# Appendix I

## Vulnerable Watersheds

# VULNERABLE WATERSHEDS

## San Juan National Forest Watersheds with the Highest Levels of Anthropogenic Disturbance

These watersheds on the San Juan National Forest (SJNF) have the greatest amount of anthropogenic disturbance and have the highest potential for impacts to aquatic, riparian, and wetland resources due to the high percentage of anthropogenic activities. The potential effects for all anthropogenic activities were analyzed by cumulating the percentile ranking for each of the identified anthropogenic activities. A total of six different activity categories was used for this process using all the activities: transportation, water use, vegetation management, urbanization, mineral extraction, and recreation. The values of 1 through 5 were assigned based on the percentile in which that Hydrologic Unit Code (HUC) watershed was located for the anthropogenic activity, with 5 being the highest percentile of impact. The watersheds in the following table were listed in Quantile 5 for all anthropogenic activities, which correspond to the 100th to 80th percentile range for percentage of watershed area affected by anthropogenic disturbances (Winters, Staley et al. 2006). These watersheds may be good candidates for remediation. The watersheds in Quantiles 1 through 4 can be found in the Aquatic, Riparian, and Wetland Ecosystem Assessment for the San Juan National Forest (Winters, Cooper et al. 2006, Winters, Staley et al. 2006).

**Table I.1: Watersheds on the San Juan National Forest with the Highest Levels of Anthropogenic Disturbance**

| HUC 6 | HUC 6 Name | Recreation | Urbanization | Minerals | Transportation | Vegetation | Water Use | Total | Cluster* |
|---|---|---|---|---|---|---|---|---|---|
| 140801070103 | Chicken Creek | 3 | 4 | 3 | 5 | 5 | 3 | 23 | 4r |
| 140300020209 | Upper Dolores River-Taylor Creek | 4 | 2 | 3 | 5 | 4 | 5 | 23 | 5r |
| 140801011601 | Upper Beaver Creek | 2 | 3 | 5 | 3 | 5 | 5 | 23 | 5r |
| 140801020401 | Martinez Creek-Dutton Creek | 5 | 3 | 1 | 4 | 4 | 5 | 22 | 5r |
| 140801010403 | Fourmile Creek | 3 | 2 | 3 | 4 | 4 | 5 | 21 | 2r |
| 140300020105 | Lower West Dolores River | 2 | 3 | 3 | 3 | 5 | 5 | 21 | 5r |
| 140801050106 | Upper Cherry Creek | 2 | 5 | 3 | 5 | 3 | 3 | 21 | 5r |
| 140801040502 | Elbert Creek | 3 | 3 | 3 | 5 | 4 | 3 | 21 | 5r |
| 140300020303 | Upper Lost Canyon | 4 | 2 | 1 | 4 | 5 | 4 | 20 | 2r |
| 140801070102 | West Mancos River | 1 | 3 | 2 | 5 | 5 | 3 | 19 | 2r |
| 140801010402 | Laughlin Park | 3 | 2 | 3 | 3 | 3 | 5 | 19 | 5r |
| 140300020402 | Beaver Creek-Trail Canyon | 1 | 3 | 4 | 4 | 4 | 3 | 19 | 4r |
| 140300020307 | House Creek | 1 | 2 | 3 | 5 | 5 | 3 | 19 | 4r |
| 140300020604 | Dolores Canyon-Lake Canyon | 3 | 2 | 3 | 3 | 4 | 4 | 19 | 4r |
| 140801010404 | Upper Pagosa Springs | 2 | 4 | 3 | 3 | 4 | 3 | 19 | 4r |
| 140801010606 | Navajo River-Weisel Flat | 5 | 2 | 3 | 3 | 3 | 3 | 19 | 4r |
| 140801010607 | Coyote Creek | 2 | 2 | 3 | 4 | 4 | 4 | 19 | 4r |
| 140801011404 | Vallecito Reservoir | 5 | 2 | 1 | 3 | 4 | 4 | 19 | 5r |
| 140801020301 | Upper Devil Creek | 4 | 2 | 1 | 4 | 5 | 3 | 19 | 5r |
| 140801020501 | Yellow Jacket Creek | 2 | 3 | 3 | 3 | 4 | 4 | 19 | 4r |
| 140801070105 | East Fork of Mud Creek | 1 | 5 | 5 | 3 | 2 | 3 | 19 | 4r |
| 140801011302 | Middle Beaver Creek | 2 | 3 | 4 | 3 | 4 | 3 | 19 | 5r |
| 140801040203 | Lower Cascade Creek | 5 | 2 | 2 | 4 | 4 | 2 | 19 | 2r |

*Clusters are defined in the narratives following the table.

