Options for Flow-Control Compliance and Stream Stability Analysis

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Flow Control Standard

Post-project runoff peaks and durations must not exceed pre-project levels if an increase could cause erosion or other significant effects on beneficial uses.

Contra Costa Approach

- Establish a clear standard
- Provide options for compliance
- Encourage LID
- Provide the tools
- Dive in!

Flow Control Compliance Options

1. No increase in directly connected impervious area (or drainage efficiency)
2. Implementation of flow control IMPs
3. Runoff does not exceed pre-project flow peaks and durations
4. Projected increases in runoff peaks and durations will not accelerate erosion of receiving stream

Flow Control Compliance Options

(Stormwater C.3 Guidebook: Appendix D)

1. No increase in directly connected impervious area (or drainage efficiency)
   - Site design to minimize imperviousness and retain/detain runoff (LID approach, Ch. 3)
   - Inventory of existing vs proposed impervious area
   - Qualitative comparison of pre- vs post-project drainage efficiency; describe:
     - Design of self-retaining areas & treatment IMPs, OR
     - Decreased time of concentration and runoff volume

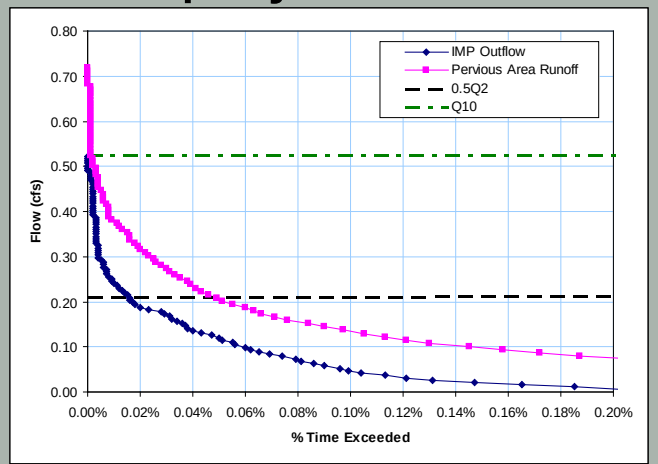
Flow Control Compliance Options

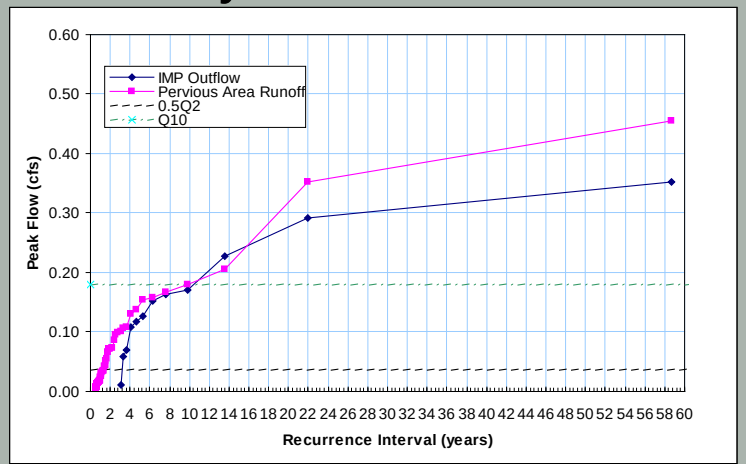
2. Implementation of flow control IMPs

- Select and size IMPs following C.3 Guidebook procedure

Flow Control Compliance Options

3. Runoff does not exceed pre-project flow peaks and durations
   - Continuous simulation hydrologic modeling to demonstrate peak and duration control
   - Duration standard: 0.1Q2-Q10, post-project below pre-project (allowance: <10% exceedance over <10% of the simulation)
   - Peak flow standard: 0.5Q2-Q2, post-project below pre-project; Q2-Q10, 10% allowance for 1-year interval





