II. PHYSICAL DOMAIN

A. Geology

1. Characterization

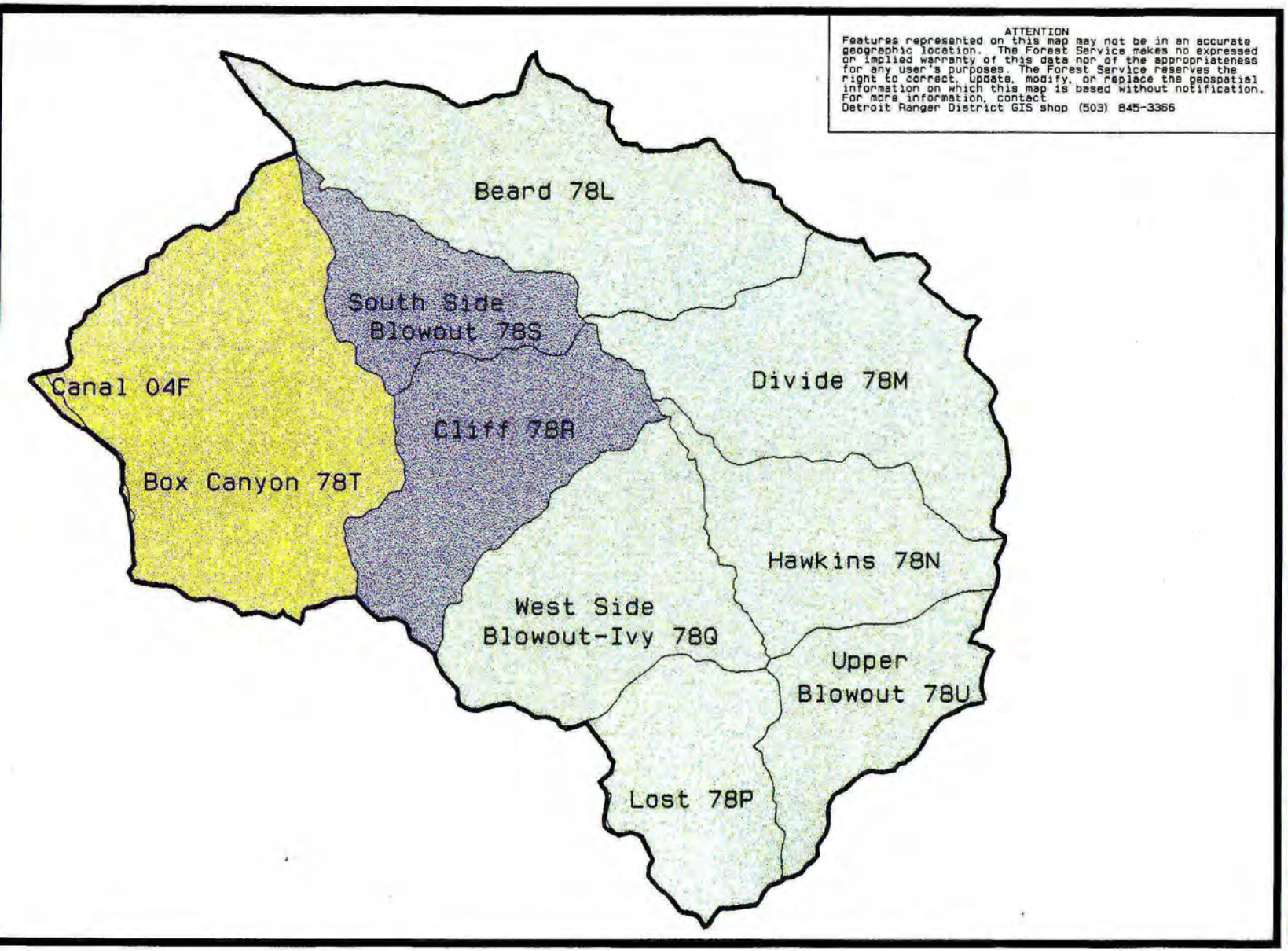
The 34,154 acre Blowout analysis area is a geomorphically complex terrain with a diverse topographic expression. Landforms range from highly glaciated upland benches and flats at the headwaters of Ivy Creek; to steep rocky canyons and crags of lower Box Canyon; to the large scale stabilized slump/earthflow complexes and associated glacial deposits of Hawkins and Divide Creeks; to the flat stable river terraces at the confluence of Blowout and Ivy Creeks.

