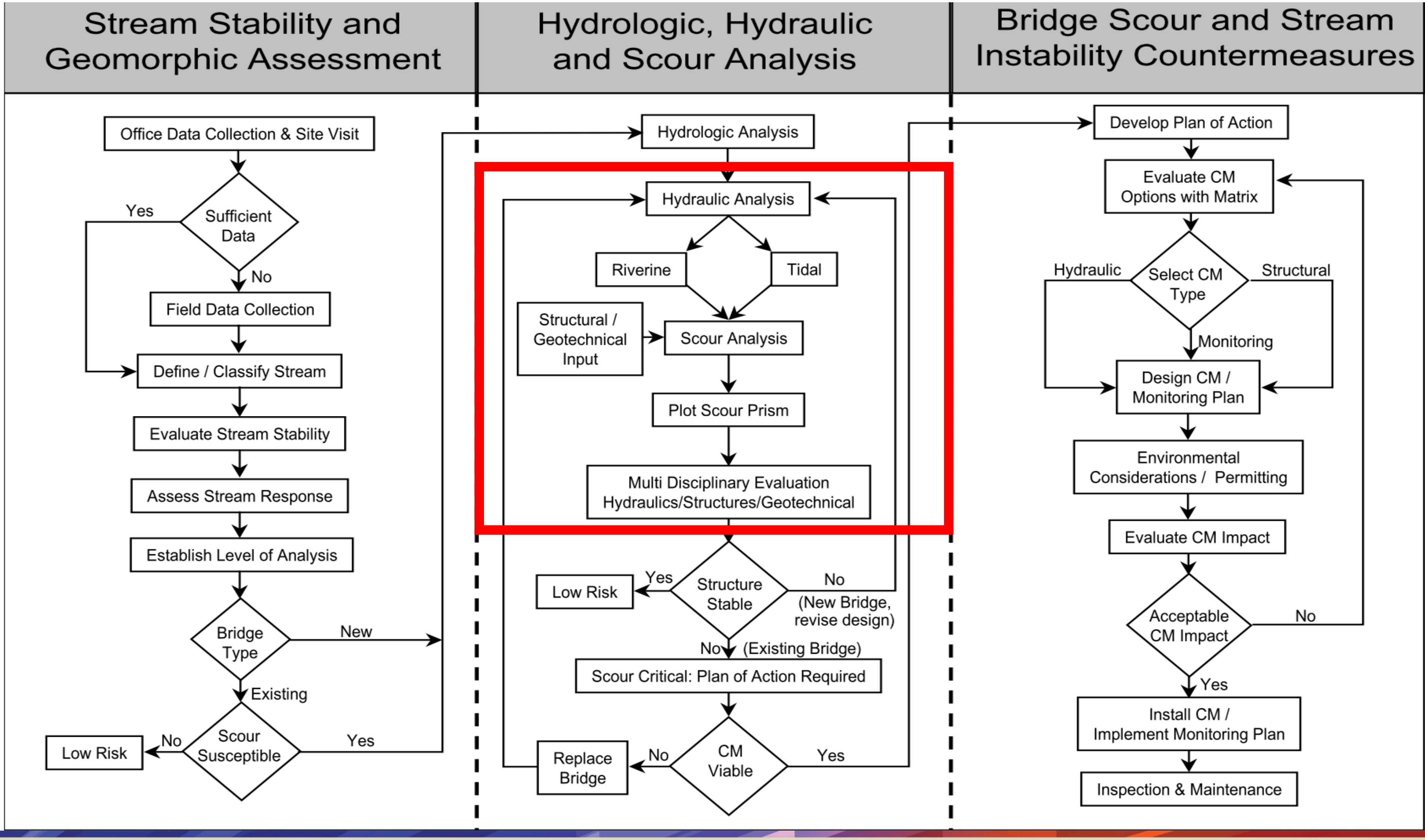
Channels in Floodplains






1820 - 1830
1765
Moss Island
Cut off 1821
1930 - 1932
N
5km
3
2
1
1881 - 1893

Step 2 – Local Scour Analysis



Local Scour Characteristics

Scour is the result of flowing water eroding the material from the bed and banks of streams.

Localised scour is attributable to the presence of a bridge

Hydraulic Considerations

These hydraulic considerations are important inputs to hydraulic design

- Stream gradient
- Stream velocity
- Tailwater
- Time of submergence

Flow Velocity Consideration

- Flow velocity – natural case: watercourse without a structure.
- Desirable velocity – objective of drainage design.
- Maximum permissible velocity – limit for design (usually conditional).

