# WARSSS Task Outline

Below is an outline of the three levels of the Watershed Assessment of River Stability and Sediment Supply (WARSSS; Rosgen, 2006.) It emphasizes the field work needed to execute each level; these activities are in **bold** font and highlighted in yellow.

## Reconnaissance Level Assessment (RLA)

| Step | Information Sources/Activities |
|---|---|
| 1. Compile existing data (p. 3-2) | Compile WQ monitoring reports that are focused on sediments, topo maps, aerial photos, soil & geology maps, GIS LiDAR, flood history, land use map, historic land use (especially related to channel stability; dredging, urbanization, etc.). |
| 2. Review landscape history (p. 3-6) | ID problem magnitude, extent, and trends, focusing on land uses. |
| 3. Summarize activities affecting sediment supply & channel stability (p. 3-6) | Divide WS into sub WSs with similar land use history (Table 3-1, p. 3-7). |
| 4. ID specific source relations (p. 3-8) | ID links between land use and erosional processes, by sub WS (Table 3-2. p. 3-9), and ID places with likely erosion problems. |
| 5. Review landscape overview & map watershed (p. 3-10) | **Site visit** to assess uncertainties from steps 1-4.<br>ID sediment source areas and/or processes that affect sediment supply & river stability.<br>ID & map stream & valley types. |
| 6. ID hillslope processes (p. 3-13) | Overlay soil maps with land use, and use info in previous steps, to ID sites prone to upland erosion. |
| 7. Document surface erosion (p. 3-14) | ID reaches with potential surface erosion, using soil & topo maps, aerial photos, & the criteria in Table 3-3, p. 3-14. Enter results into Worksheet 3-1, p. 3-15. |
| 8. Document mass erosion (p. 3-16) | ID reaches with potential mass erosion, using criteria in Table 3-4, p. 3-16. Enter results into Worksheet 3-1, p. 3-15. |
| 9. Assess hydrologic processes (p. 3-16) | See step 10. |
| 10. ID streamflow changes (p. 3-17) | ID reaches with changes in vegetation, urbanization, water diversions, plus assess reservoir and road location, using criteria in Table 3-5, p. 3-17. Enter results into Worksheet 3-1, p. 3-15. |
| 11. Analyze channel processes (p. 3-18) | Using maps and photos, ID reaches with potential changes in channel morphology and stability, using criteria in Table 3-6, p. 3-18. Enter results into Worksheet 3-1, p. 3-15. |
| 12. ID impacts to streambanks and channels (p. 3-19) | ID reaches where banks and/or channel have been altered, using criteria in Table 3-7, p. 3-19. Enter results into Worksheet 3-1, p. 3-15. |
| 13. Summarize problem verification (p. 3-20) | Plot results from Worksheet 3-1 on to watershed map and ID reaches for RRISSC assessment. |
| 14. Eliminate reaches that do not contribute to impairment (p. 3-20) | |
| 15. Select reaches for RRISSC (p. 3-20) | |

**Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC)**

| Step | Information Sources/Activities |
|---|---|
| 1. ID land uses (p. 4-4) | Augment info from RLA-Step 2, as per Table 4-1, p. 4-4 to 4-7. Create map coverages of hillslope, hydrologic, and channel processes. |
| 2. Perform landscape & river inventory (p. 4-7) | Compile info listed in Table 4-2, p. 4-8, using data from RLA-Step 1. **Need regional reference curve, stream classification data, pebble counts.** |
| 3. Determine variables influenced (p. 4-10) | Review info in Tables 3-1, 3-2, and 4-1, and use Table 4-3 (p. 4-11) to identify which Worksheets to use. |
| 4. Compile data for risk rating system (p. 4-12) | Compile data from steps 4-6 thru 4-19, and enter into Worksheet 4-2, p. 4-13. |
| 5. Compile data for hillslope processes (p. 4-14) | Overlay land use, including roads, over soil/geology hazard maps for reaches identified in the RLA, and use in steps 6, 7, and 8. |
| 6. Hillslope: Mass erosion (p. 4-14) | Use aerial photo-interpretation and the info in Table 4-4 (p. 4-16), Figure 4-1 (p. 4-19) and Figure 4-2 (p. 4-20) to ID sites prone to avalanches or slumps. Enter results in Worksheet 4-3, p. 4-18. |
| 7. Hillslope: Roads (p. 4-21) | Estimate risk using Worksheet 4-4 and Figures 4-3, 4-4, 4-5, and 4-6. Enter final risk results in Worksheet 4-2, p. 4-13. Applies to 1st and 2nd order streams. *Rather complicated.* |
| 8. Hillslope: Surface erosion (p. 4-26) | Estimate risk using Worksheet 4-5 and Figures 4-7, 4-8, 4-9, 4-10, 4-11, 4-12, and 4-13. Enter final risk results in Worksheet 4-2, p. 4-13. |
| 9. Rate risk for hydrologic processes (p. 4-34) | Compile data on vegetative cover, reservoir operations, water diversions, irrigation return flows, and water transfers. |
| 10. Assess potential for streamflow changes (p. 4-35) | Use previous data and Figures 4-14, 4-15, 4-16, and 4-17; enter results into Worksheet 4-6 (p. 37). |
| 11. Rate risk for channel processes (p. 4-43) | Compile data, especially historic aerial photos. |
| 12. General stability assessment (p. 4-43) | Not really a step; brief discussion of steps 13-15. |
| 13. Bank erosion risk (p. 4-44) | Use previous data and Figures 4-18, 4-19, 4-20, 4-21, and Worksheet 4-7 (p. 4-45); enter results into Worksheet 4-2, p. 4-13. |
| 14. In-channel mining (p. 4-50) | Use Figure 4-22 and Worksheet 4-8 (p. 4-51); enter results into Worksheet 4-2, p. 4-13. |
| 15. Direct impacts (p. 4-53) | Use previous data, especially historic aerial photos and vegetation maps, with Figures 4-23, 4-24, 4-25, and Worksheet 4-9 (p. 4-54); enter results into Worksheet 4-2, p. 4-13. |
| 16. Enlargement (p. 4-59) | Use stream type and info from steps 10, 13, 14, and 15, Worksheet 4-10 (p. 4-60) and Figure 4-26; enter results into Worksheet 4-2, p. 4-13. |

**Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC), completed**

| Step | Information Sources/Activities |
|---|---|
| 17. Aggradation/excess sediment (p. 4-62) | Use stream type, aerial photos, info from steps 6, 7, 8, 13, 16, and Figure 4-27 and 4-28, and Worksheet 4-11 (p. 4-64); enter results into Worksheet 4-2, p. 4-13. |
| 18. Channel evolution/ successional states (p. 4-67) | Use stream type, reference stream condition, Figure 2-38, and Table 4-5; enter results into Worksheet 4-2, p. 4-13. |
| 19. Degradation (p. 4-69) | Use stream type and info from steps 10, 14, 15, 18, Figure 4-29, and Worksheets 4-12 (p. 4-70) and 4-13 (p. 4-71); enter results into Worksheet 4-2, p. 4-13. |
| 20. Summarize sediment supply & channel stability risk (p. 4-73) | Not really a step; brief discussion of steps 21 and 22. |
| 21. Summarize consequences (p. 4-73) | Use information in Worksheet 4-2 (p. 4-13) to identify reaches for steps 22, 23, and 24. |
| 22. ID low risk reaches (p. 4-73) | Discard low risk reaches. |
| 23. ID moderate risk reaches (p. 4-74) | Choose whether to advance moderate risk reaches to the PLA process, or merely mitigate and monitor. |
| 24. ID high risk reaches (p. 4-74) | Proceed to Prediction Level Assessment (PLA) |

**Prediction Level Assessment (PLA)**

| Step | Information Sources/Activities |
|---|---|
| 1. Develop or obtain reference curves (p. 5-9) | **Perform appropriate surveys – seems to overlap with RRISSC step 2.** See Figure 5-2 (p. 5-11) for procedure. |
| 2. Calculate drainage area (p. 5-12) | Was probably performed earlier. |
| 3. Field calibrate bankfull discharge (p. 5-14) | Establish bankfull dimensions (see text and Figures 5-3, 5-4, and 5-5 for survey suggestions), and calibrate to gage. Enter results into Worksheet 5-1, p. 5-13. |
| 4. Calculate bankfull discharge & dimensions (p. 5-20) | Use previous data, reference curves and Worksheet 5-2 (p. 5-21). Enter results into Worksheet 5-1, p. 5-13. |
| 5. Classify stream reaches – Level II (p. 5-28) | As per Figures 2-13 and 2-14, and Worksheet 5-3 (p. 5-29). |
| 6. Calculate detailed dimensionless ratios (p. 5-30) | Use previous data and Worksheet 5-4 (p. 5-31). |
| 7. Identify stream stability indices (p. 5-34) | **Perform appropriate surveys, including Pfankuch rating.** Use Worksheets 5-6 and 5-7, Figures 5-9 through 5-17, and Tables 5-3 and 5-4. Record data in Worksheet 5-5 (p. 5-35). |
| 8. Calculate BEHI and NBS (p. 5-54) | **Perform appropriate surveys.** Use Worksheet 5-8 (p. 5-55) and associate figures for BEHI, and Worksheet 5-9 (p. 5-66) and associated figures for NBS. There are 7 options for calculating NBS. |
| 9. Predict annual streambank erosion rate (p. 5-78) | **Requires field calibration of BEHI & NBS.** Record data in Worksheet 5-10 (p. 5-81). |
| ***Predicting total annual sediment yield with FLOWSED (steps 10 – 15). Data requirements in Table 5-12.*** | |
| 10. Develop dimensionless flow-duration curve (p. 5-89) | Different procedures whether stream is snowmelt-dominated or stormwater-dominated; p. 5-89. |
| 11. Sample bankfull discharge, bedload and suspended load (p. 5-92) | **Perform appropriate surveys at or near bankfull stage.** |
| 12. Establish dimensionless sediment rating curves (p. 5-93) | Use data from step 11; plot bankfull discharge vs. sediment loads. |
| 13. Establish dimensioned sediment rating curves (p. 5-94) | Multiply bankfull discharge and sediment values from step 11 by the appropriate ratios from step 12. *Regional curves may be substituted.* |
| 14. Establish dimensioned flow-duration curve (p. 5-96) | Multiply bankfull discharge from step 11 by Qmnd/Qbkf ratios from step 10. |
| 15. Calculate annual sediment yield for bedload & suspended sediment (p. 5-97) | Use curves from step 13 and curve from step 14; enter results into Worksheet 5-11 (p. 5-88). |

