Draft Nez Perce–Clearwater National Forests
Forest Plan Assessment

2.0 Air, Soil, and Water Resources and Quality

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2. Air, Soil, and Water Resources and Quality

2.1 Air Resources and Quality

2.1.1 *Existing Information*

Relevant existing information available regarding air quality can be separated into regulatory and implementation guidance documents. The following documents provide regulation regarding air quality in the Plan area:

- State of Idaho, Department of Environmental Quality Regulations
- Environmental Protection Agency Regulations

The following documents provide implementation guidance regarding air quality in the Plan area:

- Montana/Idaho Airshed Group Operating Guide (Montana/Idaho Airshed Group 2010)
- Clearwater and Nez Perce Fire Management Plan (updated annually)

2.1.2 *Informing the Assessment*

2.1.2.1 Current Conditions

Regulatory agencies require compliance with established standards as they relate to air quality. These standards usually have spatial as well as temporal threshold(s) assigned to them and are the basis for the implementation guides. The implementation guides or plans explain how management activities can or will occur while staying within established regulations and associated thresholds for air quality. These standards also explain and outline more site-specific concerns, such as cumulative effects and impacts to local entities and how those effects will all be considered when complying with regulations and laws.

The Clearwater and Nez Perce Fire Management Plan (FMP) is revised annually and provides guidance for implementing federal fire policy, Forest Service Manual direction, and Forest Plan direction. The FMP incorporates existing interagency plans and assessments and considers the best available science to assess and plan on a landscape scale. The Montana/Idaho Airshed Group (Group) is composed of State, federal, tribal, and private member organizations who are dedicated to preserving the air quality in Montana and Idaho. The Montana/Idaho Airshed Group Operating Guide (Montana/Idaho Airshed Group 2010) is meant to provide accurate and reliable guidance to members of the Group and contains pertinent agreements, guidelines, deadlines, plan, and procedures inherent to successfully operating the Group smoke management program. The intent of the smoke management program is to minimize or prevent smoke impacts while using fire to accomplish land management objectives. The smoke management program is designed to help burners meet Idaho and Montana regulatory requirements.

The Idaho Department of Environmental Quality (IDEQ) and Environmental Protection Agency regulations provide guidance for the protection of air quality. These documents are the most recent regulations concerning air quality and are considered the best available information at this time.

The Western Montana/North Idaho Smoke Management Plan and the Clearwater and

Nez Perce FMP utilized information from the regulations discussed above as well as other recent science. These plans are created using the most recent information concerning air quality and are considered the best available science.

2.1.2.2 Trends and Drivers

Air quality will continue to be a concern for land managers, regulatory agencies, and the public. Smoke management concerns will intensify as populations increase and amount of prescribed and/or wildland fire smoke increases.

2.1.2.3 Resource-Specific Information

The Nez Perce–Clearwater National Forests and adjacent communities generally have very good air quality. The months of July, August, and September are the months where air quality may be impacted, although generally not to unhealthy levels. Wildland fires, prescribed fires, and agricultural field burning can adversely impact air quality for days during these months. The IDEQ and the Nez Perce Tribe regulate the agricultural burning throughout the year while working with the Western Montana/North Idaho Airshed group to coordinate projects and potential air quality impacts from each prescribed burn.

2.1.3 *Information Needs*

No additional information needs have been identified.

2.2 Soil Resources and Quality

2.2.1 *Existing Information*

The publications listed below are considered the best available science used to inform soil quality management in the planning area. This research helps define the relationships between soil quality and productivity, soil disturbance, and forest land management.

- Forest Soil Conservation and Rehabilitation in British Columbia (Forest Science Program 2002)
- Coarse Woody Debris: Managing Benefits and Fire Hazard in the Recovering Forest (Brown et al. 2003)
- Using Soil Quality Indicators to Assess Forest Stand Management (Burger and Ketling 1990)
- Managing Coarse Woody Debris in Forests of the Rocky Mountains (Graham et al. 1994)
- Decaying Organic Materials and Soil Quality in the Inland Northwest: A Management Opportunity (Harvey et al. 1987)
- Assessment of Soil Disturbance in Forests of the Interior Columbia River Basin: A Critique (Miller et al. 2010)
- Sustained Productivity of Forests is a Continuing Challenge to Soil Science (Nambiar 1996)
- Wildland Fire in Ecosystems: Effects of Fire on Soils and Water (Neary et al. 2005)
- Soil Quality Standards and Guidelines for Forest Sustainability in Northwestern North America (Page-Dumroese et al. 2000)
- Soil Carbon and Nitrogen Pools in Mid- to Late-successional Forest Stands of the Northwestern United States: Potential Impact of Fire (Page-Dumroese and Jurgensen 2006)
- National Soil Disturbance Monitoring Protocol (Page-Dumroese et al. 2009)
- Scientific Background for Soil Monitoring on National Forests and Rangelands (Page-Dumroese et al. 2010)
- Are We Maintaining Productivity of Forest Lands? Establishing Guidelines through a Network of Long-term Studies (Powers 1990)
- Assessing Soil Quality: Practicable Standards for Sustainable Forest Productivity (Powers et al. 1998)
- Effects of Soil Disturbance on the Fundamental, Sustainable Productivity of Managed Forest (Powers 2002)
- The North American Long-term Soil Productivity Experiment: Coast-to-coast Findings from the First Decade (Powers et al. 2004)

- The North American Long-term Soil Productivity Experiment: Findings from the First Decade of Research (Powers et al. 2005)
- Detrimental Soil Disturbance Associated with Timber Harvest Systems on National Forests in the Northern Region (Reeves et al. 2011)
- Managing Organic Debris for Forest Health (Schnepf et al. 2009)
- A Review of Chemical and Physical Properties as Indicators of Forest Soil Quality: Challenges and Opportunities (Schoenholtz et al. 2000)
- Soil Survey of the Nez Perce National Forest Area, Idaho (unpublished data available in the project record)
- Land System Inventory: First Review Draft, Clearwater National Forest (Wilson et al. 1983)

2.2.2 *Informing the Assessment*

For the soil resources, the best available science was used to inform the assessment.

2.2.2.1 **Current Conditions**

Soils of the Nez Perce–Clearwater National Forests

The Forests are located mostly in the Clearwater Mountains but also include part of the Seven Devils Mountains. The Clearwater Mountains are intrusive mountains formed on the Idaho Batholith. A highly dissected hilly landscape initially formed on the Idaho Batholith and was later uplifted. Major streams carved deep canyons into the hilly landscape as the result of uplift. The Seven Devils Mountains are intensely folded and faulted andesite flows, shale, and limestone. In the western part of what was the Nez Perce National Forest, basalt flows formed plateaus. Remnants of the old hilly landscape remain in the southwestern part of what was the Clearwater National Forest and on major mountain ridgetops. The mountains with the highest elevations were glaciated by alpine glaciers. Alpine glaciation produced a distinctive landscape dominated by glacial cirques, U-shaped glacial valleys, and broad glaciated mountain ridgetops. The survey area is in the headwaters of the Clearwater River and the drainageway of the Salmon River. Principal watercourses are the North, South, and Middle forks of the Clearwater River and the Lochsa, Selway, and Salmon rivers.

Most soils in the Forests were formed during recent times (Holocene; 10,000 years ago). The bedrock in the area, which provides soil parent materials upon weathering, was emplaced over much longer periods of time. The Belt Supergroup rocks of Precambrian Age (more than 600 million years old) were laid down in a seabed and subsequently metamorphosed. These rocks are mostly schist, gneiss, siltite, argillite, and quartzite. The Seven Devils Volcanics were extruded in the southwestern part of what was the Nez Perce National Forest and are of Permian and Triassic Age (208 to 286 million years old). These volcanics are metamorphosed andesite flows associated with shale and limestone. The Idaho Batholith granitics were intruded during late Cretaceous time (66 to 110 million years ago). Most of these rocks are quartz monzonite, granodiorite, quartz diorite, and granite. Some smaller granitic areas were apparently implanted within the Idaho Batholith during early Tertiary time (60 million years ago). A variety of metamorphic rocks are associated with the Idaho

Batholith. Many of these rocks are gneiss or schist that are located near the margins of the granitics and probably represent the metamorphism associated with the intrusions. Miocene basalt flows (13 to 25 million years old) overlie portions of the western part of what was the Clearwater National Forest and the southwestern corner of what was the Nez Perce National Forest.