Flow Control Compliance Options

4. Projected increases in runoff peaks and durations will not accelerate erosion of receiving stream

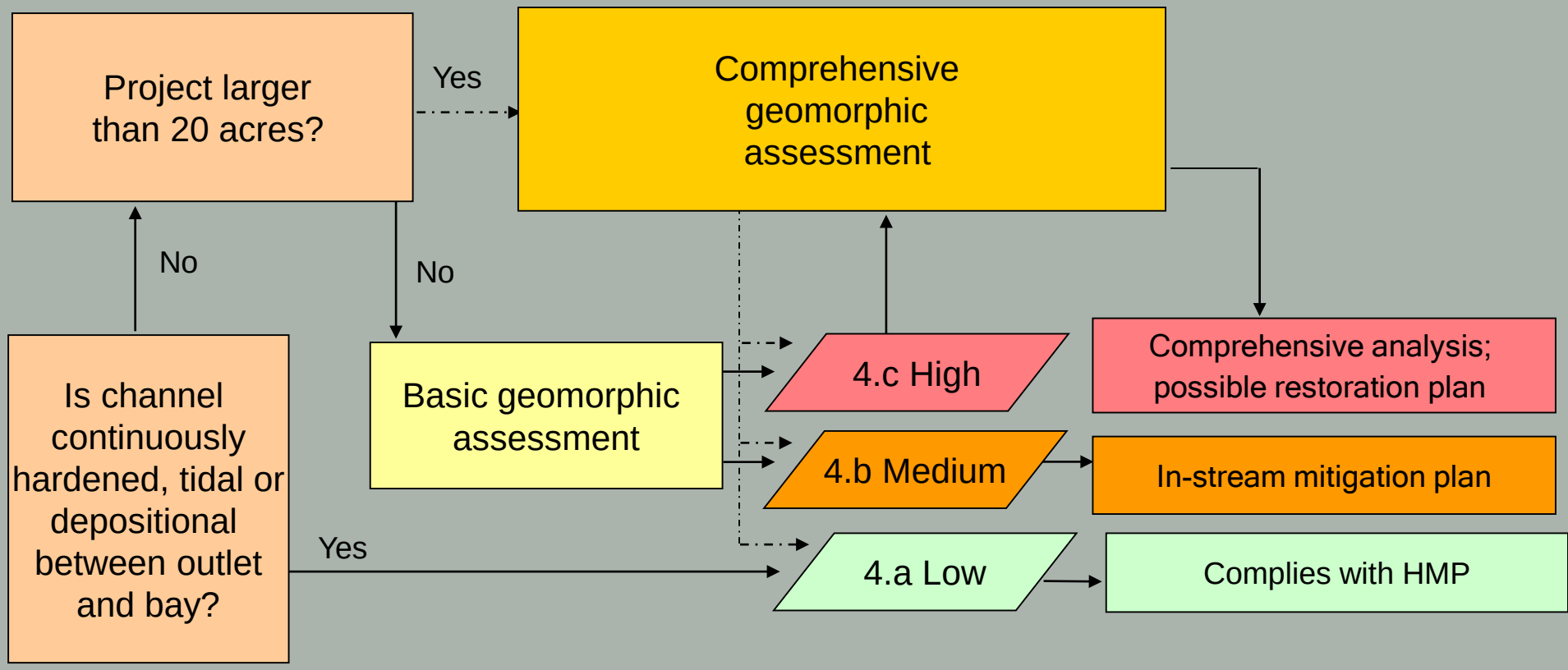
- Assess vulnerability of receiving stream to hydrograph modification impacts:

4.a Low Risk – stream not vulnerable, project complies

4.b Medium Risk – stream currently stable, but accelerated erosion cannot be ruled out; propose in-stream measures to mitigate for increased runoff

4.c High Risk – stream unstable under current conditions, vulnerable to increases in flow peak/duration; propose comprehensive in-stream restoration (or flow control)

Assess stream vulnerability to erosion



Municipal staff and RWQCB must be involved EARLY ON in the development of any in-stream mitigation plan

Assess stream vulnerability to erosion

4a. Low Risk – demonstrate stream channels between the project and the Bay/Delta are:

- *Enclosed pipes* – storm drain map or other municipal data
- *Hardened bed and banks* – field reconnaissance, CCFCD
- *Tidally-influenced* – channel elevation, field recon.
- *Aggrading* – inspection by qualified professional; CCFCD

Assess stream vulnerability to erosion

4b. Medium Risk

- basic geomorphic assessment to document risk class
- Propose appropriate in-stream mitigation measures
- Subject to regulatory review/approval

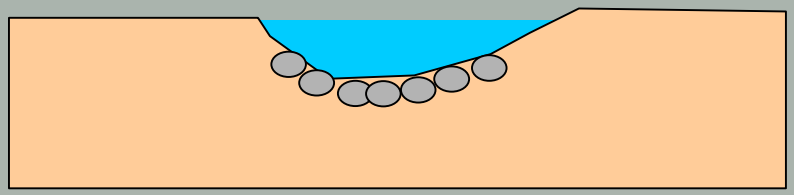
Assess stream vulnerability to erosion

4c. High Risk

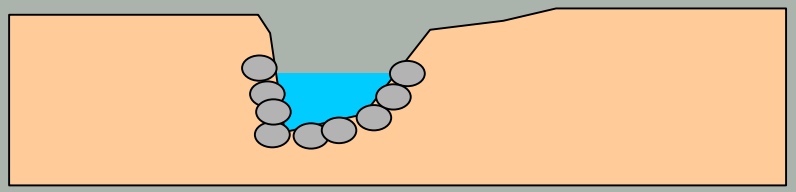
- Basic geomorphic assessment to make initial determination
- Comprehensive geomorphic assessment for mitigation planning
- High standard for in-stream mitigation