Types of Bridge Scour

Three categories of localised scour:

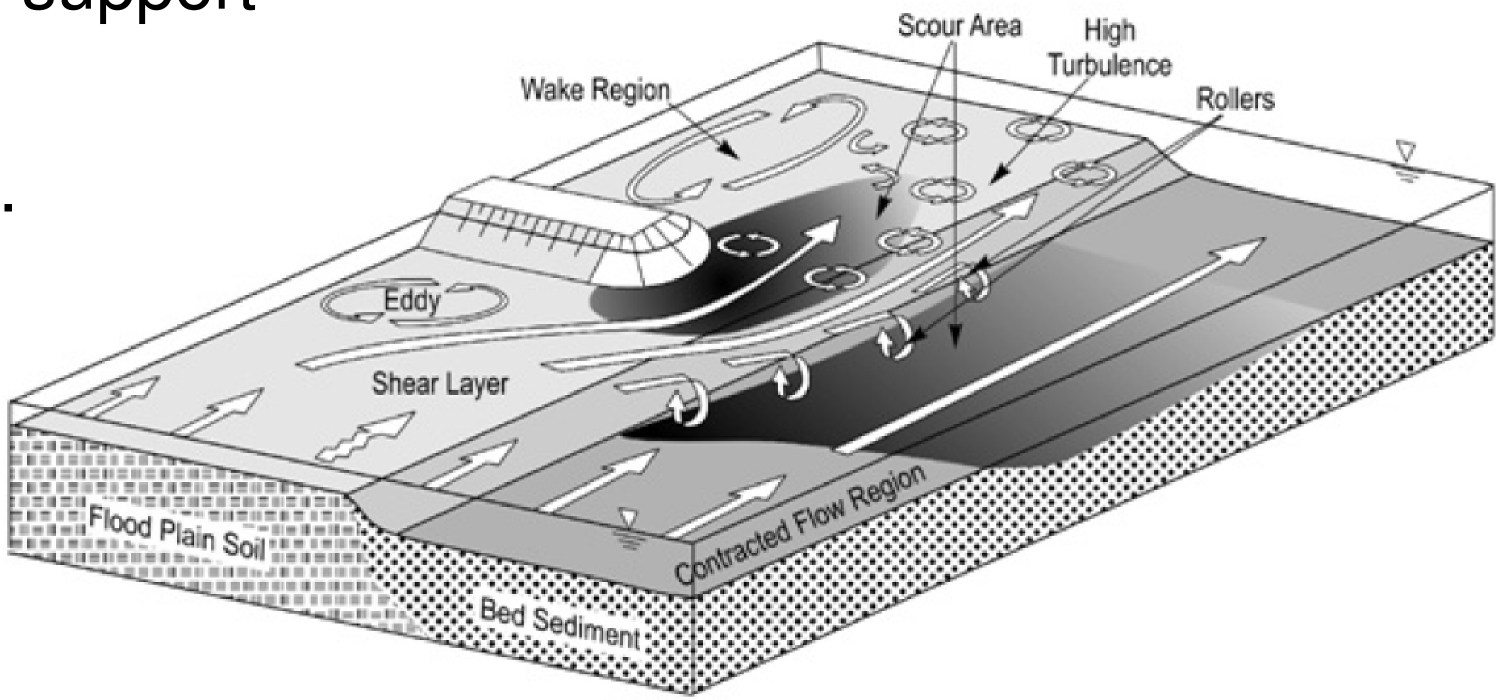
- Contraction scour
- Local scour at abutments
- Local scour at piers

Step 1 identifies sediment transporting regimes for localised scour as:

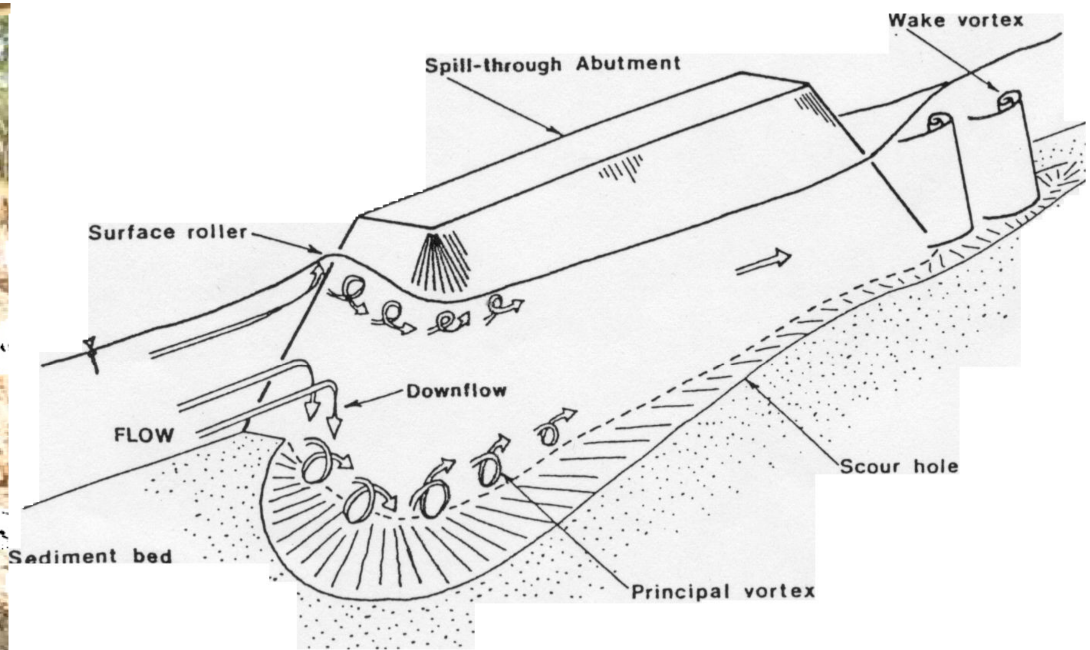
- Clear-water scour, or
- Live-bed scour