The Blowout is located entirely within the Western Cascades physiographic region, and is composed of older Tertiary lava flows, tuffs, and breccias around 17 to 32 million years old. Most of this strata was previously assigned to the Little Butte Sequence. Overlying these rocks and capping the ridges at the south end of the study area are andesites and basalts of 10 million to 17 million years of age. These rocks have previously been designated as the Sardine Formation by some authors (Walker and Duncan, 1989). The surface expression of these rock formations has been extensively changed by stream erosion, glacial activity and slope instability.

In the last several hundred thousand years to a million or more years ago, several glacial periods have extensively altered the landscape and created a variety of new features, such as cirque basins and morainal deposits. Since then, many of these features have been eroded by stream action and slope instability. Locally, the materials of the Little Butte Series weather to form deep colluvial and residual soils that give rise to a variety of unstable landtypes. Stabilized slump/landflow features, such as sag ponds, bench and scarp topography, and disrupted drainages, are common in Cliff Creek, Hawkins Creek and Divide Creek. In localized areas of most drainages, actively unstable remnants of these larger landflows can still be found scattered within the stabilized terrain.

Based on topographic expression and geomorphic history, the Blowout analysis area can be stratified into three relatively distinct landform blocks: 1) Areas that principally contain steep rocky canyons - 6,858 acres; 2) Sub-drainages that principally display topography formed by slope instability and/or fluvial/glacial action - 21,686 acres; and 3) A transition area that contains elements common to both the steep canyons and the slump/glacial topography - 5,603 acres. The following is a general description of each landform block, starting with the western most block and moving to the east (*see landform map #4*).

Blowout WA
Landforms



Legend

- Steep Rocky Canyons
- Transition Zone
- Slump and Glacial Features

Request 2023e

Scale 1:100000
08/28/00

Map # 4

Steep Rocky Canyons

This area is defined by the Box Canyon drainage. Aptly named for its distinctive rectangular drainage pattern and steep side walls, the elevation ranges from 1560 feet to 4930 feet. Notably, much of this nearly 3500 feet of relief can be found on sustained steep sideslopes that extend from very small, intermittent, alluvial terraces along Box Canyon Creek to the plateau like, upland benches above. Except in the headwaters, the area is generally highly dissected, with steep, shallow rocky soils and numerous rock outcrops. The headwaters display limited areas of benches and more gently rolling terrain that resulted from cirque activity associated with glaciations, long past (probably mid to early Pleistocene). Soils are primarily residual or colluvial in origin, with some glacially derived soils located in the more gently sloping terrain in the upland areas.

Transition Area

As the name implies, this landform block is geomorphically a transitional area between the steep, shallow, rocky, colluvial soils that predominate in Box Canyon and the relatively gently sloping, deep and often glaciated soils common to much of the Blowout. The transition area has characteristics of both the steep rocky canyons to the west and the glacial/slump topography to the east. Distinctive in appearance, the area includes Southside Blowout (78s) and Cliff Creek (78r) where elevations range from 1560 to 4580 feet and 1840 to 4970 feet respectively. Not surprisingly, this landform block is perhaps the most geomorphically diverse and complex area within the Blowout study area. It contains landforms that range from highly glaciated upland benches and headwalls at the higher elevations, to large-scale stabilized slump/earthflow complexes, to localized areas of actively unstable landflows, to steep, shallow soiled, highly dissected headlands with rock scarps and bluffs, to relatively flat stream terraces in the lowlands near the confluence with Blowout Creek. The complex highly dissected topography is evident with stable upland benches that formed from glacial activity (probably mid to early Pleistocene) separated by precipitous precipices. Extensive, very steep, shallow rocky sideslopes encompass the crags and extend to the valley bottoms. Soils are primarily residual and colluvial in nature on the steeper slopes, with glacial soils on the benches, and alluvial deposits in the valley bottoms. Some mixing of soils has occurred with the large to small scale slope instability that is common to many areas.