Basic geomorphic assessment

Shear stress sensitivity



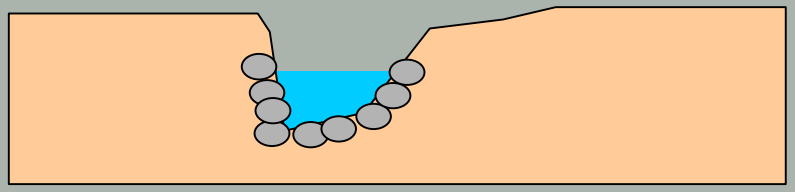
Wide, shallow channel – little increase in shear stress with Q. Q2 dissipates over floodplain



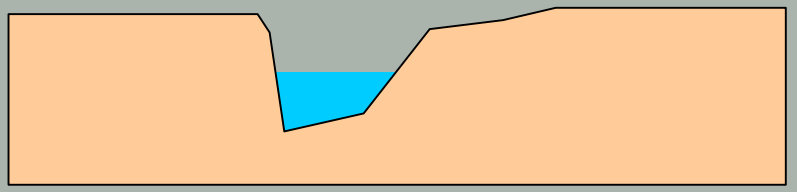
Narrow, deep channel – large increase in shear stress with Q. Q2 confined in channel.

Basic geomorphic assessment

Channel Resistance



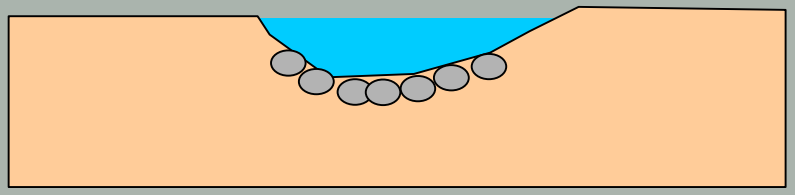
Coarse sediment and vegetated channel - less erosion-prone



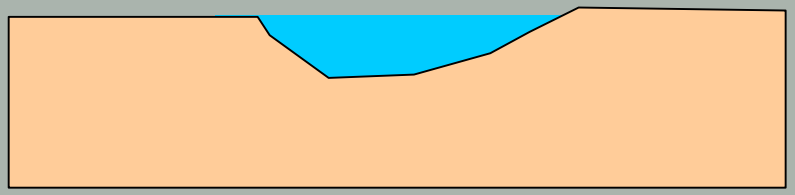
Fine sediment and unvegetated channel - more erosion-prone