Contraction Scour

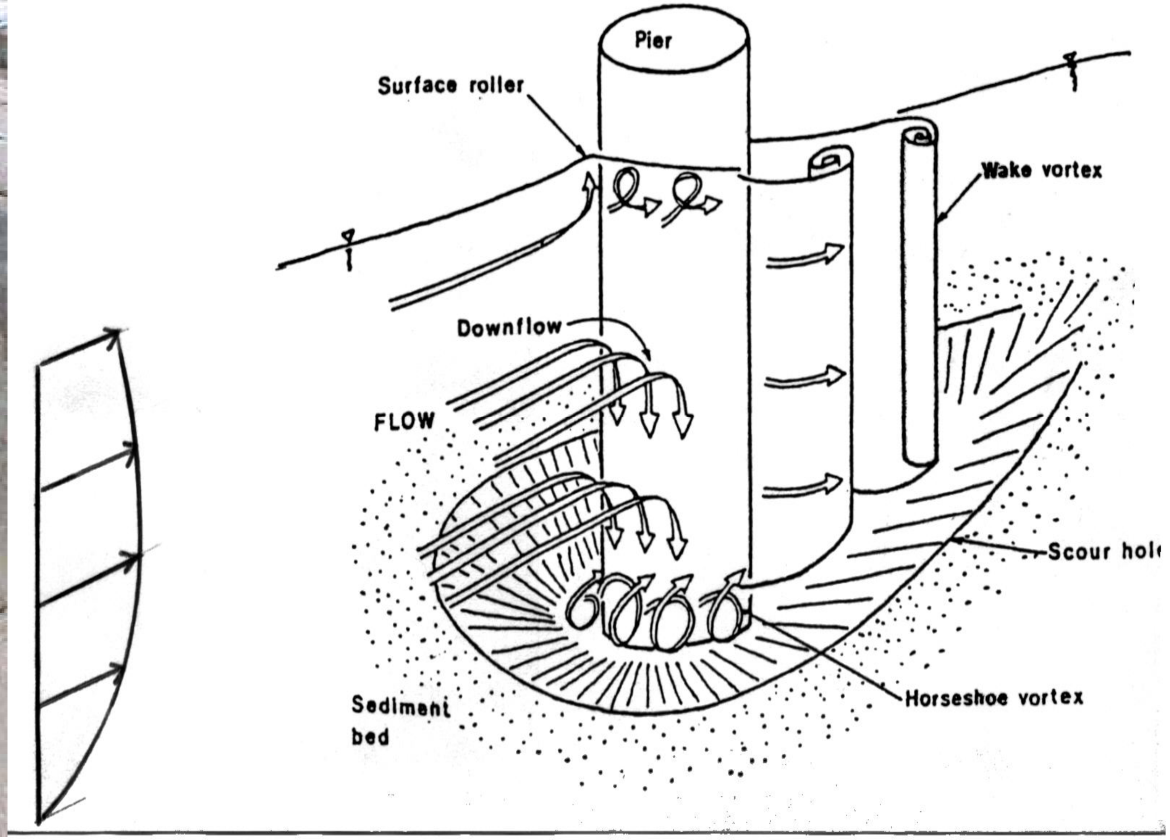
Contraction scour can result from the embankments of a bridge restricting a floodplain. It results in the erosion of streambed soils and sediment that provide support for bridge foundations.



