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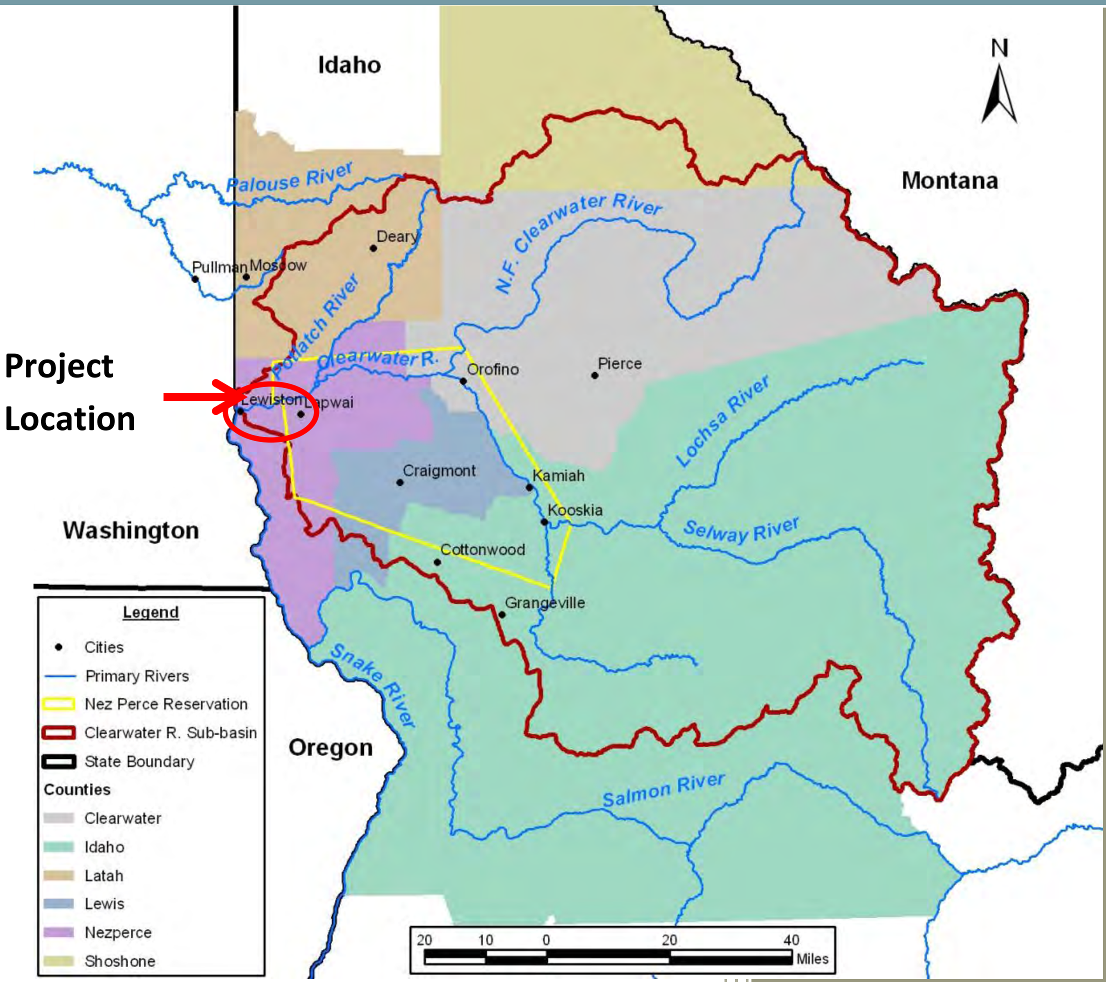
Nez Perce County Lower River Tributaries Appendix 3 Computation of Pro Rata Target Erosion Limits for Cultivated Land



12-digit HUC's:
170601030306 (Tammany Creek),
1706010305 (TenMile Canyon),
170603061307 (Lindsay Creek),
1706013061308 (Hidden Canyon),
170603061308 (unnamed tributary)