Increasing channel vulnerability

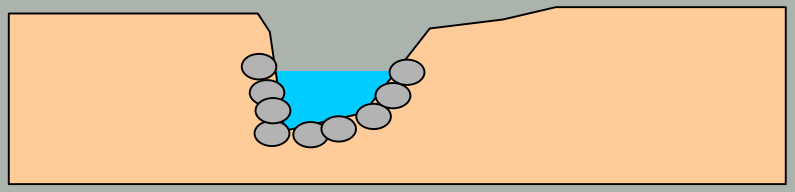
Basic geomorphic assessment



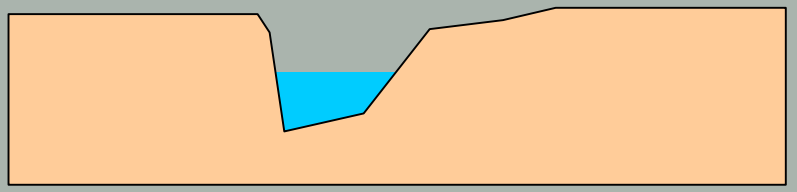
resistant sediment,
not very entrenched



non resistant sediment,
not very entrenched



resistant sediment,
highly entrenched



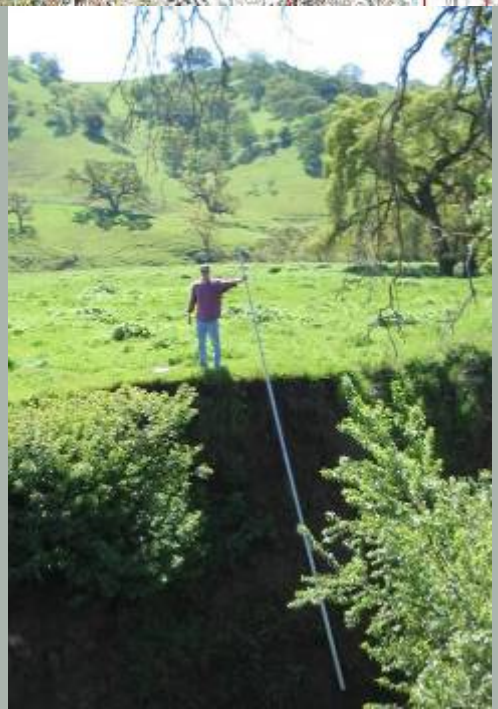
non resistant sediment,
highly entrenched

Increasing vulnerability

Increasing channel vulnerability

Basic geomorphic assessment

- Assessed 20 stream sites in Contra Costa County
- Use best professional judgment to make initial risk assessment
- Measured numerous relevant field parameters
- Identified type and thresholds of field data that objectively led to same results as the professional judgment



Field Reconnaissance

Marsh Creek near Oakley
Low gradient flood channel

Low Risk

Note however: channel misclassified as riprap in GIS (applicants will need to ground truth)

Field Reconnaissance

Marsh Creek near Marsh Creek reservoir
Low-moderate gradient, natural channel, eroding outside bends

Medium Risk

Some excess energy can be expended on floodplain and vegetation, but limited potential for lateral erosion

Field Reconnaissance

Upper Marsh Creek
medium gradient, confined channel

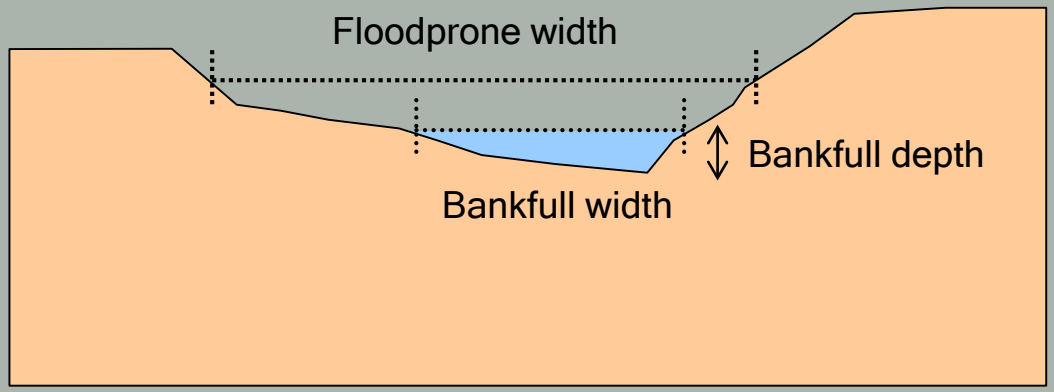
High Risk

Excess energy directed to eroding bank

Basic geomorphic assessment – Primary Indicators

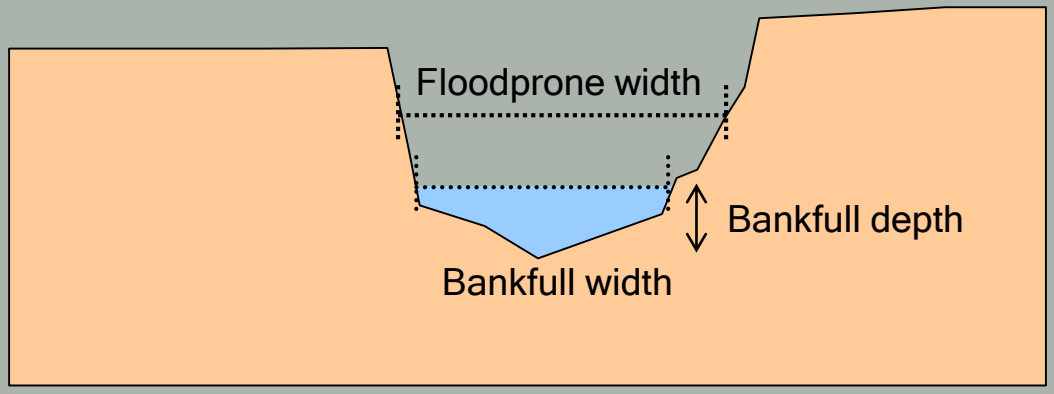
Entrenchment Ratio = (Floodprone Width*) / (Bankfull Width)