**Cluster 2r:** The watersheds in cluster 2r are characterized by a high-elevation snowfall-driven hydroclimatic regime. The streams are underlain by rock units derived from mainly non-igneous formative processes. This cluster is dominated by high-gradient streams with a snowmelt regime that produces moderate to high yields of both coarse and fine sediment. Anthropogenic influences could have large influences on low-gradient reaches if excessive sediment were produced. Sediment produced in this cluster could influence stream reaches downstream. Watersheds in this cluster occupy the majority of the highest-elevation watersheds in the San Juan Mountains. Cluster 2r is among the most sensitive to changes in the thermal regime. Watersheds in this cluster are relatively unresponsive to changes in sediment regime resulting from the overall dominance of high-gradient stream channels.

**Cluster 4r:** The watersheds in cluster 4r are driven by a predominantly mixed precipitation hydroclimatic regime. The largely high-gradient streams in this cluster are typically underlain by non-calcareous lithology of a non-igneous origin. This cluster is dominated by high-gradient streams with a mixed snowmelt and rainfall flow regime that produces moderate to high yields of both coarse and fine sediment. The rain- and snow-driven conditions would produce a significant amount of sediment if exposed during periods of increased runoff. Cluster 4r watersheds are mainly at mid-elevations. A mixture of stream gradients is present. Cluster 4r is somewhat sensitive to changes in the thermal regime. Anthropogenic disturbance that increases sediment production would be detrimental to fish populations and riparian communities.

**Cluster 5r:** The watersheds in cluster 5r are driven by a predominantly mixed precipitation regime. The largely high-gradient streams in this cluster are typically underlain by lithology of a non-igneous origin. This cluster is dominated by high- and mid-gradient streams with a mixed snowmelt and rainfall regime that produces moderate to high yields of both coarse and fine sediment. Because of the heterogeneity of conditions within this cluster more site-specific analysis would be necessary to determine potential for sediment movement from management activities. Cluster 5r is somewhat sensitive to changes in the thermal regime. Additional sediment would be temporarily stored during low-flow conditions, degrading the biotic condition (Winters, Cooper et al. 2006).

## San Juan National Forest Watersheds Most Sensitive to Anthropogenic Disturbances

The sensitivity of a stream to human-caused disturbance is determined by the physical characteristics of the stream and its watershed. Table I-2 below summarizes watersheds that are naturally sensitive to disturbance (Winters, Cooper et al. 2006). Management activities planned within these watersheds may need additional design features that would minimize erosion potential and also minimize changes to stream flow regime and sediment load.

Most streams on the SJNF are high-gradient streams and consequently are assigned the lowest sensitivity to changes in water and sediment delivery. The channel bed and banks of these stream segments are composed of very coarse sediment that is less likely to experience a substantial change in mobility as a result of either a decrease or increase in water supply. These reaches also usually pass excess sediment downstream fairly efficiently and are less likely to have channel erosion than lower-gradient stream segments.

Low-gradient streams are typically assigned the highest sensitivity to changes in water and sediment yield. The materials forming the channel bed and banks in these stream segments are likely to be the most mobile of all the gradient categories and thus most likely to be eroded in response to increased flow or reduced sediment load. Eroded materials can be deposited in response to reduced flow or increased sediment load

The watersheds that were determined to be the most sensitive to anthropogenic disturbance typically occur at low to mid-elevations in mixed rain-snow precipitation regimes or rainfall-dominated regimes. These watersheds have been labeled 4r and 6r. Only watersheds with more than 20% of their area within the SJNF were included in the table.

**4r Watersheds:** These watersheds occur mainly at mid-elevations. A mixture of stream gradients is present although they contain mostly high-gradient streams. These watersheds are typically underlain by non-calcareous lithology of a non-igneous origin. The 4r watersheds are driven by mixed rain and snow precipitation regimes. The mixed snowmelt and rainfall flow regimes produce moderate to high yields of both coarse and fine sediment. These precipitation conditions would produce a significant amount of sediment if anthropogenic disturbances were to occur during periods of increased runoff. Activities that trigger sediment production would be detrimental to the fish populations and riparian communities in these watersheds.

**6r Watersheds:** The majority of these watersheds are driven primarily by rainfall hydroclimatic regimes with mixed rain and snow precipitation regimes. The streams in this cluster are underlain by rock units formed by predominantly non-igneous processes. These watersheds are dominated by erosive parent material that produce moderate to high yields of both coarse and fine sediment. These watersheds are also influenced dramatically by sediment produced upstream in other watersheds. Sediment deposition could influence stream-bank stability and over-wide channels where deposition occurs. Braiding of the stream channel could be realized in low-gradient channels where deposition occurs from upstream. This cluster is also sensitive to anthropogenic activities that alter the surface and subsurface hydrology.