Nez Perce Soil and Water Conservation District

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NEZ PERCE
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1. Purpose

A target water quality based limit for rill and interrill erosion of cultivated land in the Tammany Creek watershed can be inferred from the Total Maximum Daily Load analysis (TMDL) for sediment in Tammany Creek developed by the Idaho Department of Environmental Quality in 2001 (IDEQ, 2001) and amended it in 2010 (IDEQ, 2010). If the target erosion limit is expressed pro rata for the entire watershed, then it may be applied to the other watersheds in the NWQI study area that do not have limits determined by a TMDL. The term *pro rata* in this context means that the limiting mass of erosion ($ton \cdot yr^{-1}$) for an element[1] of the sediment balance is divided by the total watershed area to obtain a nominal limiting erosion rate ($ton \cdot ac^{-1} \cdot yr^{-1}$) for that element, in this case the rill and interrill erosion of annually cultivated land that only comprises a portion of the total watershed.

2. Pro Rata Watershed Erosion Limit for Tammany Creek

DEQ estimated that 64 percent of the sediment in Tammany Creek comes from sheet and rill erosion and 36 percent comes from streambank erosion. Surface erosion from agricultural land and rural development were combined in the analysis. Total suspended solids in the stream flow were measured by NPSWCD for the study and surface erosion (soil loss) was estimated with RUSLE in a GIS analysis by DEQ. The main channel of

[1] Potentially a pro rata limit could be specified for any element of the sediment budget: bank erosion, ephemeral gully erosion, municipal storm drainage, ect.

Tammany Creek below sampling point TC4 was considered the perennial stream. All other channels were considered ephemeral.

The DEQ surface erosion analysis assumed that on average, 30 percent of the 22,332-acre total watershed area, or about 6,700 acres[2], contributes sediment to Tammany Creek through direct runoff and connected concentrated flow channels. The TMDL analysis used a sediment delivery ratio of 0.13 for rill and interrill erosion. Both the sediment source area and the sediment delivery ratio are important factors in the load allocation for agricultural nonpoint sources.

Table 2 in the 2010 addendum to the TMDL gives the monthly load capacity of Tammany Creek according to the IDEQ analysis. The load capacity ranges from 120 pounds per day (lbs/day) in August and September to 1,139 lbs/day in April. Summing the months give an annual load capacity of 5,280 lbs/day (964 tons/yr). The total load allocation for nonpoint sources given in the report is 4,356 lbs/day (795 tons/year). Since 64 percent of the load was judged to come from sheet and rill erosion, the target annual sediment yield limit from cultivated land is approximately:

$$S_y = 0.64 \times 795 \cdot \frac{ton}{yr} = 509 \cdot \frac{ton}{yr} .$$

With a sediment delivery ratio of 0.13, the target total of sheet and rill erosion is:

$$A_{ir} = \frac{509 \cdot \frac{ton}{yr}}{0.13} = 3{,}914 \cdot \frac{ton}{yr}$$

[2] Paragraph A.4.3 in the 2001 TMDL report.

and the pro rata target erosion rate for cultivated land *relative to the entire watershed* is:

$$A_{irl} = \frac{3{,}914 \cdot \frac{ton}{yr}}{22{,}332 \cdot ac} = 0.18 \cdot \frac{ton}{ac \cdot yr}$$

This calculation indicates that for water quality purposes, an appropriate pro rata watershed-level target limit for edge-of-field sheet and rill erosion from cultivated land in the NWQI project area is 0.18 $ton \cdot ac^{-1} \cdot yr^{-1}$.

A pro rata watershed target limit for agricultural erosion is an equitable, though not perfect, way to represent agricultural sediment impacts on water quality. Given the same pro rata watershed target limit, a watershed comprised mostly of cultivated land should have more stringent goals for agricultural sediment reduction than a forested watershed that has only a small area of cultivated land. In the latter case, agricultural practices likely have little impact on water quality at the outlet of the watershed.