Slump and Glacial Terrain Area

The slump/glacial landform block is dominated by fluvioglacial deposits and/or older stabilized earthflow terrain. Included within this block are the Beard (78l), Divide (78m), Hawkins (78n), Westside Blowout-Ivy (78q), Lost (78p) and Upper Blowout (78u) subwatersheds. Elevation ranges from 1560 feet to 5770 feet. This landform block also displays a complex highly dissected topography of rolling benches and flats with occasional near vertical scarps and cliffs. Rock scarps are generally headwalls that have developed large slump/earthflow activity. West Side Blowout, Lost, and Upper Blowout form, respectively, the west, central, and east sides of a large cirque basin (probably from the mid Pleistocene) that created an extensive valley glacier in most of the Blowout drainage. Soils vary in origin, but are often glacial or fluvial in many areas, and the more residual types often slumped into place. Soil mixing is quite common with various soil types juxtaposed in the landscape because of the extensive slope instability.

2. What Do Humans Value That Is Associated With Geology?

a) Landform has aesthetic, spiritual and functional value (i.e. vistas, vision quests, recreation settings, travelways for humans and animals, etc.)

b) Geologic resources have utilitarian and economic value (i.e. crushed rock to surface roads and decorative stones for landscaping or building).

c) Natural geologic processes and their influences on the ecosystem are valued.

3. What are the highest priority issues or resource concerns associated with geology?

a) Whether current erosion processes that are dominant in the Blowout watershed are within the natural range of variability or whether they have been influenced to such an extent by human activities that they are now outside that range.

b) A more specific subset of the above issue is whether management activities such as timber harvest and road construction were major contributors to the landslides that occurred in the Blowout watershed during the 1996 flood event and whether the number and types of landslides were outside the range of natural conditions that might be expected in such a storm event.

c) Collectively the Blowout study area has some of the best growing sites on the Ranger District. In addition, some of the best fertilization response has been on soils in the Blowout. But, about 5 percent of the watershed contains areas that are among the most unstable on the entire Detroit Ranger District. Because of the inherent instability of portions of the Blowout watershed, there is a concern about whether these sensitive soil areas can be identified and avoided when planning and implementing management activities in the watershed.

d) Old tractor logged units have compaction levels that exceed Forest Plan standards and guidelines.

e) Soils in the Blowout cover a wide range of types and particle sizes. Some of the weathered Western Cascade volcanic parent materials produce clay size particles. The fine clays, commonly called Smectites, are a major cause of turbidity that affects downstream water quality.

4. What and where are the management direction/activities, human uses, or natural processes that affect the dominant erosion processes?

a) **Current/Reference Conditions:** *What erosion processes are currently/ historically dominant within the watershed? What are the current/historic conditions and trends of the dominant erosion processes prevalent in the watershed? Where have they occurred or are they likely to occur?*

Steep Rocky Canyons (see Map 4)