Mineralogy, past weathering environments, faulting, and hydrothermal effects have influenced bedrock character. Bedrock at lower elevations, on relatively low-relief landscapes, is usually well weathered and more than 5 feet below the surface, with relatively few rock fragments. The bedrock at higher elevations and on steep slopes is hard, coherent, and weakly weathered, with many hard, angular rock fragments in the lower soil layers. Basalt, rhyolitic rocks, and limestone have weathered slowly. Hard, angular rock fragments are common in the lower soil layers when soils are formed in material derived from these rocks. Granitic rocks have been chemically weathered at low elevations on relatively low-relief landscapes. Weathered granitic rocks are soft and rapidly break down to fine gravel and sand when exposed by excavation. Weathered quartzite in a small, intensely faulted area in the northeast portion of the survey area has similar properties.

Most soils in the Forests have surface layers formed in loess that has been influenced by volcanic ash. A layer of this loess was deposited on the survey area approximately 6,700 years ago by the eruption of Mount Mazama in Oregon. Additional loess that has been influenced by volcanic ash was deposited by eruptions of Mount St. Helens and Glacier Peak. These loess deposits vary in thickness, depending on location: in some depressions, deposits are over 36 inches thick; steep southerly aspects at lower elevations have very thin deposits that may be mixed with underlying materials; and no deposits exist on the most southerly end of the Forests. Soil surface layers formed in loess are an excellent medium for plant growth. Soils with the thickest loess surface layers tend to be the most productive. Most soil surface layers are formed in loess that has been influenced by volcanic ash or loess mixed with subsoil material; lower soil layers are formed in materials derived from other sources. An ash-influenced surface layer is resistant to erosion when undisturbed, but if disturbed, it has a high risk of surface erosion. These surface soils are also highly susceptible to compaction.

The following parent material groups and associated hazards are found on the Forests.

Alluvium is unconsolidated material sorted and deposited by water; it usually contains rounded rock fragments. Alluvium forms floodplains and terraces along major streams and rivers. These features are narrow and linear. Limitations due to flooding, high water tables, and proximity to major streams are associated with these deposits.

Glacial till is unconsolidated deposits of clay, sand, gravel, and boulders. Most glacial till in the survey area is of local origin, and characteristics of the local bedrock determine the properties of till deposits. Tills derived from granitic rocks have sandy textures. Tills derived from basalt, andesite, and Tertiary sediments have loamy textures. Glacial till occurs on moraines, in glacial trough bottoms, and on the lower slopes of glacial trough walls and cirque headwalls. Glacial till deposits ravel on steep road cutbanks.

Tertiary sediments and well-weathered metasediments are upland alluvial deposits or deeply weathered schist influenced by alluvial deposits. These sediments occur on mountain slopes and rolling uplands. They are generally sandy clay loam and clay loam and may have rounded rock fragments. Subsoils are generally very thick and tend to perch water. Erodible subsoils and substrata are associated with these parent materials.

Granitic rocks are granite, gneiss, schist, and associated quartzite. These rocks weather to sandy loam or loamy sand or to sand. Chemical weathering determines the content and hardness of rock fragments; it is most intense at low elevations and in high-precipitation zones. Lower soil layers are erodible.

Weathered granitics (grus) are granitic rocks that have rock structure, but they are soft and can be dug with a spade. Soil derived from these rocks contains large amounts of fine gravel-sized particles of weakly consolidated rock. Many of these particles can be crushed with the fingers. In some areas, the lower soil layers are formed in weathered granitic rock and are relatively impermeable to roots and water. The layers rapidly break into a mixture of pea-sized gravel and sand when exposed by excavation. These parent materials generally occur on rolling uplands and are associated with erodible subsoils and very erodible lower soil layers. Lower soil layers formed in weathered granitic rocks are very difficult to revegetate when exposed.

Mica schist geology forms loam and sandy loam textured soils containing 10%–20% mica. These soils occur on rolling uplands, mountain slopes, and stream breaklands. Rock fragment content depends upon the degree of chemical rock weathering. Soils with weak subsoil clay accumulations are associated with these parent materials. Materials containing mica are unstable on steep slopes, and road cutbanks and fill slopes tend to slough. They are resistant to erosion. When used as native road surface, they tend to rut when rock fragment content is low.

Metasedimentary rocks form sandy loam and silt loam textured soils. Rocks are mainly quartzite, siltite, and argillite of the Precambrian Belt Supergroup. Chemical weathering determines rock fragment content and hardness. Parent materials derived from metasedimentary rocks are divided into two groups according to the amount and hardness of rock fragments. These properties affect erodibility of soils formed in these parent materials.

Well-weathered quartzite geologies form very fine sandy loam or loamy fine sand textured soils with few rock fragments. The lower substrata are formed in weakly consolidated, weathered quartzite, which rapidly breaks into fine sand when exposed by excavation. These parent materials are on rolling uplands, mountain slopes, and stream breaklands in the Deception, Upper Moose, and Comet Creek drainages. Soils with very erodible subsoils and substrata are associated with this parent material.

Weakly weathered metasedimentary rocks form sandy loam soils containing many angular rock fragments. These materials are on rolling uplands, mountain slopes, and stream breaklands. Soils formed in these parent materials have subsoils and substrata resistant to erosion.

Basalt is hard, commonly well-fractured bedrock. Soil derived from basalt is loamy and contains many hard, angular or subangular rock fragments. Soil with subsoil clay accumulations is associated with basalt.

Rhyolitic rocks are mostly hard, well-fractured andesite. The Seven Devils Volcanics formation consists of rhyolitic rocks. Limestone and slate are included in places. Soil derived from rhyolitic rocks is loamy and contains many hard, angular rock fragments. Subsoil clay accumulations are associated with rhyolitic rocks.

The following landforms and their associated sensitivities are found on the Nez Perce–Clearwater National Forests.

Stream bottoms are nearly level, slightly concave areas near streams containing stream floodplains, low terraces, and alluvial fans. These landforms are long and narrow. Lower soil layers are porous and gravelly. Soils have fluctuating water tables. Most of this landform is a riparian area.

Stream terraces and alluvial fans are nearly level to gently sloping deposits of alluvial material along rivers. Stream terraces are flat to slightly concave step-like benches with short, steep descending slopes facing the stream. Lower soil layers are gravelly and permeable. Alluvial fans are cone-shaped deposits at the mouths of steeply graded streams. Materials may be stratified and contain many rock fragments. Stream terraces and alluvial fans can deliver sediment to streams efficiently because of proximity to higher-order streams.

Rolling foothills consist of low-relief rolling hills ranging from 3,000 to 5,200 feet in elevation. Slope gradients are generally <40%. Well-developed dendritic drainage systems characterize these landscapes. Soi1s are developed from well-weathered igneous and metamorphic rocks. Soils usually have a volcanic ash surface overlying deep, weakly developed, nonskeletal subsoils. Bedrock weathering often exceeds 10 feet in depth. This landtype association is highly productive and intensely managed for timber production. It has few silvicultural limitations and is relatively stable, with road prism erosion being the major watershed problem.

Low-relief rolling uplands are rounded hills 100 to 300 feet high. Slopes are straight to convex with gradients of 10%–40%. Drainageways are gently concave. The drainageway pattern is dendritic. Low-relief rolling uplands underlain by weathered granitic rocks have a dense pattern of drainageways with short reaches. Roads constructed on low-relief rolling uplands cross drainageway channels frequently. Many forest roads built on this landform have a high potential to contribute sediment to the channels.

High-relief rolling uplands are rounded hills 250 to 500 feet high. Slopes are convex with gradients of 25%–50%. Drainageways are concave. The drainageway pattern is dendritic. High-relief rolling uplands deliver sediment to streams efficiently because of moderate slope gradients and moderate distances between drainageway channels. Slope gradients and aspects are complex, and combinations of tractor and cable yarding are needed to harvest timber.