Local Scour at Abutments



Local Scour at Piers



Quantifying Scour Depth, y_s

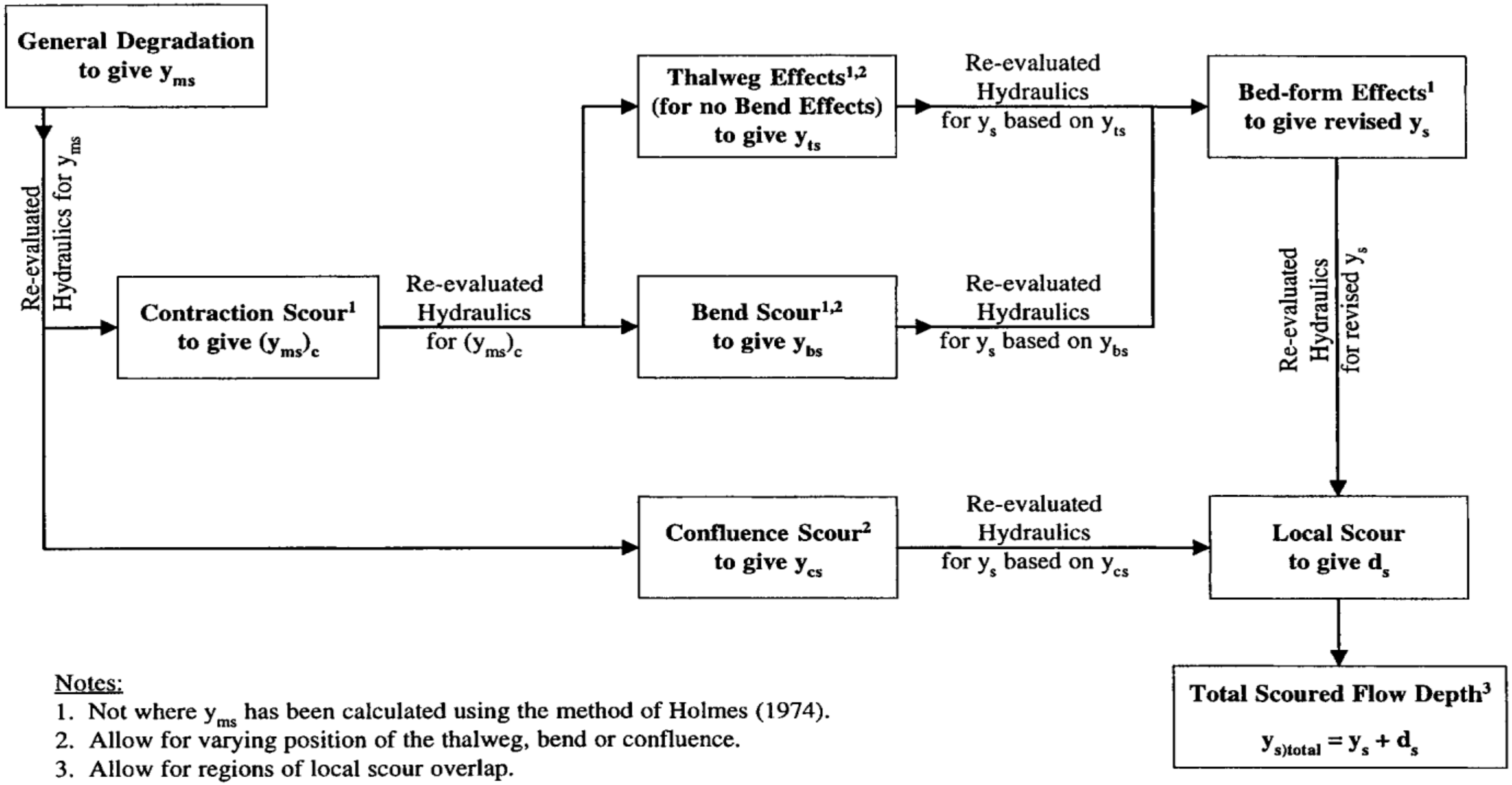