Floodprone width = width at 2 x bankull depth



ER > 1.6 – risk class is "Medium"

channel is non entrenched



ER < 1.6 – risk class is "High"

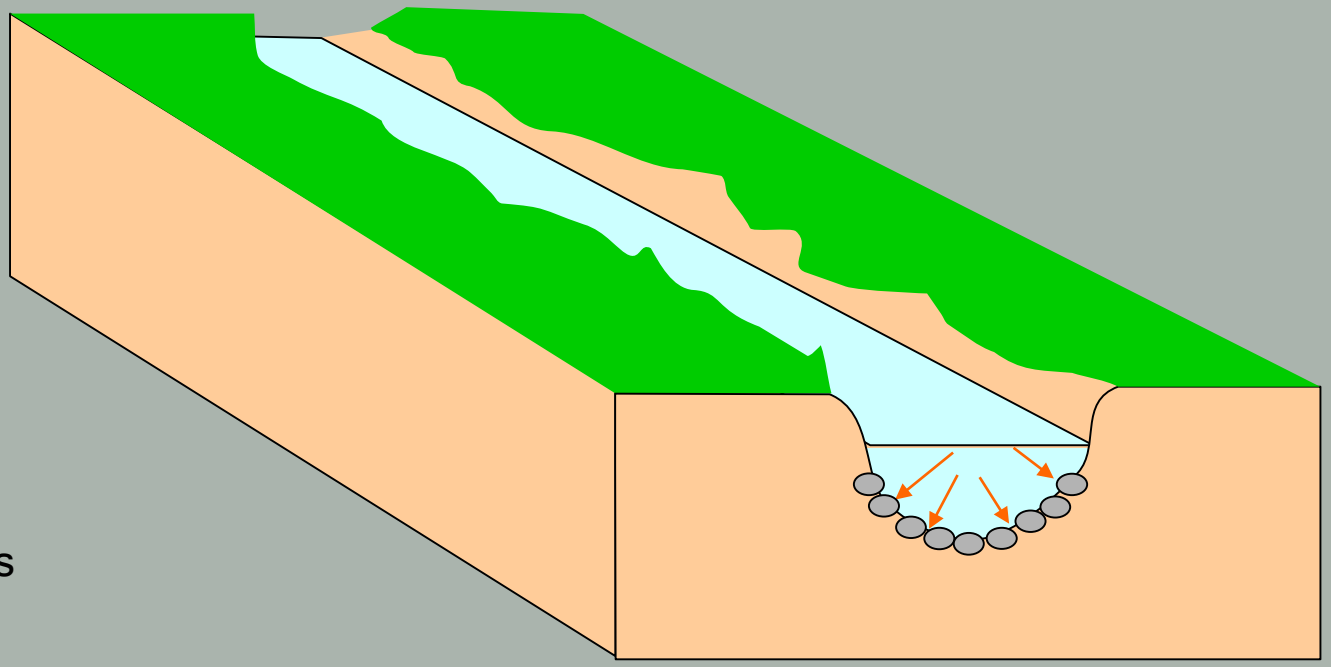
channel is entrenched

Basic geomorphic assessment – Primary Indicators

Entrainment ratio = (shear resistance)/(shear stress)

If ER > 2.0 risk class is “Medium”
- channel is stable under existing flows but may erode under higher flows

If ER < 2.0 risk class is “High”
- channel is unstable under existing flows and will erode under higher flows



AvBoundShearStress = g.HR.s

Basic geomorphic assessment – Secondary Indicators

1. Active bank erosion class
2. Sediment reduction impact
3. Channel width/depth ratio
4. Schumm channel classification

bank erosion: low

bank erosion: medium

bank erosion: high

Basic geomorphic assessment

	Primary Criteria	
Vulnerability	Medium	High
Entrenchment Ratio	> 1.6	< 1.6
Entrainment Ratio	< 2.0	> 2.0

If both primary criteria indicate the same vulnerability class, that class is adopted.

If primary criteria disagree, use preponderance of secondary criteria.