3. Example Calculations

The application of the pro rata limit for rill and interrill erosion is illustrated with the following examples.

3.1 Example 1 – Calculate and Compare the pro rata erosion rate to the limit.

Total watershed area is 5,000 ac

Area of cultivated land is 2,000 ac

The rill-interrill erosion rate is 1.50 ton/ac/yr

Calculate: $A_{irp} = \frac{1.50 \cdot \frac{ton}{ac \cdot yr} \times 2{,}000\ ac}{5{,}000 \cdot ac} = 0.60 \cdot \frac{ton}{ac \cdot yr}$

Conclusion: Erosion from cultivated land significantly exceeds the pro rata watershed limit of 0.18 ton/ac/yr. This watershed would be a high priority for enhanced conservation practices to reduce rill and interrill soil erosion and improve water quality.

3.2 Example 2 – Calculate and Compare the pro rata erosion rate to the limit.

Total watershed area is 5,000 ac

Area of cultivated land is 400 ac

The rill-interrill erosion rate is 1.50 ton/ac/yr

Calculate: $A_{irp} = \frac{1.50 \cdot \frac{ton}{ac \cdot yr} \times 400\ ac}{5{,}000 \cdot ac} = 0.12 \cdot \frac{ton}{ac \cdot yr}$

Conclusion: Cultivated land erosion is much less than the pro rata erosion limit of 0.18 ton/ac/yr. This watershed would be a lower priority for enhanced conservation practices intended to significantly improve water quality.

3.3 Example 3– Calculate the limiting area of cultivated land.

Total watershed area is 5,000 ac

The rill-interrill erosion rate is 1.50 ton/ac/yr

The pro rata watershed erosion rate is 0.18 ton/ac/yr

Calculate: $C_{area} = \frac{0.18 \cdot \frac{ton}{ac \cdot yr} \times 5{,}000\ ac}{1.50 \cdot \frac{ton}{ac \cdot yr}} = 600\ ac$

Conclusion: The limiting area of cultivated land in the watershed is 600 acres to meet water quality objectives.

3.4 Example 4– Calculate the limiting erosion rate of cultivated land.

Total watershed area is 5,000 ac

Area of cultivated land is 3,000 ac

The pro rata watershed erosion rate is 0.18 ton/ac/yr

Calculate: $A_{irp} = \frac{0.18 \cdot \frac{ton}{ac \cdot yr} \times 5{,}000\ ac}{3{,}000\ ac} = 0.30 \cdot \frac{ton}{ac \cdot yr}$

Conclusion: The maximum acceptable rate of rill and interrill erosion on cultivated land in the watershed to meet water quality objectives is 0.30 ton/ac/yr.

3.5 Example 5– Two different tillage practices.

Total watershed area is 5,000 ac

Area of conservation tillage land is 1,000 ac

Conservation tillage land channel connectivity factor 0.80

Conservation tillage erosion rate 2.0 ton/ac/yr

Area of no-till land is 2,000 ac

No-till land channel connectivity factor 0.60

No-till erosion rate 0.4 ton/ac/yr

The pro rata watershed erosion rate is 0.18 ton/ac/yr

Calculate: $A_{irp} = \frac{2.0 \cdot \frac{ton}{ac \cdot yr} \times 0.80 \times 1{,}000\ ac + 0.4 \cdot \frac{ton}{ac \cdot yr} \times 0.6 \times 2{,}000\ ac}{5{,}000\ ac} = 0.42 \cdot \frac{ton}{ac \cdot yr}$

Conclusion: The combined erosion of cultivated land significantly exceeds the pro rata watershed limit of 0.18 ton/ac/yr. Enhanced conservation practices should be applied to one or both tillage areas to meet the pro rata limit. The planner should consider the practicality and economics of possible conservation practices to achieve a cost effective long-term solution.