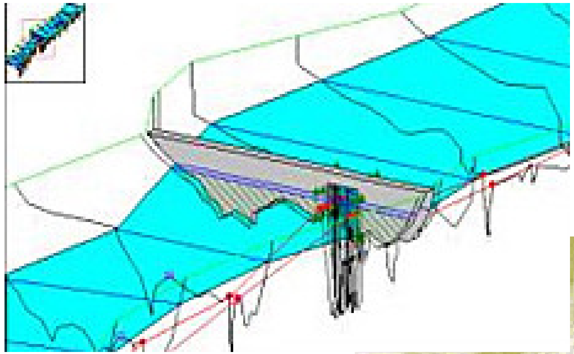
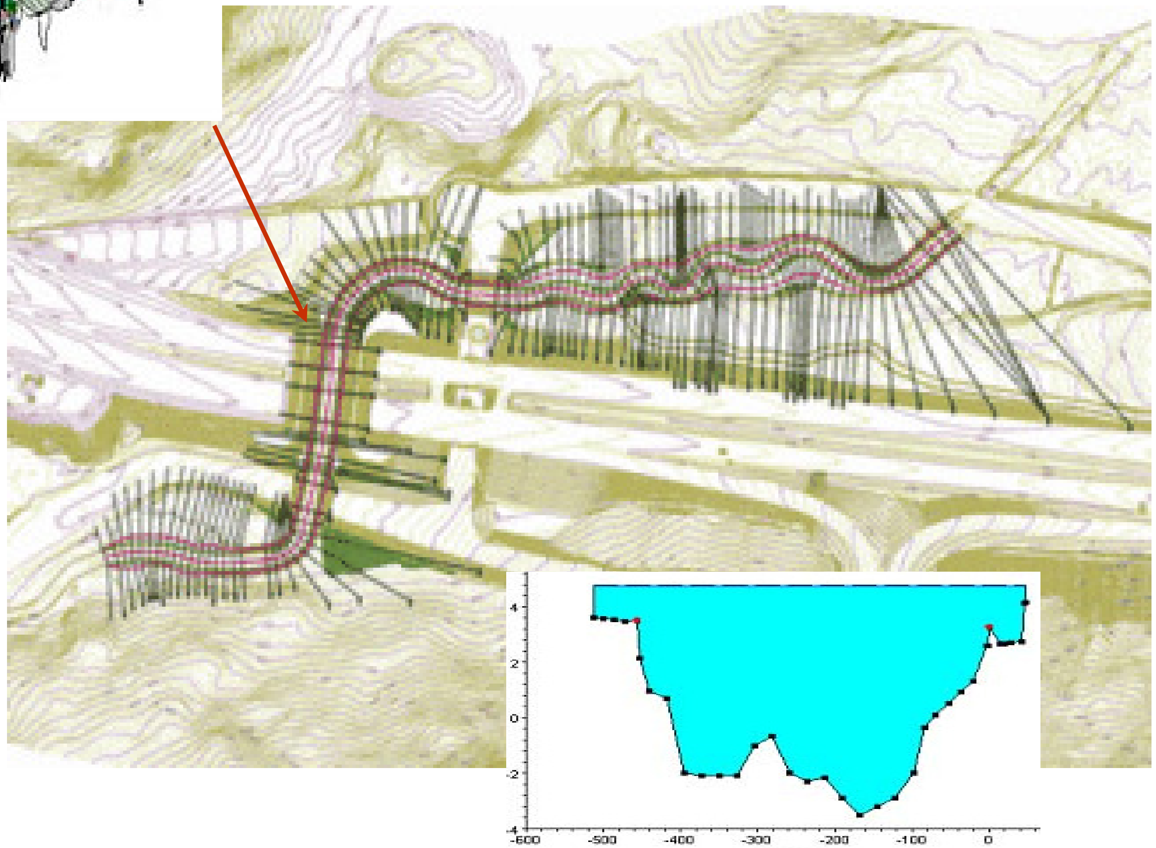