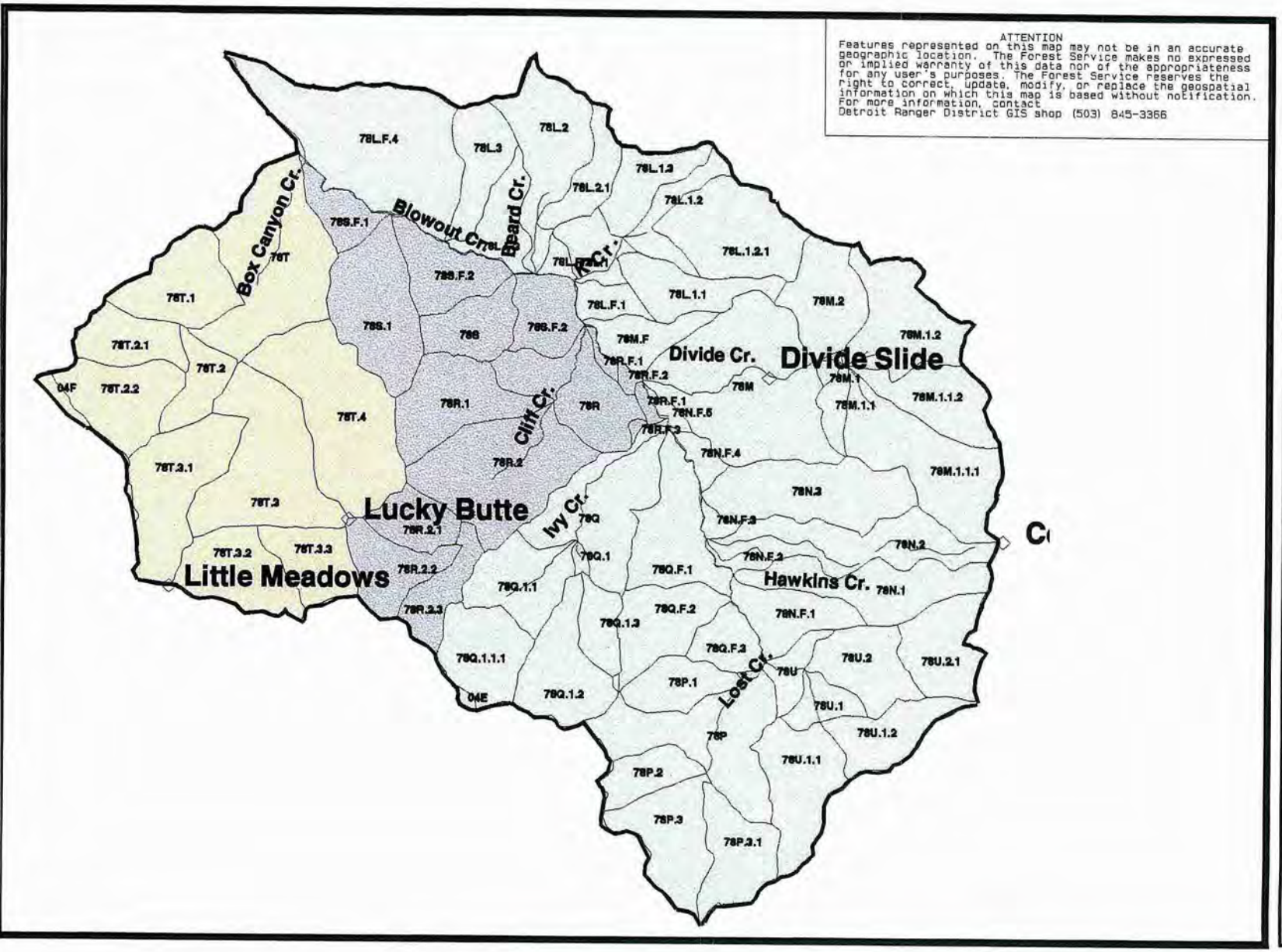
Slope Forming Processes: Stream downcutting of the volcanic formations that comprise the Western Cascades has been the principal process in this drainage for several million years. Older (probably mid to early Pleistocene) glaciation(s) created a upland bench system with occasional remnant glacial deposits in the southern portion of this landform block. Stabilized slump/landflow activity has reshaped some of these more gently sloping, deeper soil areas in the head waters, with some small actively unstable areas still present. Some slumping of the weathered Cascade volcanics is also present.

Sediment Delivery Mechanisms: The principal sediment delivery system in operation is downslope movement of the soil mantel by creep or colluvial process. This process is accelerated during large scale fire events, which occurred in much of the basin approximately 500 years ago and again 150-200 years ago. Some localized areas of instability are present with debris chutes in the lower canyon (especially 78t.1 and 78t.2, see map #5) and earth flows in the upper canyon. The two largest active slumps occur just west of Lucky Butte (along the south boundary of 78t.3) and north of Little Meadows (78t.3.1); their effected areas are about 80 and 60 acres respectively. The unstable areas, although not extensive in nature in this large basin, probably provide a nearly continuous supply of sediment to the main stream channel, as well as side channels, that probably equals the outputs from colluvial processes over the fire cycle period.

Transitional Area (See Map 4)

Slope Forming Processes: In the long term of several millions of years, slopes have resulted primarily as a result of steam downcutting by Blowout Creek and its many tributaries. This activity was accelerated in the last million years or so with extensive glacial activity in the early to mid Pleistocene era. In the nearer term of several hundred to several thousand years, slumps, earthflows and debris chutes have played and continue to shape the landforms and streams of this basin. Massive landflows from the Blowout

Subdivisions of Sixth Field Watershed (PDIVs)



Legend

- Steep Rocky Canyons
- Transition Zone
- Slump and Glacial Features

Request 2023f

Scale 1:100000
06/28/00

Map # 5

Cliffs area, for example, pushed Blowout Creek to the south, and this resulted in the steep canyons and rock cliffs that dominate the opposite stream banks contained in this landform block.

Because of the considerable amount of sediment input to the system, stream erosion and deposition have shaped the lower portion of this drainage. In the confluence area of the Blowout and Ivy Creeks, channel changes are evident where the Blowout has shifted locations from west to east several times over a distance of almost one half mile. Evidence of this stream relocation continues downstream. As the confluence of Blowout and Cliff Creek approach, extensive stream terrace deposits have formed with some as high as 400 feet in elevation above the current valley floor.