Plateaus are broad, undulating to hilly, mountain summits. Slopes are straight to slightly convex with gradients of 10%–25%. Drainageways are broadly concave and very widely spaced. All are first-order drainageways. Plateaus deliver sediment to streams inefficiently because of gentle slopes and widely spaced channels. These landforms are underlain by basalt bedrock that is resistant to weathering. Soils are 20 to 60 inches deep over bedrock, and lower soil layers contain many rock fragments.

Basalt plateaus and rolling hills consist of low-relief plateaus, ranging from 2,000 to 3,600 feet in elevation. Slope gradients are generally <30%. Landscapes are characterized by well-developed dendritic drainage systems. This unit occurs along the eastern edge of the Columbia River basalt flow. Ancient alluvium and Palouse loess of varying thickness overlie the basalt. Soils are silty textured with a thick ash cap and are well developed. Basalt plateaus and rolling hills are the most productive lands and have few silvicultural limitations. Road limitations include rutting and subsequent erosion during wet periods.

The Palouse steppes comprise the eastern edge of the Palouse Prairie, which consists of low-relief rolling Aeolian (wind-deposited) hi1ls. Parent material is wind-deposited loess ranging up to several hundred feet thick. Soils are well developed and silty in texture. Most of the steppe is now cultivated, but the area was originally grassland with Douglas-fir and ponderosa pine on north aspects and in draws.

Dissected mountain slopes are complexes of narrow ridges about 500 to 1,000 feet high. Slopes are nearly straight with gradients of 25%–60%. The drainageway pattern is parallel, though some branching of lower-order drainageways occurs. Dissected mountain slopes deliver sediment to streams efficiently because of moderately steep to steep straight slopes and channels that are relatively close together.

Mountain slopes are complexes of ridges 300–750 feet high. Slopes are convex with gradients of 10%–45%. Drainageways are gently concave. The drainageway pattern is dendritic. Mountain slopes deliver sediment to streams inefficiently on gently sloping ridges and with moderate efficiency on moderately steep side slopes. Many forest roads built on this landform have the potential to contribute sediment to streams.

Mountain ridges are broadly rounded ridges. Slopes are convex with gradients of 5%–45%. Drainageways are poorly defined and widely spaced. Nearly all are first-order drainageways. Mountain ridges deliver sediment to streams inefficiently because of gently sloping, broadly convex slopes and widely spaced streams. These landforms are in cold, high-elevation climates, and most materials contain many angular rock fragments. Many forest roads built on this landform have the potential to contribute sediment to streams.

Colluvial and frost-churned mountain slopes occur on mid and upper slopes of major ridge systems. Elevations range from 2,000 to over 6,000 feet. Slopes are steep, dissected, and straight to slightly convex at lower elevations. Slopes become broad and rounded with few stream dissections at higher elevations. Localized glaciation occurs on north and east aspects of high ridges and peaks. Bedrock is moderately weathered at lower elevations and weakly weathered at higher elevations. Soils are moderately deep to deep and are usually covered with an ash cap. Soils are colluvial or frost churned and are weakly developed. Coarse fragment content increases with elevation and reaches 75% on higher ridges. This unit covers a broad range of management potentials. Productivity is moderate to high at the lower elevations, depending on aspect, and low to moderate at higher elevations. Silvicultural limitations and opportunities vary due to the variation in soils, climate, and vegetation. Lower slopes are moderately stable with localized zones of mass instability. Stability increases with elevation, with the broad, rounded upper ridges being among the most stable lands on the Forests.

Palouse Mountains consist of steep, moderate-relief ridge systems on the Palouse District. Slopes are straight and dissected, with gradients of 40%–60%. Elevations range from 3,000 to 5,500 feet but are mostly less than 4,000 feet. Bedrock is moderately weathered Belt rock. Soils are moderately to weakly developed; they are well drained and have thick ash caps. This soil type is very productive, with few silvicultural limitations and only local stability problems.

Nivational hollows are depressions on northerly aspects of mountain slopes. These hollows have a teardrop shape in outline, with the narrow end downslope. They form the upper reaches of drainageways. Slopes are concave with gradients of 10%–45%. Drainageways are poorly defined. Most are first-order drainageways. Nivational hollows occur at high elevations; their origins are thought to be related to snow accumulation on the lee side of ridges in periglacial climates. A series of more strongly expressed hollows appears at increasing elevation until they merge with glacial cirque basins at even higher elevations. Nivational hollows deliver sediment to streams efficiently because of concave slopes, which tend to concentrate runoff, and closely spaced drainageways.

Glacial cirques are concave, bowl-shaped basins with headwalls 500 to 2,500 feet high. Glacial cirques have steep to nearly vertical headwalls and flat to gently sloping basin floors. Bedrock may outcrop on headwalls. The basin floors have glacial till deposits and some small lakes. Glacial cirque headwalls deliver sediment to the basin floor efficiently because of steep concave slopes. The basin floor tends to trap and delay moving sediment. Regolith water storage capacity is limited by bedrock and moves out of this landform rapidly, particularly during snowmelt.

Moraines are rolling to hilly glacial till deposits with a topography characterized by randomly oriented mounds and depressions. The drainageway pattern is weakly developed with first-order drainageways with long reaches. Surface drainageways are poorly developed, and many depressions have no outlet. Because of the steepness of slope, moraines deliver sediment to streams with low efficiency on gently sloping moraines and with moderate efficiency on moderate and steeply sloping moraines.

Glacial trough bottoms are the nearly level to gently sloping bottoms of U-shaped glacial valleys. Slope gradients are generally 0%–25% but may range to 40% adjacent to valley walls. Trough bottoms have thick mantles of glacial till, glacial outwash, stream alluvium, and debris from adjacent valley streams. Glacial trough bottoms deliver sediment to streams efficiently because most of this landform is close to a stream. Because of their location, these landforms are often desirable areas for a variety of activities, such as road construction and recreation. Much of this landform is a riparian area.

Glacial trough walls are concave sides of U-shaped glacial valleys. Slopes are vertically concave with gradients ranging from 25% to more than 60%. The drainageway pattern is parallel. Glacial trough walls deliver sediment to streams efficiently because of steep slopes and relatively closely spaced drainageways. Lower slopes are mantled by thick glacial drift deposits that thin the upslope. The lower slopes help to slow rapid runoff from upper slopes. Many forest roads built on this landform have the potential to contribute sediment to the streams.

Glaciated ridges, peaks, and cirques are characterized by cirque basins, scoured troughs, steep rocky crags, and other features of strong alpine glaciation. Elevations are over 5,500 feet and usually over 6,000 feet except in the bottom of deep troughs. Alpine lakes are common. Bedrock is scoured and very weakly weathered, with rock outcrop occupying a large percentage of the unit. Soils have developed in glacial tills of varying depths, but they are predominantly shallow and excessively well drained. Most of this landtype is considered noncommercial because of poor site quality, difficult access, and high values for dispersed recreation.

Ice cap scoured and depositional lands occur on the southern and eastern portions of the

Powell District. It consists of undulating uplands with low relief. The uplands are dissected by broad U-shaped valleys. Elevations for the uplands range between 5,000 and 6,000 feet, with valley bottoms dropping to 4,000 feet. The entire area was overlain by a thick ice cap that caused scoured ridges and till deposition in draws and depressions. Bedrock is hard, fractured, and weakly weathered. Soils on scoured ridges have thick ash caps over stony, well-drained subsoils of moderate depth. Soils in draws and depressions are deep and commonly have compacted layers within 4 feet of the surface. Areas with compacted soils are poorly drained and wet much of the year. Management characteristics of this unit are dominated by large amounts of spring runoff and high water tables in areas with compacted tills. Water tables can be raised to or near the surface through vegetation removal. Surface soil erosion can be severe on disturbed soils with high water tables. Well-drained areas are quite stable and have few watershed problems. However, these areas are intermingled with poorly drained areas over much of the unit, complicating management potential.

Landslide deposits are lobate deposits of material. Slip scarps and toes of small slumps give the surface of these deposits an irregular, hummocky appearance. The drainageway pattern is deranged, with stream channels appearing and disappearing because of subsurface disruption of groundwater flow. Landslide deposits deliver sediment to streams efficiently because landslides may be deactivated and deposit sediment directly into closely spaced drainageway channels.