In 2/3rds of cases (n=20) the primary criteria led to a decisive result that was in agreement with the field judgment

Example field sheets

Site 74 – Briones Valley Headwaters

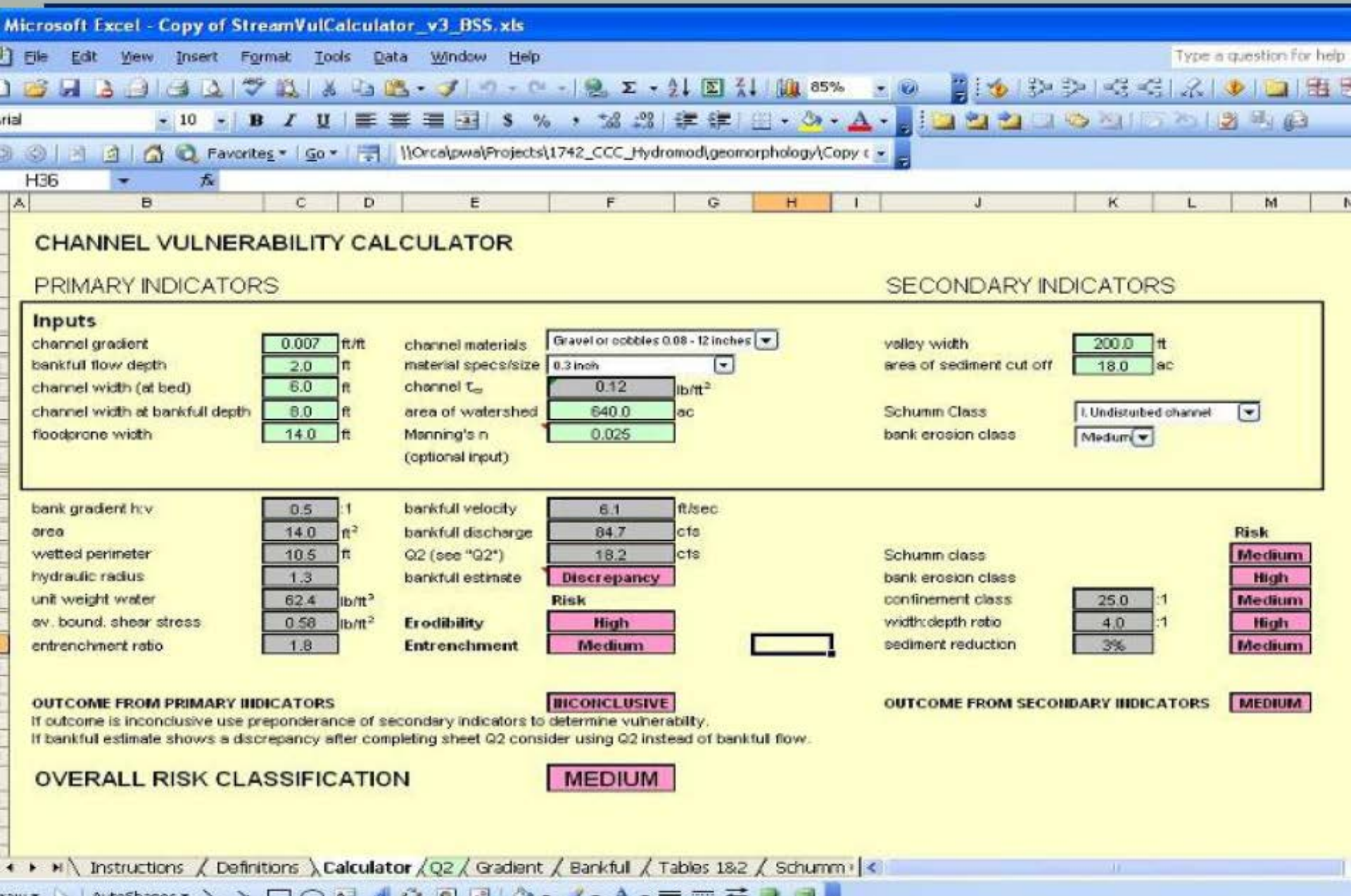
Site Coordinates	**604189, 4196462**	Site Datum:	**UTM WGS 1984**
Primary Attributes		Confinement Class	WC (H)
Entrenchment Ratio	1.06 (H)	Active bank erosion	Moderate
Entrainment Ratio	8179 (H)	Active sediment supply	Moderate
Secondary Attributes		Bed Materials	silty clay (H)
Bankfull Width (ft)	9	Bank Materials	silty clay (H)
Bankfull Depth (ft)	0.5	Average Gradient	0.58%
Width/Depth Ratio	18.0 (M)	**CLASSIFICATION**	HIGH

(m) – Medium Criterion, (h) – High Criterion

RISK JUSTIFICATION: Primary attributes are High. Fine substrate combined with evidence of localized bank erosion and significant channel incision under existing conditions; moderate supply of sediment will help maintain an alluvial mantle and prevent incision, although reduction in supply could destabilize the channel; high width/depth ratio may be a result of channel widening associated with cattle-driven sedimentation.