Sediment Delivery Mechanisms: As was discussed previously, slope instability by both translational (debris chute) and rotational (slump/earthflow) failures are the dominate sediment delivery methods in this basin. Two active rotational failures of about 12 and about 30 acres toe at principal creeks. Over a dozen, highly debris chute prone hillsides ranging from 3 to as much as 15 acres currently display features which indicate that considerable instability has occurred in the last 50 years, and more is to follow. These slide zones will continue to supply the streams with sediment for decades, and possibly for centuries to come. Finally, creep and colluvial deposition certainly play some role in sediment delivery, especially in the more stable areas. Large woody debris often controls the size and extent of the debris flows.

Slump and Glacial Terrain

Slope Forming Processes: Major slope forming processes have been stream incision into highly weathered volcanic strata, glaciation, and slope instability. Direct glacial deposition (moraines or tills) or slump/earth flows of glacially derived material have been the dominate process in this drainage. Indeed, almost all areas show some influence from glaciation, slumping, or stream downcutting of this material. In some higher elevation areas, benches comprised of residual soil and saprolite show the effects of glacial scour in the distant past. Blowout Creek itself has been significantly manipulated by large earthflows that moved to the south from the highlands. It is difficult to date these events, but it appears to be several thousand years old although that is only a guess at this point. The extensive low gradient reaches of the Blowout main stem with their broad meandering channels have resulted from the base level controls that the large landflows established.

Sediment Delivery Mechanisms: The major sediment delivery systems at work today range from slow, but steady, creep to the rapid forces of slope instability. One significant sediment mover is creep and the associated down slope colluvial processes that are constantly at work and accelerate during periods of large scale fire events. The Beard area for example, has an extensive fire history in the last 500 years with much of the area burning and reburning.

Most areas show an extensive history of slump related soil movement that continues to the present day. The Divide Creek Slide of 150 to 200 acres, located between Cooper's Ridge and Divide Creek (on the boundary between 78m and 78m.2), has blocked Divide Creek on numerous occasions and shifted the channel several hundred feet in the process. Extensive stream terraces from about 40 to over 200 feet in elevation above Divide Creek and extending to the confluence with the Blowout, testify to the extensive sediment input in the past. Field evidence indicates that this slope instability will continue to supply a significant amount of sediment and woody debris to lower Divide Creek and the Blowout for decades to come. On the other hand, for the upper part of Divide Creek, creep and colluvial processes are predominant and certainly accelerate during periods of large scale fire events. Divide also has an extensive fire history in the last 500 years with much of the area burning and reburning in the last 140 years or so.

Another distinctive active landflow somewhat over 100 acres is located (on the boundary between 78n.1 and 78n.2) west of Coffin Mountain and includes about 3000 feet of the Hawkins Creek channel. This land flow appears to move intermittently in surges with previous movements at 65 and perhaps 130 years to 300 years ago, as well as a major movement over 500 to 600 years ago. These have obviously had a considerable effect on the Hawkins Creek channel from the extensive sediment input and stream relocation. For example, some field evidence indicates that Hawkins Creek and the long parallel channel to the south flowed into each other and formed one channel. Whatever the case, this unstable site has been and will continue to supply a significant amount of sediment and woody debris to Hawkins Creek for decades to come. For many of the streams in this drainage however, creep and colluvial processes are now the predominant sediment generator, and these processes certainly accelerate during periods of large scale fire events. Similar to Divide Creek, Hawkins Creek has an extensive fire history in the last 500 years with much of the area burning and reburning.

At this point in time, much of the Blowout main stem geometry is controlled by slope instability. As one would suspect, this is the primary sediment delivery method to the stream. One example is the Blowout Slide. Currently at over 70 acres, this slide toes directly into the river and has now buried a small waterfall that was present only a few years earlier. Another example involves an actively unstable area at the northwest corner of Upper Blowout (78u) and the southwest corner of Hawkins (78n.F.1) that also toes directly into the Blowout. Again, this earthflow has moved the main stem of the stream to the west approximately 200 to 300 feet in the last couple of hundred years or so. These unstable areas, as well as many others not mentioned, have supplied and will continue to supply the upper Blowout with an enormous amount of sediment for centuries to come.

b) **Comparison of Current and Reference Conditions**: *What are the natural and human causes of change between historical and current erosion processes in the watershed?*