Undissected stream breaklands are steep and have straight to concave slopes up to 3,000 feet high. Slope gradients are 60% or greater. The drainageway pattern is parallel. Undissected stream breaklands deliver sediment to streams efficiently because of steep slopes. Many forest roads built on this landform have the potential to contribute sediment to the streams.

Dissected stream breaklands are steep and have straight to concave slopes up to 3,000 feet high. Slope gradients are 60% or greater. The drainageway pattern is parallel, but some branching of low-order streams occurs. Dissected stream breaklands deliver sediment to streams very efficiently because of steep slopes and closely spaced drainageways. Many forest roads built on this landform have the potential to contribute sediment to the streams.

Breakland drainageway heads are triangular features, with the narrow end downslope at the heads of drainageways on stream breaklands. Slope gradients range from 40% to more than 60%. The drainageway pattern is pinnate, with the confluence of drainageways near the lower, narrow end of the landform. Breakland drainageway heads deliver sediment to streams very efficiently because of steep slopes and closely spaced drainageways. The point where drainageways converge at the lower apex of the landform tends to accumulate sediment. This convergence may be a source of debris avalanches and flash floods. Many forest roads built on this landform have the potential to contribute sediment to the streams.

Breaklands consist of steep slopes adjacent to rivers and their tributaries. The slopes are oversteepened as a result of streams downcutting faster than the adjoining slopes could retreat. Elevation varies from 1,600 to 6,000 feet, and relief of several thousand feet is common. Slopes are long and straight to concave in shape. Gradients exceed 60%. Bedrock is moderately to weakly weathered. Rock outcrop is common. Soils are colluvial and weakly developed and vary widely in properties. Soils on northerly aspects tend to be deep and skeletal with a mixed ash cap. On southerly slopes, soil depths vary from deep to <20 inches deep. Ash caps are thin or missing on shallow soils and are mixed on others. These lands are the most unstable on the Forests. Instability and the high cost of access limit management potential. Productivity varies from high on the northerly aspects to low or noncommercial for shallow droughty soils on southerly aspects. Regeneration is a problem on southerly slopes because of droughtiness and high soil temperatures.

Current Forest Service Direction for Soil Management

Soil quality management on the Nez Perce–Clearwater National Forests is guided by National and Regional Direction found in the Forest Service Manual (FSM) Chapter 2550 Soil Management and the Chapter 2550 Region 1 Soil Management Supplement (1999) Soil Quality Standards (SQS).

Soil disturbance has been the focus of soil management on Forest Service lands for many years. The current Forest Plans for the Forests both place disturbance caps on management activities. While the limits are different, the goal for each is the same: to maintain the productivity of the land. FSM Chapter 2550 Region 1 Soil Management Supplement places a detrimental disturbance cap of 15% on management activities. Detrimental soil disturbance (DSD) is defined as disturbances, including the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement, that indicate when changes in soil properties and soil conditions would result in significant change or impairment of soil quality.

In 2010, the FSM Chapter 2550 Soil Management was amended at the national level. The emphasis of soil management was changed to an approach focusing on long-term soil quality and ecological function instead of disturbance tracking. The FSM defines 6 soil functions: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. The objectives of the National Direction are 1) to maintain or restore soil quality on National Forest System lands and 2) to manage resource uses and soil resources on National Forest System lands to sustain ecological processes and function so that desired ecosystem services are provided in perpetuity.

2.2.2.2 **Trends and Drivers**

- Identify important attributes or characteristics of soils and sites that make them susceptible to loss of integrity resulting from specific uses, disturbances, or environmental change.
- Identify existing impairments, such as critical loads, acidification, or invasive species impacts.

Land use practices, such as grazing, logging, and mining, have been occurring on the Nez Perce–Clearwater National Forests since their creation. Impacts of these uses are evident in the soils today. Long-term grazing of livestock has formed terraces on the steep slopes of grasslands in the White Bird area. Some early mechanized logging practices on the Forests include Idaho Jammer Logging. This style of logging involved building parallel roads across the hillslope at intervals of 100 to 500 feet, which resulted in harvest units with up to 40% of the area covered in roads. Many of these roads remain on the landscape today. Soil productivity in the Florence region has declined due to loss of topsoil and organic material, mixing of subsoil, and displacement from mining in the late 1800s. Over time, practices have evolved, reflecting an awareness of the impacts to soils. Livestock numbers have been adjusted to meet the capabilities of the land, logging practices have shifted to less-impactive equipment (e.g., cable and skyline methods), and mining operations are required to reclaim their areas of impact. In early 21st-century forest management, soil restoration is included in the majority of projects in order to meet the desired conditions for the land.

Fires are an important ecological driver for the Forests. Several landscape scale fires have occurred throughout the Forests over time. Such fires, if hot enough, can cause damage to soils. When the organic layers are removed through fire, the soil is susceptible to erosion. In some areas on the Forests, the majority of soils eroded after the fires of the early 1900s. These soils are found in brushfields recovering from those historic fires.

Certain attributes associated with the soils in the Forests make them susceptible to decreased soil quality and productivity. Soils that have a topsoil containing ash are extremely susceptible to decreased soil quality due to compaction, erosion, and soil mixing. Compaction restricts plant rooting, lowers water-holding capacity, and decreases infiltration. Surface soil loss through displacement and mixing with less productive substrata decreases soil productivity. Displacement occurs during temporary road construction, excavation of skid trails and landings, and displacement of soils during ground ground-based harvest. The loss of the Mazama ash cap would reduce the water-holding capacity and increase the overall soil bulk density. These effects would decrease available soil moisture and tree root penetrability. Since volcanic ash is not replaced, the effects of erosional losses of the ash cap would be long-term. Areas with ground disturbance may become more favorable for weed invasion, which can reduce overall soil productivity.

The soil organic layer is extremely important to all soils on the Forests, especially those formed from low-nutrient geologies like granite. Soil organic matter is fundamentally important to sustaining soil productivity. Soil organic matter is influenced by fire, silviculture activities, and decomposition and accumulation rates. The organic component of soil is a large reserve of nutrients and carbon and is the primary site for microbial activity. Forest soil organic matter influences many critical ecosystem processes, including the formation of soil structure. Soil structure influences soil gas exchange, water infiltration rates, and water-holding capacity. Soil organic matter is also the primary location for nutrient recycling and humus formation, which enhances soil cation exchange capacity and overall fertility. Soil organic matter depends on inputs of biomass (e.g., vegetative litter, fine and coarse woody debris) to build and maintain the surface soil horizons, support soil biota, enhance moisture-holding capacity, and prevent surface erosion. Woody debris in the form of slash provides a practical and effective mitigation for reducing harvest impacts on soil physical function and processes. The retention of coarse (>3 inches in diameter) woody debris is essential to maintaining soil organic matter, soil productivity, and sustainable forest ecosystems.

Soils formed from grussic granitics comprise the third group of sensitive soils on the Forests. These soils are typically noncohesive and coarse textured and are susceptible to erosion and mass wasting. These grus soils are droughty with low water- and nutrient-holding capacities; therefore, keeping the thin surface organic layer intact is extremely important.

The final group of sensitive soils is the landslide-prone terrain. For the Nez Perce National Forest, landslide-prone areas are generally located on slopes >60% and landslide deposit landtypes. During storm and flood events in 1995 and 1996, over 860 landslides occurred across the Clearwater National Forest. A survey was conducted to review these landslides, and 5 factors were identified to assess the inherent risk of landslides on the Clearwater National Forest. The 5 factors are geologic parent material, elevation, aspect, slope angle, and landform (Table 1).