**Table I.2: Watersheds on the San Juan National Forest Most Sensitive to Anthropogenic Disturbances**

| HUC 6 | HUC 6 Name | Cluster |
|---|---|---|
| 140300020301 | Spruce Water Canyon | 4r |
| 140300020304 | Middle Lost Canyon | 4r |
| 140300020306 | Upper Dolores River-Italian Creek | 4r |
| 140300020307 | House Creek | 4r |
| 140300020308 | McPhee Reservoir-Dolores River | 4r |
| 140300020402 | Beaver Creek-Trail Canyon | 4r |
| 140300020406 | McPhee Reservoir-Beaver Creek Inlet | 4r |
| 140300020506 | Brumley Valley | 6r |
| 140300020507 | Dawson Draw | 4r |
| 140300020509 | Pine Arroyo | 4r |
| 140300020511 | Disappointment Valley-Wild Horse Reservoir | 6r |
| 140300020601 | Dolores River-Salter Canyon | 4r |
| 140300020602 | Narraguinnep Canyon Natural Area | 4r |
| 140300020603 | Dolores Canyon-Cabin Creek | 4r |
| 140300020604 | Dolores Canyon-Lake Canyon | 4r |
| 140801010304 | Middle Rio Blanco | 4r |
| 140801010306 | Lower Rio Blanco-San Juan River | 4r |
| 140801010404 | Upper Pagosa Springs | 4r |
| 140801010406 | Mill Creek | 4r |
| 140801010606 | Navajo River-Weisel Flat | 4r |
| 140801010607 | Coyote Creek | 4r |
| 140801010701 | Montezuma Creek | 4r |
| 140801010702 | San Juan River-Trujillo | 6r |
| 140801011503 | Ute Creek | 6r |
| 140801011504 | Upper Spring Creek | 6r |
| 140801020302 | Lower Devil Creek | 6r |
| 140801020404 | Middle Stollsteimer Creek | 6r |
| 140801020405 | Lower Stollsteimer Creek | 6r |
| 140801020501 | Yellowjacket Creek | 4r |
| 140801020502 | Piedra River-Stollsteimer | 6r |
| 140801020503 | Piedra River-Navajo Reservoir Inlet | 6r |
| 140801070103 | Chicken Creek | 4r |

# San Juan National Forest and Tres Rios Field Office Watersheds with Potential Salinity Issues

The watersheds in Table I-3 have a high potential for salinity issues since more than 50% of the watershed contains marine-derived Mancos or Lewis Shale, or the watershed was identified for salinity control potential in the Colorado River Basin Salinity Control Act of 1974. Information about cluster types as determined by the USFS Aquatic, Riparian and Wetland Ecosystem Assessment (Winters, Cooper et al. 2006) was available only for watersheds on lands administered by the SJNF. It should be noted that in addition to a high potential for salinity issues, Upper Cherry Creek also has a high amount of anthropogenic disturbance at this time.

**Table I.3: Watersheds on the San Juan National Forest and Tres Rios Field Office with Potential Salinity Issues**

| HUC 6 | HUC 6 Name | Watershed Size (acres) | Shale Soils (acres) | Shale Soils (% of watershed) | Shale Soils under BLM Management (acres ) | Shale Soils under USFS Management (acres ) | Cluster |
|---|---|---|---|---|---|---|---|
| 140300020401 | Upper Beaver Creek - McPhee | 29,386 | 22,978 | 78 | 0 | 1,991 | 5r |
| 140300020405 | Lower Plateau Creek | 20,507 | 13,350 | 65 | 419 | 3,081 | 5r |
| 140300020501 | Bear Creek-Disappointment Creek* | 10,583 | 9,226 | 87 | 287 | 0 | 5r |
| 140300020502 | Disappointment Creek Headwaters* | 17,516 | 14,830 | 85 | 776 | 3,157 | 5r |
| 140300020503 | Sheep Camp Valley* | 12,004 | 8,019 | 67 | 5,620 | 238 | 5r |
| 140300020504 | Ryman Creek* | 15,909 | 15,441 | 97 | 579 | 11,605 | 5r |
| 140300020505 | Upper Disappointment Creek* | 26,058 | 19,138 | 73 | 8,996 | 7,291 | 5r |
| 140300020506 | Brumley Valley* | 22,809 | 11,430 | 50 | 5,834 | 4,989 | – |
| 140300020507 | Dawson Draw* | 17,689 | 394 | 2 | 0 | 329 | 4r |
| 140300020508 | Spring Creek* | 33,864 | 18,365 | 54 | 15,261 | 0 | – |
| 140300020510 | Upper Disappointment Valley* | 11,826 | 4,356 | 37 | 2,513 | 76 | 5r |
| 140300020511 | Disappointment Valley-Wild Horse Reservoir* | 10,384 | 709 | 7 | 706 | 0 | 6r |
| 140300020512 | Middle Disappointment Valley* | 12,705 | 5,946 | 47 | 4,106 | 0 | – |
| 140300020513 | Lower Disappointment Valley* | 18,851 | 9,057 | 48 | 6,132 | 0 | – |
| 140300030401 | Naturita Creek* | 56,142 | 34,747 | 62 | 290 | 732 | 5r |
| 140300030408 | Broad Canyon* | 13,692 | 749 | 5 | 286 | 0 | – |
| 140300030501 | Nelson Creek* | 19,587 | 14,099 | 72 | 4,492 | 0 | – |
| 140300030502 | Beards Corner* | 10,247 | 7,802 | 76 | 3,046 | 0 | – |
| 140300030503 | West Fork Dry Creek* | 29,441 | 3,269 | 11 | 1,144 | 0 | – |
| 140300030504 | Upper Dry Creek8 | 38,598 | 22,124 | 57 | 9,700 | 0 | – |
| 140801010404 | Upper Pagosa Springs | 13,634 | 8,677 | 64 | 0 | 4,480 | 4r |
| 140801010405 | McCabe Creek | 12,826 | 11,244 | 88 | 0 | 1,832 | 5r |
| 140801010406 | Mill Creek | 14,815 | 8,716 | 59 | 0 | 3,946 | 4r |
| 140801010407 | Echo Canyon Reservoir | 14,521 | 9,633 | 66 | 0 | 984 | 5r |