Fire is a natural ecological component of the west Cascades ecosystem. Fire recurrence intervals estimated at about 200-400 years seem to occur in the natural system, with shorter intervals recorded in some critical high lightning areas. From a soil productivity standpoint, most naturally occurring wildfires were not kind to the soil resource. Most duff and down woody debris were consumed, along with extensive amounts of

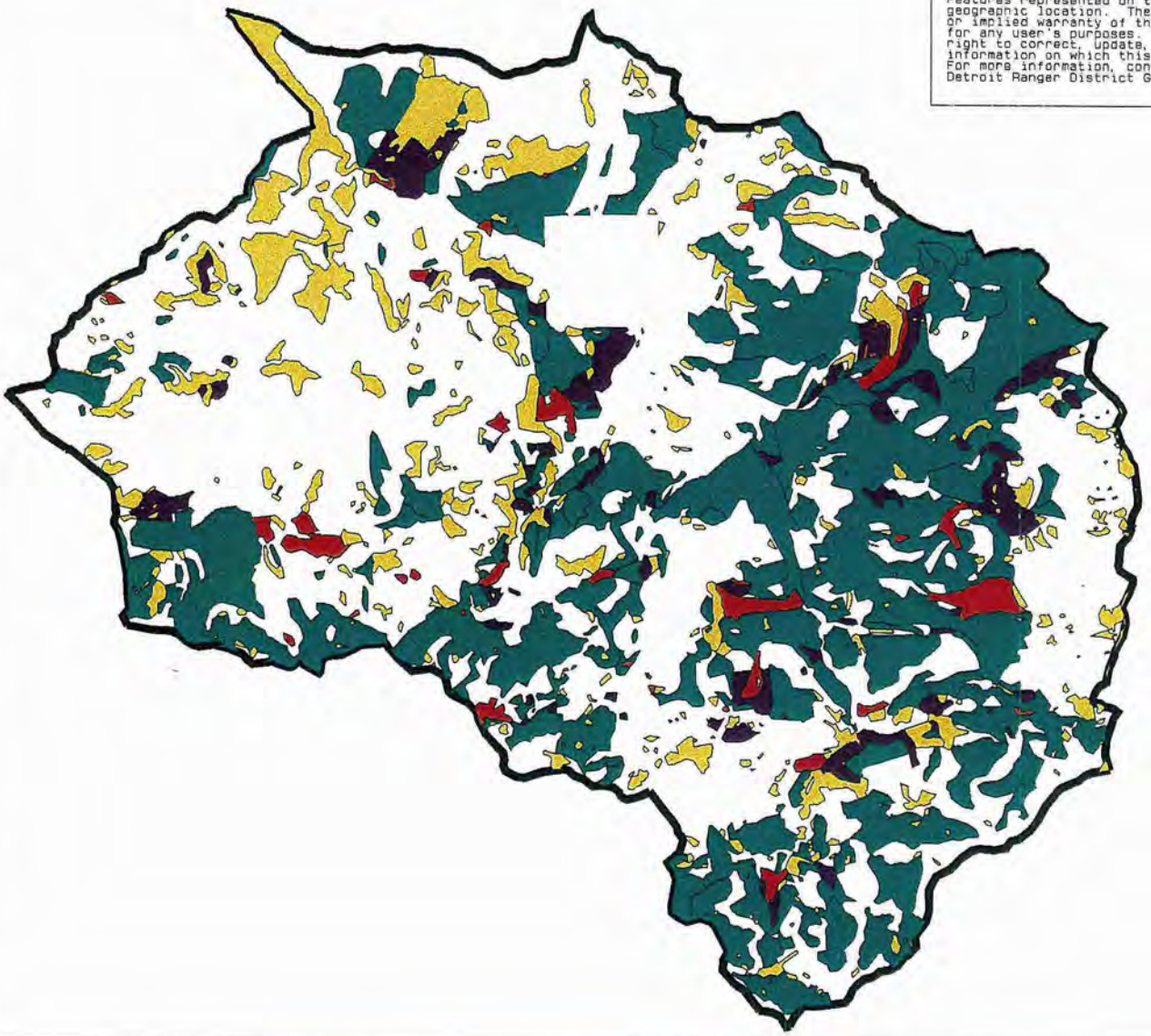
above-ground, living organic matter. Timber management and the concomitant slash treatment in the 1970's and early 1980's tended to duplicate severe fires, or worse, with tractor piling. Since about 1985, with the initiation of duff retention standards, the retention of down woody debris, the use of non-fire treatments such as grapple piling and the elimination of dozer piling, the prospects for long term soil productivity have improved considerably. Aggressive fire fighting standards and techniques have lessened the severity of fires or reduced the acreage affected.