Table 1. Landslide hazard factors and hazard risk rating for the Clearwater National Forest

Factor	Type	Rating[a]
Geologic Parent Material	Border Zone metamorphics (1.06 slides/1000 acres)	High
	Belt Series metasediments (0.56 slides/1000 acres)	Moderate
	Idaho Batholith granitics (0.28 slides/1000 acres)	Low
	volcanics (0.16 slides/1000 acres)	Low
	sediments (0.16 slides/1000 acres)	Low
Elevation	3001–3500 feet (1.66 slides/1000 acres)	High
	less than 2000 feet (1.65 slides/1000 acres)	High
	2501–3000 feet (1.48 slides/1000 acres)	High
	3501–4000 feet (1.10 slides/1000 acres)	High
	2001–2500 feet (0.90 slides/1000acres)	Moderate
	4001–4500 feet (0.85 slides/1000 acres)	Moderate
	4501–5000 feet (0.50 slides/1000 acres)	Low
	above 5000 feet (few)	Low
Aspect	south (21.8% of the slides)	High
	southwest (20.8%)	High
	west (16.8%)	Moderate
	southeast (14.9%)	Moderate
	northwest, north, northeast, east (few)	Low
Slope Angle	Greater than 56% (2.00 slides/1000 acres)	High
	46%–50% slopes (0.73 slides/1000 acres)	Moderate
	51%–55% slopes (0.59 slides/1000 acres)	Moderate
	41%–45% slopes (0.43 slides/1000 acres)	Low
	less than 35% (few)	Low
Landform	mass wasted slopes (1.72 slides/1000 acres)	High
	breaklands (1.12 slides/1000 acres)	High
	stream terraces/valley bottoms (0.70 slides/1000 acres)	Moderate
	colluvial midslopes (0.54 slides/1000 acres)	Moderate
	low-relief hills, frost-churned ridges (few)	Low

[a]High = >1.0 slides/1000 acres; Moderate = 0.5–1.0 slides/1000 acres; Low = <0.5 slides/1000 acres

2.2.2.3 Resource-Specific Information

Current Soil Inventories and Improvement Needs

Terrestrial Ecological Unit Inventories including soil mapping have been completed on both Forests in the 1970s and 1980s. Nez Perce National Forest Soil Mapping was conducted between 1981 and 1986 by US Forest Service Soil Scientist/Ecologist. A Local Forest Publication of the data was printed in 1987. In 2006, National Cooperative Soil Survey (NCSS) published a copy of the survey. The survey encompasses approximately 1.3 million acres of the Forest; Wilderness areas were not mapped. Edge joins with the Idaho County

Area were being completed in 2010–2011. The Nez Perce National Forest soil survey has been correlated and entered into the National Soil Information System (NASIS) database and the Soil Survey Geographic Database (SSURGO). Information garnered during the joining efforts showed inconsistencies within the Nez Perce National Forest survey as well as inconsistencies with the Idaho County Survey.

Clearwater National Forest Soil Mapping was conducted between 1971 and 1979 by US Forest Service Soil Scientists and additional staff. A Local Forest Publication of the data was printed in 1983. The survey encompasses approximately 1.5 million acres of the Forest; Wilderness areas were not mapped. The Clearwater National Forest soil survey was slated to be correlated and entered into NASIS and SSURGO by Natural Resources Conservation Service (NRCS) in 2011; however, funding fell through, so this part of the project was not completed.

No Forest-wide inventories of soil improvement needs exist. Soil improvement needs have been identified on a project-by-project basis.

Ability of Soil to Maintain Ecological Functions

FSM Chapter 2550 Soil Management defines soil function as any ecological service, role, or task that soil performs. The FSM identifies 6 soil functions: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. Soil is the foundation of the ecosystem; in order to provide multiple uses and ecosystem services in perpetuity, these 6 soil functions need to be active.

Soil biology is the presence of roots, fungi, and microorganisms in the upper sections of the soil. Diversity of soil biology is beneficial for several reasons: the complex process of decomposition and nutrient cycling requires a varied set of microorganisms. An intricate group of soil organisms can compete with disease-causing organisms and prevent a problem-causing species from becoming dominant. Several organisms are involved in creating and maintaining the soil structure important to water dynamics in soil. Many antibiotics and other drugs and compounds used by humans come from soil organisms. Most soil organisms cannot grow outside of soil, so it is necessary to preserve healthy and diverse soil ecosystems to preserve beneficial microorganisms. Loss of organic matter, loss of topsoil, and compaction are the three main impacts to soil biology.

Soil hydrology is the ability of the soil to absorb, store, and transmit water, both vertically and horizontally. Soil can regulate the drainage, flow, and storage of water and solutes, including nitrogen, phosphorus, pesticides, and other nutrients and compounds dissolved in the water. With proper functioning, soil partitions water for groundwater recharge and use by plants and animals. Changes in soil bulk density, soil chemistry, soil structure, soil pores, and ground cover can alter soil hydrology. The main impacts to soil hydrology on the Forests are compaction, erosion, loss of vegetation cover, and hydrophobicity from severe burns. The historic soil impacts from past activates have affected soil hydrology especially in areas where road densities are high.

Nutrient cycling is the movement and exchange of organic and inorganic matter back into the production of living matter. Soil stores, moderates the release of, and cycles nutrients and other elements. During these biogeochemical processes, analogous to the water cycle, nutrients can be held in the soil, transformed into plant-available forms, or lost to the atmosphere or water. Soil is the major switching yard for the global cycles of carbon, water, and nutrients. Carbon, nitrogen, phosphorus, and many other nutrients are stored, transformed, and cycled through soil. Decomposition by soil organisms is at the center of the transformation and cycling of nutrients through the environment. Decomposition liberates carbon and nutrients from the complex material making up life-forms and puts them back into biological circulation so they are available to plants and other organisms. Decomposition also degrades compounds in soil that would be pollutants if they entered groundwater or surface water. The major impacts to nutrient cycling are compaction and loss of organic matter and topsoil.

Carbon storage is the ability of the soil to store carbon. The carbon cycle illustrates the role of soil in cycling nutrients through the environment. More carbon is stored in soil than in the atmosphere and aboveground biomass combined. Soil carbon is in the form of organic compounds originally created through photosynthesis, the process whereby plants convert atmospheric carbon dioxide (CO_2) into plant matter made of organic carbon compounds, such as carbohydrates, proteins, oils, and fibers. The organic compounds enter the soil system when plants and animals die and leave their residue in or on the soil. Immediately, soil organisms begin consuming the organic matter, extracting energy and nutrients and releasing water, heat, and CO_2 back to the atmosphere. Thus, if no new plant residue is added to the soil, soil organic matter will gradually disappear. If plant residue is added to the soil at a faster rate than soil organisms convert it to CO_2, carbon will gradually be removed from the atmosphere and stored (sequestered) in the soil. Forest practices may affect soil carbon storage; research regarding Forest practices and potential effects is under way. Compaction and loss of organic matter and topsoil can be assumed to affect carbon storage.

Soil stability and support is necessary to anchor plants and buildings. Soil is flexible (it can be dug) and stable (it can withstand wind and water erosion). Soil also provides valuable long-term storage options, protecting archeological treasures and land-filling human garbage. Inherent soil properties, like soil texture and particle size distribution, play a major role in physical stability. The need for structural support can conflict with other soil uses. For example, soil compaction may be desirable under roads and houses, but it can be devastating for the plants growing nearby. Soil has a porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots. Soils also provide anchoring support for human structures and protect archeological treasures. The conflict of stability and support with plant growth capabilities is constant when dealing with roads, skid trails, recreation trails, and forest productivity. The main forest impacts to structure and stability are mass wasting, erosion, and loss of organic matter.

In filtering and buffering, soil acts as a filter to protect the quality of water, air, and other resources. Toxic compounds or excess nutrients can be degraded or otherwise made unavailable to plants and animals. The minerals and microbes in soil are responsible for filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic materials, including industrial and municipal by-products and atmospheric deposits. Soil absorbs contaminants from both water and air. Microorganisms in the soil degrade some of these compounds; others are held safely in place in the soil, preventing contamination of air and water. Wetlands soils especially function as nature's filters. Main impacts to the filtering and buffering function include those impacts to soil hydrology and soil biology.

Past forest practices have caused several impacts to soil functions (see Section 1.1.2.2). The soil functions are intertwined making it difficult to discuss them separately. There are a few impacts that can impair the majority of soil functions. These impacts are compaction, erosion, and loss of organic matter. As dicussed in Section 1.1.2.2, many of these impacts have taken place with past activities. While these impacts have not been eliminated in current practices, the Forest Service has decreased these types of effects substantially in management practices. This reduction of impacts, coupled with soil restoration activities, should show an increased capacity of the soils to provide multiple uses and ecosystem services in perpetuity.