| HUC 6 | HUC 6 Name | Watershed Size (acres) | Shale Soils (acres) | Shale Soils (% of watershed) | Shale Soils under BLM Management (acres ) | Shale Soils under USFS Management (acres ) | Cluster |
|---|---|---|---|---|---|---|---|
| 140801010408 | San Juan River-Eightmile Mesa | 25,486 | 16,031 | 63 | 27 | 3,385 | 5r |
| 140801010605 | Spring Creek | 10,265 | 8,991 | 88 | 29 | 0 | – |
| 140801011402 | Bear Creek | 12,371 | 7,017 | 57 | 0 | 4,055 | – |
| 140801020104 | Piedra River-O'Neal Creek | 16,480 | 9,278 | 56 | 0 | 4,205 | 5r |
| 140801020401 | Martinez Creek-Dutton Creek | 18,021 | 12,178 | 68 | 0 | 5,303 | 5r |
| 140801020404 | Middle Stollsteimer Creek | 14,230 | 7,778 | 55 | 0 | 5,460 | – |
| 140801050106 | Upper Cherry Creek | 24,793 | 12,853 | 52 | 88 | 4,956 | 5r |
| 140801070106 | Mud Creek-Mancos River | 10,804 | 9,342 | 86 | 1,612 | 0 | – |
| 140801070108 | Mancos River-East Rim | 15,063 | 10,213 | 68 | 2,078 | 0 | – |
| 140802020101 | Simon Draw* | 21,731 | 3,431 | 16 | 34 | 0 | – |
| 140802020102 | Stinking Springs Canyon* | 27,004 | 15,885 | 59 | 5,801 | 0 | – |
| 140802020104 | McElmo Creek-Highline Ditch* | 18,153 | 9,725 | 54 | 2,262 | 0 | – |
| 140802020105 | Lower Alkali Canyon-Narraguinnep Canyon* | 23,804 | 3,737 | 16 | 0 | 29 | 6r |
| 140802020201 | Upper Yellowjacket Canyon* | 13,935 | 399 | 3 | 0 | 90 | 4r |
| 140802020301 | Mud Creek-McElmo Creek* | 22,462 | 8,701 | 39 | 703 | 0 | – |

Selection Criteria for Watersheds: >25 acres of BLM and/or USFS lands with Lewis or Mancos Shale and either rated high for salinity control potential in the Colorado River Basin Salinity Control Act of 1974 or >50% of the watershed is Lewis and/or Mancos Shale.

* Watersheds that are rated high for salinity control potential in the Colorado River Basin Salinity Control Act of 1974.

## References

Winters, D., D. Cooper, N. Lee, N. Poff, F. Rahel, D. Staley, and E. Wohl. 2006. Aquatic, Riparian and Wetland Ecosystem Assessment for the San Juan National Forest. Report 1 of 3: Introduction and Ecological Driver Analysis. Denver: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region

Winters, D., D. Staley, J. Fryxell, and J. Krezelok, 2006. Aquatic, Riparian and Wetland Ecosystem Assessment for the San Juan National Forest. Report 3 of 3: Ecological Driver Analysis and Anthropogenic Influence Results: Synthesis and Discussion. Denver: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region.

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