vegetation; soil compaction and soil erosion; increased rates of overland flow; sedimentation; and pathogenic contamination of potable and non-potable waters. Often, the aforementioned impacts tend to be localized, however, in areas that experience substantial recreational use, the cumulative impacts to aquatic and riparian ecosystems can be both observable and measurable.

Water quality conditions in national forest both affects and is affected by recreation activities. Recreationists are strongly advised to drink treated water only, because streams throughout the BDNF are assumed to contain the protozoan Giardia species and some streams may contain fecal coliform bacteria. Recreational use will almost certainly increase in the coming decades. Projected increases in recreational use are commensurate with all alternatives. Watershed conservation practices implemented to protect aquatic and riparian resources notwithstanding, impacts to these resources will likely increase given increased use because stream and lake environments will continue to disproportionately attract forest users.

Motorized and Non-Motorized Winter Recreation

These activities have relatively low potential to adversely affect aquatic and riparian resources. These categories of winter recreational use, however, are not environmentally benign. Non-motorized winter uses include cross country skiing and snowshoeing. Motorized winter uses include snowmobiling and snow cat use for research and maintenance. Clearly, damage to vegetation and soil erosion can occur if there is inadequate snowpack to protect these resources. Also, winter motorized activities can result in compacted snow which often form barriers that alter spring runoff patterns which can result in soil erosion and gullies.

Contamination by human waste and by petroleum products such as motor oil and gasoline can degrade water quality in waters adjacent to areas of concentrated use such as parking lots and snowmobile staging areas . The likelihood and magnitude of the aforementioned impacts due to these activities are dependent on site-specific factors such as average slope, aspect, elevation, vegetation, weather conditions, available facilities, and the amount of use. Because site conditions vary, and because these sites are relatively small in area and widely dispersed, it is reasonable to assume that cumulative impacts will not be measurable at the forestwide scale. Appropriately, winter activities that appear to be problematic will be identified and rectified during project-level analysis.

Improperly designed or poorly maintained roads can modify natural drainage networks and can accelerate erosion processes that result in increased stream sedimentation, degraded aquatic habitats and altered channel morphology. Road impacts generally increase as they become more connected, in terms of hydrology, to the natural channel network. Roads and their drainage systems typically act to intercept surface and subsurface runoff and route excess runoff into the channel system resulting in increased streamflow and sediment delivery to streams. In steep terrain, roads can increase the rate of hill slope failures and soil mass wasting. Fine sediments can be delivered to streams by erosion of road surfaces as well as from non-vegetated road cut and fill surfaces. Roads can impact aquatic habitats by restricting fish passage through culverts at road-stream crossings and by increasing fine sediments that can result in reduced salmonid spawning success.

Many of the aforementioned effects of roads can be mitigated by design changes that disperse, rather than concentrate road runoff and by gravel surfacing, seasonal road closures, or by designating undisturbed protective buffers along streams to allow for filtering of fine sediments.

The effectiveness of riparian buffers generally increases with increased width; however the effects of large-scale or chronic road impacts may still impact streams even when streams are protected by wide and intact buffers.

This section describes the effects on water resources from travel management. Roads associated with vegetation management and oil and gas activities are addressed in their respective discussion.

There are more than 6,100 miles of identified motorized roads and trail under BDNF management. In addition, there are numerous other roads managed by other entities within the forest boundary, including Highways and a variety of county roads. Of these motorized routes approximately 938 miles are located within 300 feet of streams. These routes provide a background level of disturbance that contributes to direct and indirect effects on aquatic and riparian resources. Trends in increased recreation are likely to continue and will accelerate these effects.

Compliance with forest plan standards including watershed conservation practices and improved road designs should minimize problems with new or reconstructed roads. However, bringing existing roads into compliance with new protection measures is a major challenge. Roads managed under other jurisdictions on private land or run across easements also contribute cumulatively, along with forest roads, to the alteration of watershed conditions.

Future road management should consider relocation or obliteration of existing roads and ways to reduce associated impacts, because road and trail effects can be greatly reduced by proper location and design. Good location keeps roads and trails away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas and areas of high mass movement. Good design provides stable cut and fill slopes and adequate drainage that allows water to filter through vegetated buffers or sediment traps before entering the stream channel. Realignment of roads and trails so they traverse riparian areas and streams at perpendicular rather than parallel angles would improve the quality of riparian and aquatic habitats in presently impacted stream reaches by reducing chronic sediment sources. If relocation is not possible, seasonal restrictions would limit road damage and subsequent sedimentation.

There are both economic and ecological consequences from increased sediment derived from roads and other sources. Sediment does not dissipate and is carried through the stream system where it may affect diversion structures, reservoirs, and water supplies. It can shorten the usable life of structures or result in higher maintenance costs. Since channels are interconnected, sediment delivered to ephemeral channels moves on to perennial channels during spring runoff. High sediment loads impact stream health by reducing pool depths, filling interstitial spaces in the streambed used by macro-invertebrate life, adhering to gills of aquatic life, changing channel morphology, and damaging habitat.

Relative to the existing road network, the effects of proposed road construction under the various alternatives are minimal, because impacts are dominated by the existing transportation system. Maintenance, reconstruction and decommissioning all address the existing BDNF transportation system and are expected to influence aquatic resources more than road construction over the planning period.

The total miles of roads and motorized trails are expected to decrease under alternatives 2, 3, 4, 5, and 6. This which will benefit aquatic resources due to the decreased risk of road and trail