2.2.3 *Information Needs*

A comparable soil survey of the two Forests would be advantageous for land planning and consistency. Both Forests were mapped as landtype inventories with the NCSS soil mapping as a part of the process. The mapping relied heavily on plotting boundaries using aerial photography. Major features used for boundaries were landform, vegetation, geology, and elevation. The terms “map unit” and “landtype” were used synonymously. For example, Map Unit (Landtype) 22AH5 (NPNF) was delineated by identifying low-relief rolling uplands on 10%–30% slopes from granitic bedrock with cold, mixed coniferous forest in an elevation range of 4,800–6,200 feet. Field transects were completed on representative delineations of map units for the Nez Perce National Forest, and approximately 30% of the Clearwater National Forest was ground verified. Physical and chemical soil samples were collected within the survey area and similar soils in adjacent areas. Soils were identified to the Family level of classification. Soil profiles were not compared to adjacent survey area soils for consistency. Interpretations found in surveys are not consistent with each other or the NRCS soil interpretations. Riparian soils are not mapped in either survey. Correlating and uploading the surveys to the national databases (NASIS and SSURGO) would allow the Forests to have a consistent approach moving forward with interpretations and land use planning calls. NASIS and SSURGO provide a dynamic resource of soils information for a wide range of needs with several soil interpretations that are currently not available on the Forests. The data systems consist of multiple interrelated soil applications and databases. This data system aids in the collection, storage, manipulation, and dissemination of soil information.

To perform analysis such as the Relative Effective Annual Precipitation (REAP) and complete modeling efforts, both surveys would need to be in NASIS and SSURGO. REAP analysis helps identify the sites most suitable for white pine and white-bark pine restoration that could be used in Management Area delineation. Many hydrological and erosion models use the soils layers as a critical data set. The current layers do not provide an accurate, consistent data set for use in modeling efforts.

2.3 WATER RESOURCES AND QUALITY

2.3.1 *Existing Information*

The Idaho Department of Environmental Quality's (IDEQ's) Water Quality Division is responsible for ensuring that Idaho's surface, ground, and drinking water resources meet State water quality standards. IDEQ's website[1] has numerous water quality related reports, documents, maps, links to regulations, peer-reviewed literature, and brochures.

The main surface water quality report prepared by IDEQ is the biennial, Clean Water Act (CWA) 303(d)/305(b) reports; the most recent of which was prepared in 2010 (IDEQ 2011).

For waters that have pollutant impairments (i.e., those waters that are listed on the CWA Section 303(d) list), the IDEQ or its contractors prepare a subbasin assessment and Total Maximum Daily Load (TMDL) assessment. The following assessments were prepared for watersheds on the Forests:

- Lochsa River Subbasin Assessment (Bugosh 1999)
- Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Load (IDEQ 2003a)
- Lower North Fork Clearwater River Subbasin Assessment and TMDL (Henderson 2002)
- South Fork Clearwater River Subbasin Assessment and Total Maximum Daily Load (Dechert and Woodruff 2003)
- Cottonwood Creek Total Maximum Daily Load (TMDL) (IDEQ et al. 2000)
- Upper Hangman Creek Subbasin Assessment and Total Maximum Daily Load (IDEQ 2007c)
- Little Salmon River TMDL (IDEQ 2006)
- Lolo Creek Tributaries SBA and TMDL (2011)
- Palouse River Tributaries Subbasin Assessment and TMDL (Henderson 2005)
- South Fork Palouse River Watershed Assessment and TMDLs (IDEQ 2007b)
- Potlatch River Subbasin Assessment and TMDLs (IDEQ 2008)
- Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs (IDEQ 2010)
- Middle Salmon River–Chamberlain Creek Subbasin Assessment and Crooked Creek Total Maximum Daily Load (Shumar 2002)
- Middle Salmon River–Panther Creek Subasin Assessment and TMDL (IDEQ 2001h)
- Lower Selway River Subbasin Assessment (Bugosh 200)
- Snake River–Hells Canyon Total Maximum Daily Load (TMDL) (IDEQ and ODEQ 2004)

For each of the watersheds with a developed TMDL, the IDEQ works with local landowners to develop a TMDL Implementation Plan. The following watersheds have implementation plans:

- Lower North Fork Clearwater River Sub–basin TMDL Implementation Plan (CSWCD 2004)

[1] http://www.deq.idaho.gov/water-quality.aspx

- South Fork Clearwater River TMDL Implementation Plan (South Fork Clearwater River Watershed Advisory Group 2006)
- Little Salmon River Total Maximum Daily Load Implementation Plan for Agriculture, Forestry, and Urban/Suburban Activities (2008)
- Potlatch River Subbasin Total Maximum Daily Load Implementation Plan for Agriculture (ISCC 2010)
- Middle Salmon River–Panther Creek (2002)
- Snake River–Hells Canyon (2003)

The following are reports on groundwater aquifers, monitoring wells, and groundwater management plan:

- Idaho's Groundwater Quality Plan: Protecting Groundwater Quality in Idaho (Ground Water Quality Council 1996)
- Camas Prairie Nitrate Priority Area Groundwater Quality Management Plan (IDEQ and ISCC 2008)

The Forests have numerous community and public drinking water supply points of diversion. The following are the three designated municipal drinking water supply watersheds: City of Elk River, Clearwater Water Association (Wall Creek), and Elk City Water District (American River). All but the City of Elk River have a municipal watershed protection plan developed with the Forests. The IDEQ has numerous drinking water assessments for drinking water facilities on the Forests or for communities that derive their drinking water from sources on the Forests:

- Big Eddy Marina, Clearwater County, Idaho PWS #2180007 Source Water Assessment Report (IDEQ 2001a)
- Dworshak Power House, Clearwater County, Idaho PWS #2180009 Source Water Assessemnt Report (IDEQ 2001d)
- Freeman Creek Campground, Clearwater County, Idaho PWS #2180010 Source Water Assessment Final Report (IDEQ 2001e)
- City of Elk River (PWS 2180013) Source Water Assessment Final Report (IDEQ 2005)
- Konkolville (Surface Water) PWS #2180019 Source Water Assessment Final Report (IDEQ 2001f)
- City of Orofino (Surface Water) PWS #2180024 Source Water Assessment Final Report (IDEQ 2001b)
- Riverside Independent Water District (Surface Water) PWS #2180032 Source Water Assessment Final Report (IDEQ 2001m)
- USFW Dworshak National Fish Hatchery, Clearwater County, Idaho PWS #2180035 Source Water Assessment Final Report (IDEQ 2002p)
- USFS, Canyon Work Center (PWS #2180041) Source Water Assessment Final Report (IDEQ 2001l)
- USFS Kelly Forks Work Center (PWS #2180046) Source Water Assessment Final Report (IDEQ 2001i)
- USFS Musselshell Work Center (PWS #2180047) Source Water Assessment Final Report

(IDEQ 2001j)

