Nutrient sampling of streams in the landscape is provided in KirK Environmental (2003). Nutrient levels can be put in perspective by comparison to reference conditions from similar environments that are not impacted by anthropogenic nutrient sources. EPA (2000) provides nutrient guidelines for the Northern Rockies ecoregion as well as to the Montana Valley and Foothill Prairies ecoregion. The Clark Fork River Voluntary Nutrient Reduction Plan (VNRP) (Tri-State Implementation Council, 1998) also provides targets for total phosphorus and total nitrogen for the mainstem Upper Clark Fork River that can be used for comparison to nutrient levels from the tributaries in the landscape.

KirK Environmental (2003) presents two sets of nutrient samples from Cottonwood and Peterson Creek for spring runoff and baseflow. In general, nutrient concentrations in Cottonwood Creek increase downstream and are highest just above the city of Deer Lodge. Nutrient sampling also supports that nutrients are elevated in the lower reaches of Peterson Creek. Most likely, the nutrient sources are associated with instream livestock use, feeding operations, and urban drainage. Nutrient data from Caribou, Orofino, Sand Hollow, Dry Cottonwood, Perkins Gulch and Girard Gulch streams indicates that nutrients may be elevated over background levels due to livestock use of the stream corridor. Spatial trends in nutrient concentrations are not present in Caribou, Orofino, Perkins Gulch and Girard Gulch streams suggesting that nutrient sources are dispersed in these watersheds. Nutrient concentrations and loading appear to increase in lower Dry Cottonwood Creek as manure loading from livestock use increases.

### *Sediment*

Excessive amounts of sediment often have detrimental effects on streams and the aquatic communities living in them. High suspended sediment levels reduce light penetration, which may cause a decline in primary production. As a result, aquatic invertebrate communities may also decline, which may then cause a decline in fish populations. Deposited particles may also obscure sources of food, habitat, hiding places, and nesting sites for invertebrates.

Excess streambed sediment may also impair biological processes of aquatic organisms. When present in high levels, sediment may clog the gills of fish and cause other abrasive damage. Abrasion of gill tissues triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding (Wilber 1983; McCabe and others 1985). Reproductive success of fish may also be impaired by high levels of fine sediment. Fine sediment deposition reduces availability of suitable spawning habitat for salmonids and can smother eggs or hatchlings. Stream substrate inventories are available for the sites where Rosgen Level II inventories were performed by the USFS (table IIB-1). Locations of Rosgen cross-sections are shown in figure IIB-2 provided in appendix 1.

Montana water quality standards for total suspended solids (TSS) are narrative and state that TSS levels should not exceed “naturally occurring levels.” As such it is difficult to put stream sediment size and quantity in perspective where reference streams are not available that contain a fairly pristine condition. Evaluation of reference conditions based on selected least impaired streams in the landscape or unimpaired streams outside the landscape would help to determine if stream sediment is exceeding water quality standards.

TSS sampling results presented in KirK Environmental (2003) did not capture periods when TSS was obviously higher than potential natural conditions. However, large runoff events caused by rapid snowmelt or flash-floods associated with thunder storms may cause short term TSS spikes of unknown magnitude. Streambed deposition in the landscape is usually a problem over short reaches where roads are near streams or where sources of fines from excessive hoof action exacerbates sloughing of streambank material into the streambed. The roads in Dry Cottonwood Creek and Perkins Gulch which parallel the stream are notable sources of excess stream sediment.

Photo: Road #85 encroaching on Dry Cottonwood Creek.

Photo: Sedimentation issues in Dry Cottonwood Creek.

Photo: Sediment source in road surfaced with natural granitic soils in Perkins Gulch.

## Channel Morphology

Evaluation of stream channel morphology allows the comparison of stream channel and substrate characteristics between different locations. Where reference conditions are available, the stream channel and substrate characteristics can be compared against conditions typical of the range of natural variability. Bank alteration by trampling can be an important source of stream channel and riparian degradation (e.g., Clary and Webster, 1989, 1990; Belsky, et al., 1999). Of the Rosgen Level II criteria, the width to depth ratio is the most sensitive and positive indicator of trends in channel instability. Where width to depth ratios are high, increases in the sediment supply to the channel develop from bank erosion, which by virtue of becoming an over widened channel gradually loses its capability to transport sediment. Deposition occurs which further accelerates bank erosion. Impacts from bank trampling may also include a loss of ability of flood flows to access floodplains and a loss of riparian vegetation which then makes banks more vulnerable to further erosion. Where downcutting occurs localized lowering of water tables in riparian areas further exacerbates loss of riparian vegetation.

Researchers have also reported that channel degradation from trampling may occur before utilization or stubble height guidelines are met, and that channel recovery can lag behind vegetative recovery where management is altered. Kondolf (1993) found that channels in California that had been excluded from grazing for 24 years had not returned to their pre-disturbance morphology despite the growth of lush streambank vegetation. Clary and Webster (1989) provided information from other studies in their paper. They stated that "[w]hile Skovlin (1984) suggested that vegetation recovery after release from excessive grazing generally can occur within 5 to 15 years, Platts and Raleigh (1984) pointed out that impacts on fishery environments go far beyond the riparian vegetation. Channel and bank morphology, instream cover, and water flow regimens are important factors. Little is known about the recovery time for these factors in different environments." Magilligan and McDowell (1997) described geomorphic channel adjustments after more than 14 years of grazing exclusion in eastern Oregon. They concluded that 14 years might not be sufficient time for all variables to adjust. They also cite other studies' findings that "…for exclosures less than approximately five to ten years old, little geomorphic difference exists despite noticeable differences in riparian vegetation".