SITE NOTES: Locally steep eroded bluffs providing a moderate amount of sediment supply. Banks mostly stable and well vegetated. Occasional boulders and bedrock blocks in channel. Channel incised about 9 feet into valley floor.

Example Excel spreadsheet



Mitigation on 'medium' and 'high' risk streams

- Basic assessment can provide some guidance on mitigation, but more assessment and design analysis will be needed

- Modify channel so that attributes indicate greater stability
  - e.g. lower floodplain to reduce entrenchment ratio,
  - e.g. increase sinuosity to reduce entrainment ratio

Site 58 – Releiz Creek **PRELIMINARY SITE SHEET** Page 1

Site 58 – Releiz Creek

Site Coordinates **578889, 4196097** Site Datum: **UTM WGS 1984**

Primary Attributes		Confinement Class	WC (h)
Entrenchment Ratio	1.43 (h)	Active bank erosion	High (h)
Entrainment Ratio	0.54 (m)	Active sediment supply	Moderate (m)
Secondary Attributes		Bed Materials	Gravel (m)
Bankfull Width (ft)	9	Bank Materials	silt
Bankfull Depth (ft)	1.4	Average Gradient	1.98%
Width/Depth Ratio	6.4 (h)	**CLASSIFICATION**	HIGH

(m) = Medium Criterion; (h) = High Criterion

RISK JUSTIFICATION: Primary and secondary attributes are mixed. High risk class assignment due to confinement, evidence of historic incision. Coarse bed materials suggest a low risk for incision, although confinement indicates that erosion potential during large storms may be significant.

Mitigation on a ‘high risk’ stream

Mitigation on a ‘high risk’ stream

Create floodplain to reduce shear stress sensitivity and increase habitat function

Mitigation on a ‘high risk’ stream

Grade controls - lower channel gradient and reduce entrainment ratio.