- Clearwater Water District (Surface Water) PWS # 2250011 Source Water Assessment Report (IDEQ 2001c)
- Lochsa Lodge (PWS #2250035) Source Water Assessment Final Report (IDEQ 2002g)
- USFS Powell Campground (PWS #2250052) Source Water Assessment Final Report (IDEQ 2001n)
- USFS Lochsa Historical Visitor and Work Camp (PWS #2250074) Source Water Assessment Final Report (IDEQ 2002i)
- USFS Wendover Campground (PWS #2250081) Source Water Assessment Final Report (IDEQ 2002m)
- USFS Whitehouse Campground (PWS #2250082) Source Water Assessment Final Report (IDEQ 2002n)
- USFS, Wilderness Gateway Campground (PWS #2250085) Source Water Assessment Final Report (IDEQ 2002o)
- City of Juliaetta (Surface Water) PWS #2290018 Source Water Assessment Final Report (IDEQ 2001o)
- USFS Giant White Pine Campground (PWS #2290051) Source Water Assessment Final Report (IDEQ 2002e)
- USFS Laird Park Campground (PWS #2290052) Source Water Assessment Final Report (IDEQ 2002g)
- USFS Little Boulder Creek Campground (PWS #2290053) Source Water Assessment Final Report (IDEQ 2002h)
- City of Kamiah (Surface Water) PWS #2310003 Source Water Assessment Report (IDEQ 2002a)
- City of Lewiston (Surface Water) PWS #2350014 Source Water Assessment Final Report (IDEQ 2002b)
- Elk City Water and Sewer Association (Surface Water) PWS #2250017 Source Water Assessment Final Report (IDEQ 2002c)
- USFS Fenn Ranger Station and YCC Camp (PWS 2250091) Source Water Assessment Final Report (IDEQ 2003b)
- USFS Ohara Bar Campground (PWS #2250098) Source Water Assessment Final Report (IDEQ 2002j)
- USFS Red River Campground (PWS #2250101) Source Water Assessment Final Report (IDEQ 2002l)
- USFS Red River Ranger Station (PWS 2250102) Source Water Assessment Final Report (IDEQ 2003c)
- USFS Slate Creek Ranger Station (PWS 2250105) Source Water Assessment Final Report (IDEQ 2001k)
- USFS Pittsburg Landing Campground (PWS #2250111) Source Water Assessment Final Report (IDEQ 2002k)
- USFS Hazard Lake Campground (PWS #2250118) Source Water Assessment Final Report

(IDEQ 2002f)

- USFS Castle Creek Work Center and Campgrounds (PWS #2250088) Source Water Assessment Final Report (IDEQ 2002d)

IDEQ also prepares an audit of Best Management Practices (BMPs) designed to protect water quality on National Forest System lands where silviculture practices are implemented. The 2004 Interagency Forest Practices Water Quality Audit (IDEQ 2007a) is the most current report. These reports were prepared in 1985 and every four years from 1988 to 2008.

The Forests also maintain several streamflow gauging stations, bedload sampling stations, turbidity monitoring stations, precipitation gauges, and hundreds of stream temperature monitoring stations. These data are maintained in the NRIS database and by resource specialists on the Forests.

2.3.2 *Informing the Assessment*

For the water resource and quality, the best available science was used to inform the assessment.

The data and reports provide background information on the current and historic water quality conditions across the Forests. These reports also provide information on restoration opportunities as well as sensitive areas that require further protection.

2.3.2.1 Current Conditions

The current strategy is to ensure that Forests management actions continue to provide water quantity and quality that support recreational uses, healthy riparian and aquatic habitats, the stability and effective functioning of stream channels, and the ability to route flood flows. Approximately X,XXX[2] miles of stream segments within the Forests have been listed as impaired or not meeting IDEQ standards (IDEQ 2011).

The IDEQ has determined that these lakes and stream segments do not meet water quality standards for their designated and beneficial uses. State antidegradation policy requires that existing beneficial uses be maintained and protected on all water bodies. TMDL assessments have been completed or are under development and are used as guidance to improve impaired conditions (Table 2). The Forest Service shares the responsibility for completion of subbasin TMDL implementation plans with land managers and landowners within each of the subbasins listed in Table 2. The State of Idaho is the lead agency for TMDL development and approval.

[2] Forest Service staff are working with collaborators to verify this number of stream miles.

Table 2. Lakes and streams not meeting standards

Subbasin Name	Hydrologic Unit Code (HUC 4th field)	Pollutants
Clearwater River, North Fork (Upper) Subbasin	17060307	Temperature
Clearwater River, North Fork (Lower) Subbasin	17060308	Temperature Sediment
Clearwater River, South Fork Subbasin	17060305	Temperature Sediment
Hangman Creek (Upper) Subbasin	17010306	Sediment, Bacteria Temperature
Little Salmon River Subbasin	17060210	Temperature Bacteria
Lolo Creek Tributaries Subbasin	17060306	Temperature
Palouse River Tributaries Subbasin	17060108	Sediment, Bacteria Temperature, Nutrients
Potlatch River Subbasin	17060306	Sediment, Bacteria Temperature, Nutrients
Salmon River (Lower) and Hells Canyon Subbasins	17060209 17060101	Sediment, Bacteria Temperature
Salmon River (Middle)—Chamberlain Creek Subbasin	17060207	Temperature
Salmon River, Middle Fork Subbasin	17060205	Temperature
Salmon River, South Fork Subbasin	17060208	Temperature
Snake River—Hells Canyon Subbasin	17060101 17050103 17050115 17050201	Temperature, Nutrients Sediment, Dissolved Oxygen, Pesticides

2.3.2.2 Trends and Drivers

Elevated water temperature and sediment load are the two most common parameters that indicate water quality impairment on streams and rivers within the Forests (Table 1). Water temperatures are elevated above water quality standards at numerous monitoring locations throughout these subbasins. Timber harvest, roads, mining, grazing, and agricultural activities have reduced shading of surface water. From the assessment of temperature (by Idaho DEQ), it was concluded that many stream segments throughout these subbasin needed heat load reductions to meet water quality standards. Numerous restoration projects have been implemented to address this issue (e.g., riparian planting and increasing large woody debris in stream channels). Forest-wide BMPs were designed and implemented to reduce management-related stream temperature increases (e.g., minimizing prescribed fire and vegetation treatments within riparian habitat conservation areas).

The Forests are analyzing forest stream temperature monitoring and trends will be reported when those analyses are complete.

Coarse sediment, which effects salmonid spawning, has degraded water quality in many of the managed basins. Nonpoint sediment sources are mainly agricultural and grazing areas (10–30 times natural background) and forested areas (2 times natural background) (Dechert and Woodruff 2003). Point sources of sediment include municipal wastewater treatment plants, suction dredge mining, and construction and industrial storm water runoff. Numerous restoration projects have been implemented to address this issue (e.g., road decommissioning, culvert replacement). In addition, Forest-wide BMPs were designed and implemented to reduce the management-related sediment delivery to streams (e.g., resurfacing roads, minimizing prescribed fire and vegetation treatments within RHCAs).

The Forests are analyzing forest stream sediment monitoring and trends will be reported when those analyses are complete. The Forests are also analyzing forest stream flow and precipitation monitoring and trends will be reported when those analyses are complete.

Very little is known about the extent of groundwater dependent ecosystems across the Forests.

2.3.2.3 Resource Specific Information

Municipal Watersheds

Water withdrawals on the Forests are primarily for municipal water supplies and domestic drinking water. Direction for management of National Forest System watersheds that supply municipal water is provided in 36 CFR 251.9 and Forest Service Manual 2542. Watershed lands are to be managed for multiple uses while recognizing domestic supply needs. Municipalities may apply to the Forest Service if they desire protective actions or restrictive measures not specified in the Forest Plan. Formal written agreements to ensure protection of water supplies may be appropriate when multiple use management fails to meet the needs of a water user. No formal written agreements exist on either the Nez Perce or Clearwater National Forests for protecting municipal supplies. The Forests recognize the following three municipal watersheds: City of Elk River, Clearwater Water District, and Elk City Water District.

City of Elk River

In 2003, the city of Elk River, Idaho, began diverting water from Elk Creek 0.25 miles downstream from the Forest Boundary, having previously used ground water wells. The water is treated by a slow sand filter and disinfection and delivered to approximately 100 connections. The Forest Service manages 79% of the watershed above the intake. The USFS gage 1/8 mile upstream of the intake has discharge and suspended sediment records.

Clearwater Water District

The town of Clearwater diverts water (via a concrete dam in Wall Creek in the Nez Perce National Forest) into a holding tank with a Special Use Permit for the intake. The water is treated with a direct pressure mixed-media filter and treated with chlorine. This water is provided to 96 people. The Forest Service manages 100% of the watershed above the intake. The Source Water Assessment done by the IDEQ PWS#2250011 listed two potential contaminant sites, both related to mine prospects.

Elk City Water District

The town of Elk City diverts water from Big Elk Creek downstream from the Forests boundary. About 100 connections are provided by the Elk City Water District. The Forest Service manages the majority of the watershed above the intake. The Source Water Assessment done by the IDEQ PWS#2250017 listed several potential contaminant sources related to mine prospects and a CERCLA site.