**Prediction Level Assessment (PLA), continued**

| | |
|---|---|
| ***Calculate flow-related changes in annual sediment yield with FLOWSED model (steps 16 & 17)*** | |
| 16. Select and run water yield model (p. 5-100) | Select from among several choices; model should be locally calibrated. |
| 17. Calculate flow-related changes in annual sediment yield (p. 5-102) | Use Flowchart 5-12; subtract post-treatment annual yield minus pre-treatment annual yield. |
| ***Determine channel stability with POWERSED sediment transport capacity model (steps 18 & 19) and the FLOWSED model*** | |
| 18. Develop hydraulic geometry relations for a range of flows (p. 5-110) | **Survey slope, transects, and channel materials at different stages.** Get from POWERSED model? |
| 19. Calculate stream power (p. 5-111) | Use data from step 18 and flow-duration and bedload and suspended sand sediment rating curves from FLOWSED, and Worksheets 5-12a and 5-12b (p. 5-108 & 5-109). |
| 20. Determine sediment delivery from roads, surface erosion and mass erosion (p. 5-114) | Roads: use Table 5-14, Figures 5-46 & 5-47, and Worksheet 5-13. Surface erosion: use RUSLE or WEPP and the sediment delivery index (p. 5-118). Mass erosion: for debris flows and slump/earthflow processes; see p. 5-125. |
| 21. Summarize annual sediment yield from hillslope processes (p. 5-126) | Text not clear. |
| 22. Calculate sediment entrainment/competence (p. 5-129) | Use Flowchart 5-16 and Worksheet 5-15 (p. 5-135) to calculate depth and/or slope necessary to move largest particle at bankfull stage. *Sand-bed streams are not evaluated for competence, but are evaluated for transport capacity (steps 18 and 19).* **Requires riffle pebble count and bar sampling, and channel dimension data.** |
| 23. Predict channel bed response (p. 5-138) | Use capacity (steps 18 and 19) and competence (step 22) to determine bed stability. |
| 24. Calculate potential stream successional stage shift (p. 5-142) | Use Worksheet 5-16 (p. 5-142) and Figure 5-55 to assess channel adjustments and beneficial uses. |
| 25. Calculate lateral stability ratings (p. 5-144) | Use info from Worksheets 5-5 and 5-10, and Worksheet 5-17 (p. 5-145). |
| 26. Calculate vertical stability ratings (p. 5-146) | Use Worksheets 5-18 and 5-19 (p. 5-147 and 5-148). |
| 27. Calculate potential channel enlargement (p. 5-149) | Use Worksheets 5-20 (p. 5-149) and 5-21 (p. 5-152). |
| 28. Determine overall sediment supply ratings (p. 5-151) | Complete Worksheet 5-21 (p. 5-152) using information from Worksheets 5-17, 5-18, 5-19, 5-20, and 5-7. |

**Prediction Level Assessment (PLA), completed**

| **Summary evaluations (steps 29-31)** | |
|---|---|
| 29. Calculate total sediment yield (p. 5-156) | Complete Worksheet 5-22 (p. 5-155), using info from multiple previous steps and worksheets. |
| 30. Compare sediment supply to baseline condition (p. 5-157) | Complete Worksheet 5-23 (p. 5-158). |
| 31. Evaluate consequences of altered sediment supply or channel stability (p. 5-159) | Summarize and interpret previous results; see text for suggestions. |

Reference cited:

Rosgen, D. 2006. *Watershed Assessment of River Stability and Sediment Supply (WARSSS).* Wildland Hydrology, Fort Collins, CO. 193 pp.