FIG. 1. Methodology for Quantitative Prediction of Scour Depth

Floodplain Analysis using Computer Models

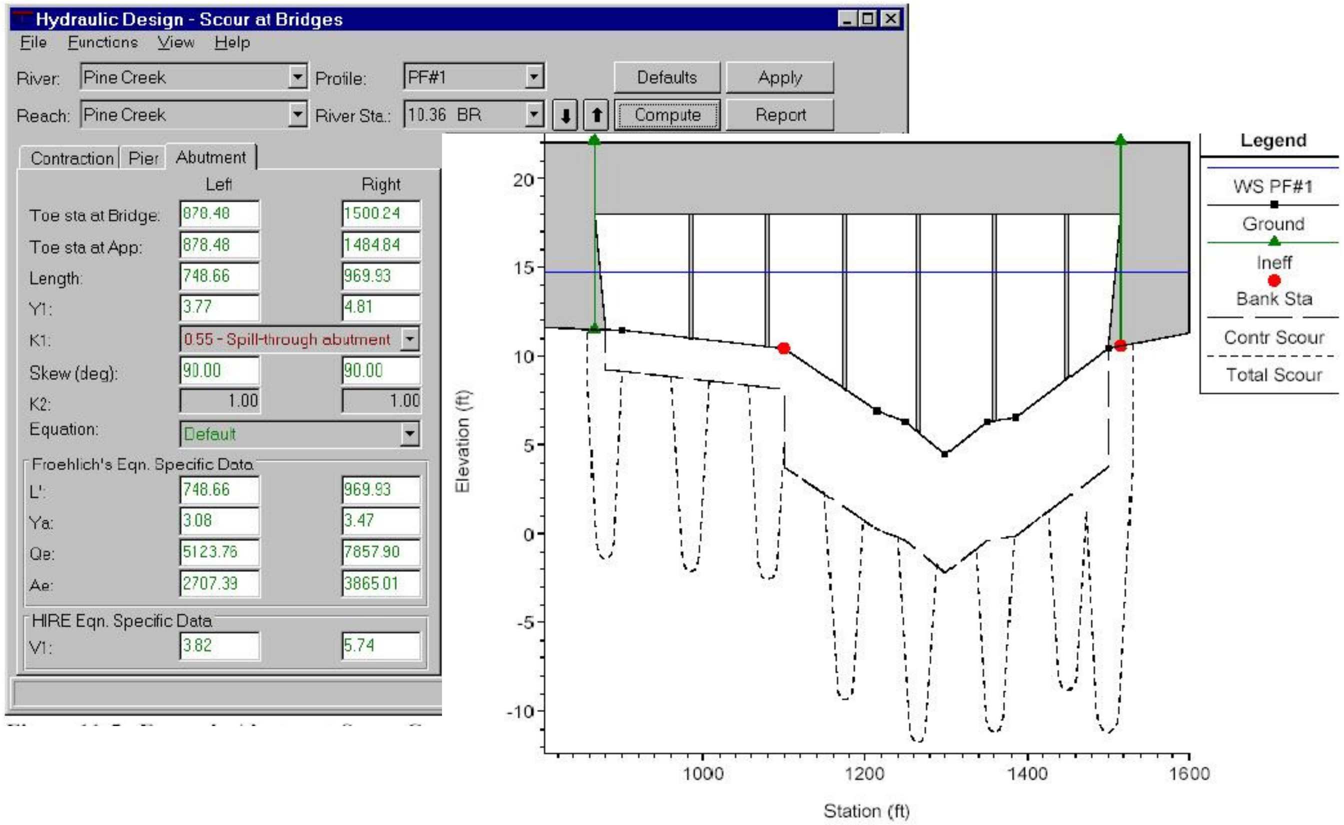


1D Flow Model:
HEC-RAS



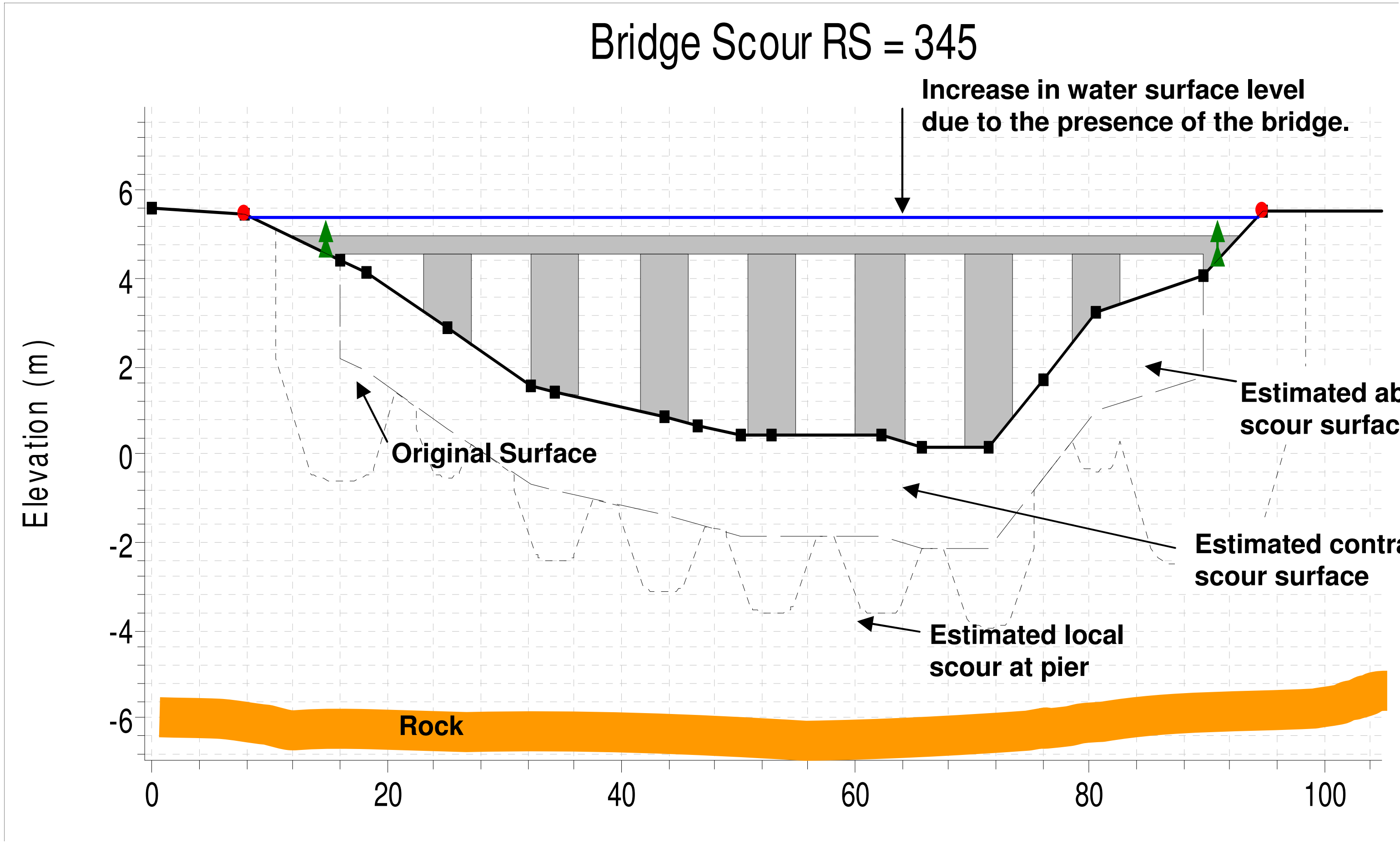
Modelling Software

- HEC-RAS
- MIKE11/21
- Tuflow/Estry



Scour calculations in HEC RAS require a hydraulic model

Approach to Bridge Design for Total Scour



Set the Foundations at a level that assumes that the point of fixity for structural design is below the calculated depth of scour.