The downstream communities of Kamiah, Orofino, Lewiston, Juliaetta, Konkolville, and Orofino Riverside also derive their domestic water supply directly from the surface water originating within the Forests. The city of Kamiah derives its drinking water from the Clearwater River and its drainage basin. The 4-hour or 25-mile time of travel zone for Kamiah includes the Middle Fork Clearwater River and its tributaries. The primary water quality issue currently facing the city of Kamiah is the threat of a potential contaminant spill into the Clearwater River or its tributaries and the problems associated with managing contamination should that occur. According to Idaho State’s drinking water database the Kamiah surface water intake has not recently encountered water quality problems. However, because of the vulnerability of the shallow, poorly screened water intake, Kamiah’s drinking water system is at a high risk of contamination. The prospect of contamination caused by a spill into the Clearwater River or its tributaries is more pronounced due to the close proximity of Highway 12, a major route for commercial traffic, including tanker trucks.

Water Rights Withdrawals

Both consumptive and non-consumptive water rights issues are currently being addressed with legal mechanisms. Water rights for National Forest purposes are claimed under State water law and Federal Reserve rights doctrine (Table 3). Historic claims, consumptive and non consumptive, are being processed under the Snake River Basin Adjudication. Consumptive claims are mostly filed under State water law, with the exception of certain reserved claims for administrative purposes. Non-consumptive claims include reserved rights for Wild and Scenic Rivers. Non-reserved instream flow claims are being processed through the State comprehensive water planning process and the Nez Perce Tribal Settlement Agreement under the Snake River Basin Adjudication. Instream flows for resource protection are also applied as conditions of special use permits.

Table 3. Number of water rights and claims

Owner	Decreed	Statutory	License	Total
Federal Government	775	136	7	918
All Others	86	75	144	305

Drinking Water/Domestic Uses

In addition to community surface water supply, groundwater drinking water sources exist for 34[3] campgrounds and ranger stations within the Forests' boundaries. More than 233 individual groundwater wells, springs and streams in or near the Forests provide domestic water to families and ranches via wells, diversions, and spring sources. Resource management has the potential to influence drinking water quality and quantity for many users.

The State of Idaho has completed a source water assessment for each of the 35 public water systems on the Forests. These assessment reports include information on the potential contaminant threats to specific public drinking water sources, the likelihood that the water supply will become contaminated, and suggested management planning actions for communities and land owners. Once completed, community or use groups develop a written plan to document drinking water protection activities at the intakes and within the appropriate source areas.

Natural Range of Variation

A very detailed description of local climate and water resources is summarized in the following excerpt from the *Clearwater River Subbasin (ID) Climate Change Adaptation Plan* (Clark and Harris 2011):

> Climate throughout most of the Clearwater River Subbasin is strongly influenced by warm, moist maritime air masses from the Pacific, except for the southernmost and high elevation eastern portions of the subbasin, which experience colder conditions more typical of the northern Rocky Mountains (Bugosh 1999). A general increase in precipitation occurs from west to east across the subbasin, coincident with increasing elevation (Stapp et al. 1984). Mean annual precipitation ranges from 12 inches at the confluence of the Clearwater and Snake Rivers to as high as 60 to 85 inches in the Bitterroot Mountains on the Selway-Bitterroot Divide. Due to colder average temperatures, winter precipitation above 4,000 feet falls largely as snow (McClelland et al. 1997). There is also a seasonal variability to precipitation patterns in the region, with very little precipitation occurring in the summer months. Average temperatures generally decrease as one moves from west to east in the subbasin, coinciding with increasing elevations.
>
> There is a large degree of variability in the hydrology [of the area], due to differences in the type of precipitation an area primarily receives (i.e., rain or snow). As noted before, precipitation generally increases from west to east through the subbasin, corresponding with increasing elevations. Peak flows generally occur in May and June, while base flows occur in the late summer months of August and September. The exact timing is quite

[3] Numbers in this section need to be verified with Forest Service staff and cooperators.

> variable, with the earliest peak flows occurring in the low elevation upland areas, and the latest peak flows occurring in the higher-elevation upland areas. Mainstem tributaries generally experience peak flows in May, however. In late winter and early spring, it is typical for rain to fall on frozen or snow covered ground under 4,000 feet elevation, often resulting in substantial peaks in the hydrograph during this period of time, while snowmelt in higher elevation regions is usually released more slowly over time.

The Forests are analyzing forest stream flow and precipitation monitoring and trends will be reported when those analyses are complete.

Flow Regimes

Flow regimes needed to sustain the biotic and abiotic integrity of aquatic ecosystems from the natural range of variation will be discussed in the aquatic section.

Future Patterns of Perturbation

A very detailed description of possible effects of climate on hydrologic processes is summarized in the following excerpt from the *Clearwater River Subbasin (ID) Climate Change Adaptation Plan* (Clark and Harris 2011):

> Regional climate change scenarios project a significant decline in snowpack for the subbasin in the coming decades, with more winter precipitation falling as rain. This reduction in peak snow accumulation will have significant implications for regional hydrology, including more runoff in winter, earlier peak flows in spring, and reduced water availability in summer. Snowpack in higher-elevation areas could actually increase if overall precipitation increases, as is predicted. But since the area of high elevation is relatively small when placed in the context of the entire Clearwater River Subbasin, the total snow pack is still expected to decline.
>
> In addition to affecting the amount of available water, climate change is also expected to reduce overall water quality, due to higher summer water temperatures and changes in the timing, intensity and duration of precipitation events. Higher temperatures can lead to reduced dissolved oxygen levels, which can have a detrimental effect on aquatic organisms. Water temperature controls the physiology, behavior, distribution, and survival of freshwater organisms, and even slight temperature changes can affect these functions (Elliot 1994). A possible increase in frequency and intensity of rainfall during fall and winter months could produce more overall pollution and sedimentation entering waterways, as well as an increased possibility of flooding in winter and early spring.
>
> Because of their shallow water depth, wetlands are especially susceptible to the effects of higher summer temperatures, earlier runoff and lower stream flows that are predicted for this region as a result of climate change. If an increased number of wetlands dry out annually, the substantial benefits they provide to the watershed will be lost and the effects of climate change on those drainages may be compounded.

Effects of Land Use, Projects, and Activities

A large volume of scientific research discussing the effects of land management activities on hydrologic processes and water resources is available (Conroy 2005). There are two primary methods for evaluating the effects of land management activities on hydrologic processes: direct and indirect. Direct methods are monitored for compliance, implementation, and effectiveness. Each of these components provides information on the effects that have already occurred as a result of land management activities. It is then inferred that comparable activities in the future will have similar results. For example, our monitoring data indicates the following:

- Decommissioning roads, especially those adjacent to streams, reduces sediment delivered to streams
- Increasing culvert capacity or removing culverts from stream crossings improves free passage of water, sediment, and woody debris
- Wildfire, timber harvest, and road building increases sediment delivery to streams

Due to the large land base that the Forest Service manages, having monitoring data for every type of project in every type of land system is very difficult. Therefore, hydrologists commonly use predictive models to evaluate the effects of land management activities. The most common parameters modeled are those that directly affect water resources following land management activities. The following parameters are commonly used by the Forests to evaluate the effects of management activities:

- Stream temperature
- Surface sediment erosion
- Sediment transport/deposition
- Rainfall/runoff and water yield
- Climate change

Numerous models are available for evaluating each of these parameters (Conroy 2005), each with its own merits, specifications, and uses. No model or set of models can definitively determine the expected effects of land management activities.

2.3.3 *Information Needs*

A backlog of monitoring data needs to be entered into databases, summarized, and analyzed. Several types of monitoring data are available that would be useful for this analysis, including BMP effectiveness monitoring data, streamflow/sediment transport data, climate data, and stream temperature data.

GIS calculations and/or map products needed:

- Summary of length of stream (by 6^{th} field HUC) that are pollutant impaired (listed by pollutant)
- Summary of length of stream (by 6^{th} field HUC) that are under existing TMDL implementation plans for restoration

Analysis needs:

- Time series analysis of stream temperatures in streams with temperature TMDLs (as well as all other streams)
- Time series analysis of existing streamflow and sediment load data from FS gauge stations (correlating changes/differences with rainfall data)
- Summary of restoration projects (by 6^{th} field HUC)

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