Immediately after installation

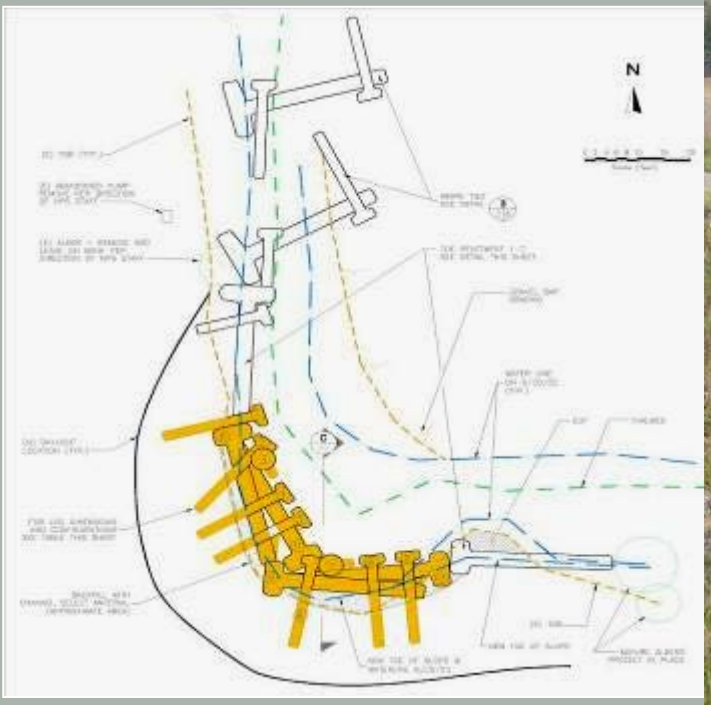
Three years later

Floodplain lowering – reduces shear stress and creates habitat

Mitigation on a ‘medium risk’ stream

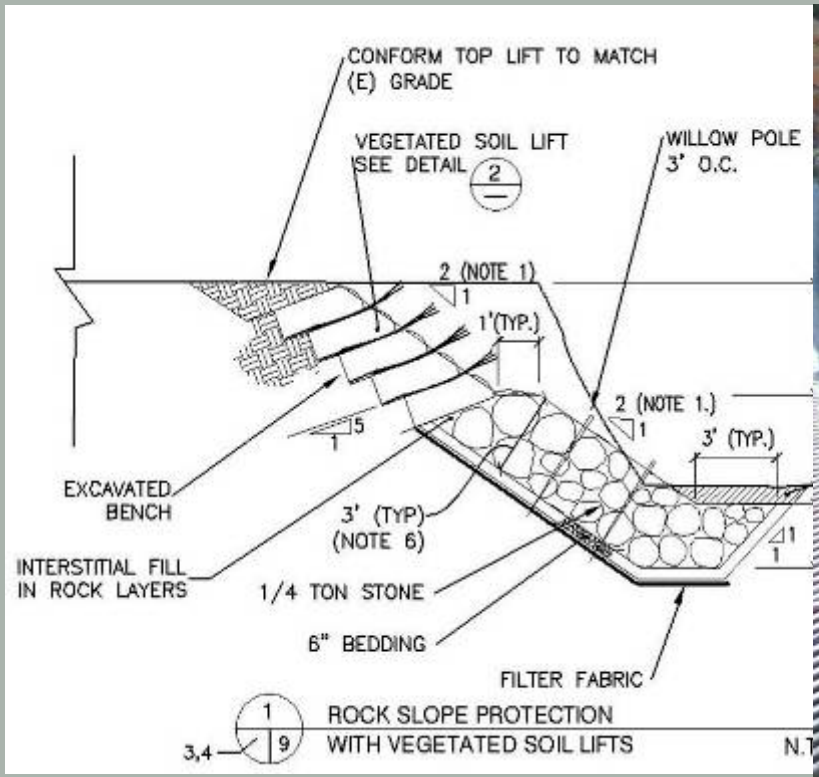
Root wad revetment – increases resistance, reduces shear stress and creates habitat

Combination of root wad revetment and willow mattress



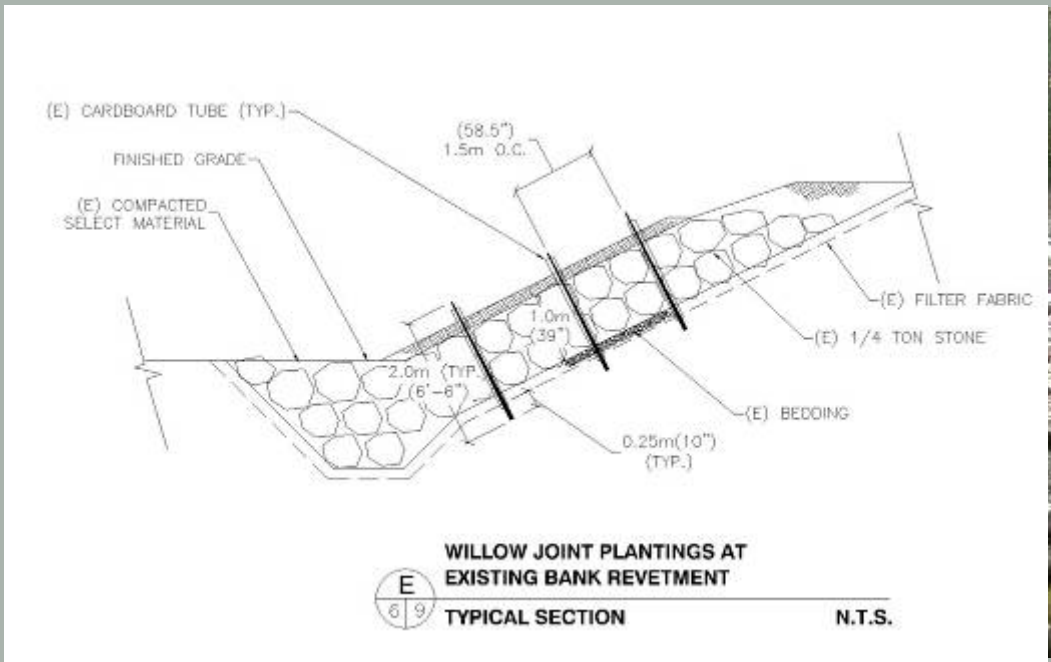
Mitigation on a ‘medium risk’ stream

Vegetated soil lift for bank reconstruction in confined sites – stabilizes bank and increases shear resistance



Mitigation on a ‘medium risk’ stream

Vegetated Rock Revetment – bank reconstruction for high stress hot spots



Summary

- For small projects, relatively simple field indicators can be used to quickly classify the majority of streams into risk categories
- Larger projects and/or more complex stream systems require more sophisticated approaches
- Mitigation should address the underlying cause of erosion, not just harden eroded areas
- Early involvement of municipal staff and regulatory agencie is key to approval of in-stream mitigation projects

Questions?