Stream channel morphology has been assessed by the USFS using numerous methods since the early 1970's. Initially, methods such as the 1972 Channel Condition and Stability Potential Classification and the Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) were qualitative. Although these older methods provided a reasonable method to compare the relative condition and functioning of streams, the analyses were not quantitative and cannot be compared to current methods such as the Rosgen Stream Classification system (Rosgen, 1996). Because the results of the stream channel assessments performed in the 1970's cannot be compared to current conditions and because these assessments are over three decades old and do not represent current conditions they will not be described further.

Rosgen Classification cross-sections performed by the USFS and KirK Environmental (2003) are shown in figure IIB-2 and table IIB-1. Additionally, Rosgen stream type information for stream reaches assessed as part of USFS fish habitat surveys are shown in table IIB-8. Streams in the project area include A2, A3, B2 through B5, C3 through C5 including subtypes of these channel forms. In general, A and B type channels are more common in the upper reaches and C type channels are more common at midstream to downstream locations. USFS data indicates that B type channels at the middle fork of Cottonwood Creek, the north fork of Perkins Gulch, and the north fork of Dry Cottonwood Creek have the potential to be E type channels under natural conditions indicating that the channel at these cross-sections may be straightened and the width to depth ratio increased. The Rosgen Classification performed in KirK Environmental (2003) does not identify potential channel type.

Potential channel type and substrate sediment size is typically determined from reference sites where channels are in a relatively pristine condition. In an area such as the EDLV landscape, reference sites may be difficult to ascertain because the area has experienced over a century of alteration by mining, logging, road building and grazing. Evaluation of channel morphologic and streambed substrate reference conditions based on selected least impaired streams if available in the landscape or unimpaired streams outside the landscape would help to determine if stream sediment is above the range of natural variability.

**Table IIB-1: Rosgen cross-sections.**

| *Stream* | *Reach* | *Rosgen Level II Class* | *Potential Class* | *Gradient* | *Width/ depth* | *Entrenchment ratio* | *substrate % sand and finer* | *Source* |
|---|---|---|---|---|---|---|---|---|
| Baggs Creek | C5 | C3 | - | - | 18.5 | 2.0 | - | KirK Environmental (2003) |
| | upstream of C5 | B3 | B3 | 1.7% | 7.5 | 1.4 | 5% | USFS 1998 field form |
| Cottonwood Creek | C2 | C3/C4 | - | 1.5% | 12.3 | 1.9 | - | KirK Environmental (2003) |
| | C3 | C4b/C5b | - | 2.3% | 7.5 | 1.6 | - | KirK Environmental (2003) |
| | C4 | B3 | - | 1.3% | 18.4 | 1.5 | - | KirK Environmental (2003) |
| | C6 | B3 | - | - | 10.9 | 2.2 | - | KirK Environmental (2003) |
| Cottonwood Creek M Fk | C8 | A3/A2 | - | - | 8.6 | 1.4 | - | KirK Environmental (2003) |
| | headwaters near divide | B4a/G4 | E4a | 4.3% | 9.5/7.4 | 2/1.3 | 30% | USFS 1998 field form |
| Cottonwood Creek N Fk | C7 | B3 | - | 9.1% | 6.9 | 1.4 | - | KirK Environmental (2003) |
| | just above C7 | B4a | B4a | 5.0% | 13.3 | 1.1 | 23% | USFS 1998 field form |
| Peterson Creek | P1 | C4 | - | 1.0% | 10.3 | 1.7 | - | KirK Environmental (2003) |
| | P3 | C5 | - | 3.0% | 10.0 | 2.0 | - | KirK Environmental (2003) |
| | P5 | C3b | - | 3.0% | 11.8 | 2.3 | - | KirK Environmental (2003) |
| | P6 | C3b | - | 5.7% | 7.1 | 1.2 | - | KirK Environmental (2003) |
| Sand Hollow | SH2 | C5 | - | 6.0% | 9.3 | 2.1 | - | KirK Environmental (2003) |
| Perkins Gulch | PG2 | B4/B3 | - | 5.6% | 2.7 | 8.6 | - | KirK Environmental (2003) |
| | PG3 | B5a | - | 4.8% | 5.5 | 4.5 | - | KirK Environmental (2003) |
| Perkins Gulch N Fk | just below PG4 | B4 | E4b | 4.1% | 12.2 | 1.9 | 47% | USFS 1998 field form |
| | PG4 | B3 | - | 3.8% | 8.7 | 1.2 | - | KirK Environmental (2003) |
| Dry Cottonwood Creek | DC2 | C5 | - | 0.8% | 18.8 | 2.3 | - | KirK Environmental (2003) |
| | DC3 | B2/B3 | - | 4% | 2.5 | 2.0 | - | KirK Environmental (2003) |
| | DC4 | B4c | - | 1.5% | 10.1 | 1.6 | - | KirK Environmental (2003) |
| Dry Cottonwood Creek N Fk | below Cottonwood Mtn | B5c | E4 | 1.1% | 20.8 | 1.4 | 62% | USFS 1998 field form |

Photo: Rosgen stream channel survey on Cottonwood Creek.

Photo: Stream channel morphology resulting from grazing impacts on private lands, middle Orofino Creek.