Keelbottom Creek

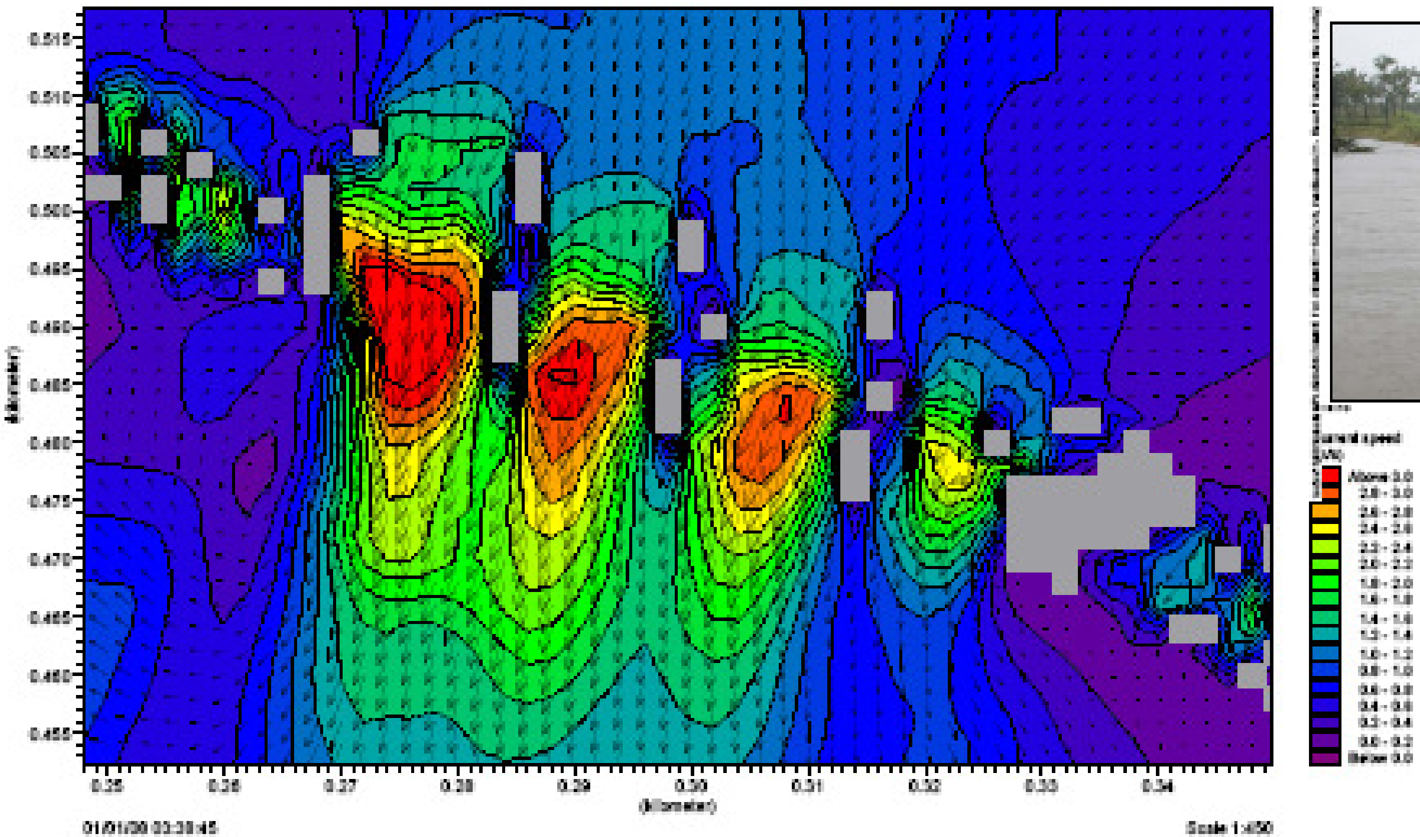
Serious scour problems since bridge was built.

On-going maintenance and repairs.

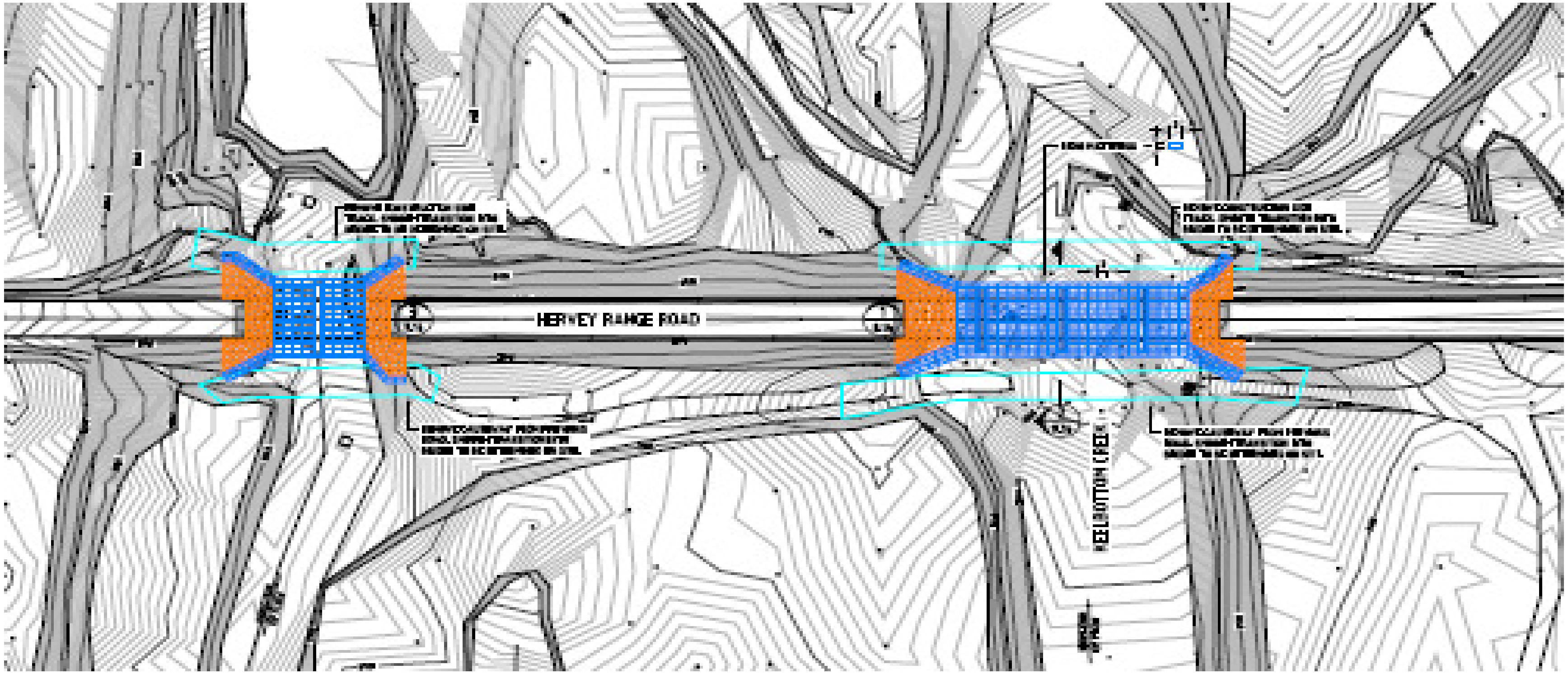
Existing rock protection ineffective.

MIKE Flood 2D Model

Detailed hydraulic modelling to show flow velocity.
Velocity more than 3m/s through bridge.

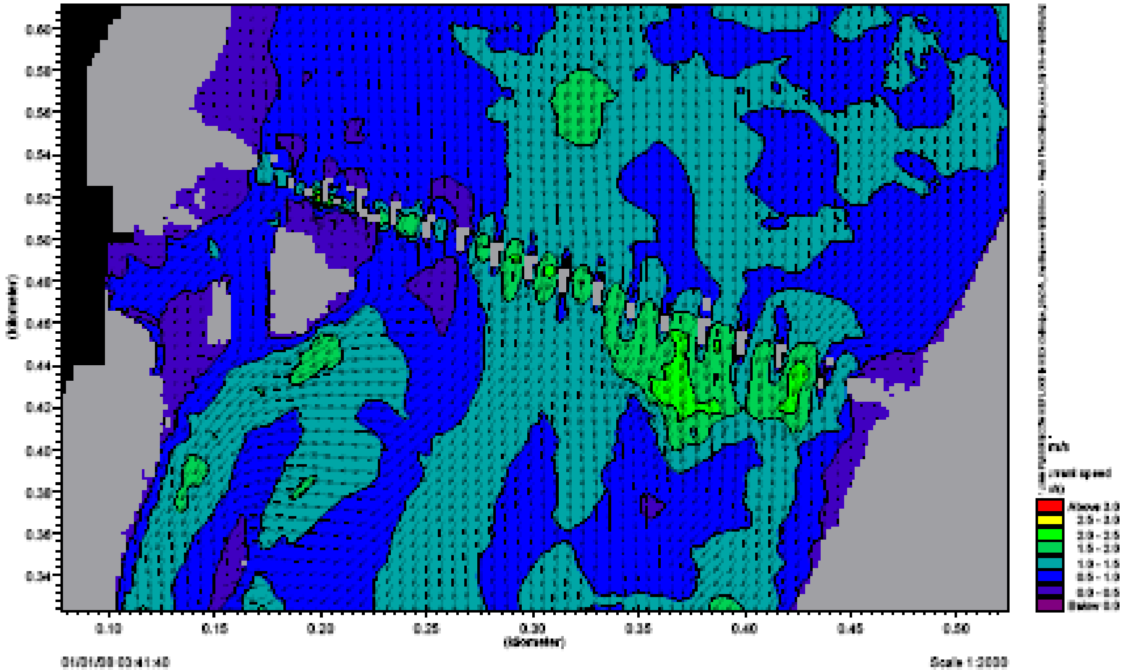


Option – Scour Protection



Gabions and rock protection
High cost
Still have high flow velocity through bridge

Option – Lengthen Bridge



Longer bridge reduces flow velocity and scour risk.

Velocity less than 1.5m/s.

Option should probably have been built initially.

High cost and inconvenience.

Summary

Hydraulics has the capability and expert knowledge to analyse complex hydraulic issues related to the state controlled road network.

Hydraulics should be one of the major concerns during planning and designing stages of TMR projects.

Underestimation of hydraulics could lead to protracted issues.
If not recognised at early stages, simple problems can lead to major concerns.

Consulting with hydraulics is as simple as a phone call.

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Questions?

Acknowledgement:

Many thanks to the photographers who created images used in this presentation