However, fire is a very natural part of the ecosystem development of the west Cascades. Disturbances are necessary and will occur. They can be controlled and manipulated or unrestrained and rampant. From a short term nutrient cycling standpoint, timber harvest with little or no slash treatment on manageable lands or protection of reserve areas is preferred in order to allow for additional buildup of organic matter and duff. Unfortunately, from a long term productivity standpoint, this desire has to be balanced with the potential for extensive, unrestrained wildfire. Uncontrolled fire at high fuel loadings and low fuel moisture will increase fire severity and cause soil damage and nutrient loss. This situation does not change significantly whether the area is untreated slash after logging, a late successional reserve, or wilderness. No specific recommendations are forthcoming as to the appropriate level of risk that should be assumed. However, control of fuel loading, either by fire or through some other mechanical or manual method, is much preferred over most wildfire scenarios. It remains to be seen if the reduction in the effective transportation system, because of funding cuts in recent years, will have an adverse effect on wildfire management because of a growing loss of access capability.

Slope instability has been and continues to be a very natural part of the Blowout landscape. Timber management with its harvest component and associated road construction can effect the rates of slope instability, either positively or negatively. To assist in the evaluation of potential effects, these critical slope instability areas have been delineated in the field and mapped by defining various land types (see map #6). They are defined geomorphically as areas that a) display evidence of periodic movement or catastrophic failure over the last 300 years or so, usually within the last 130 to 140 years, and especially within the last 30 to 50 years; b) usually include additional potentially unstable deposits or material; and c) exhibit slope or soil characteristics that indicate future catastrophic failure is likely in the foreseeable future (generally considered a major storm event such as the 50 or 100 year return interval).

Landtypes considered unsuited because harvest will result in irreversible resource damage (about 670 acres) are primarily those that are actively unstable or potentially highly unstable slump/earth flows (FW-105, BMP T-6). Some of these landtypes have actively unstable areas very closely associated, and generally in direct contact, with stream riparian areas or stream courses. These areas all commonly display slump type topography and include such features as tension cracks, bare soil scarps, leaning and fallen trees, sags and depressions, seeps, and disrupted drainages. Failure depths are such that root strength probably has little affect. However, the instability problem might be aggravated by timber harvest or catastrophic fire, as removing the trees tends to raise

Blowout WA
Unsuited/Unstable Soils



ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact
Detroit Ranger District GIS shop (503) 845-3366

Legend

- Non Regenerable (3,275 acres)
- Unstable (670 acres)
- Potentially Unstable (1,272 acres)
- Stable Landflows (10,601 acres)

Request 2023g

Scale 1:100000
08/28/00

Map # 6

ground water levels due to the loss of evapotranspiration. This in turn might reduce the soil strength and can cause increased or renewed instability.

Potentially highly unstable, not unsuited landtypes (about 1270 acres) range from the shallow, translational debris chute to the more massive, rotational, slump earth flows. Actively unstable and associated, potentially highly unstable lands, have already been excluded from consideration as unsuited lands. Potentially, moderately to highly unstable, not unsuited lands also exist in the form of marginally stabilized earthflows and highly prone debris chute areas. These landtypes are such that these areas would not meet the definitions of "unsuited" as outlined previously, but should be considered potentially unstable (FW-107). In that regard, most of these areas are associated with Class IV stream channels or the headwaters of such channels (FW-103). Probable changes in evapotranspiration and infiltration rates, as well as ground water regimes and water tables, could occur with some management activities and exacerbate the potential instability problems further, either locally or as a cumulative effects condition. These landtypes and most complexes of these landtypes have been excluded from management considerations, unless a site specific evaluation concludes otherwise.

At this point it needs to be **highlighted** that 1) the Blowout is the most unstable drainage within the North Santiam system on Federal land; 2) the area of instability is mapped and occupies about 1900 acres; and 3) the Blowout analysis area contains over 34,000 acres of land. The actively or potentially highly unstable terrain makes up only about 5% of the landscape. In other words, almost 95% of the area is available for management from a stability standpoint. This does not take into account the 3275 acres of unsuited unregenerable terrain, as well as extensive areas set aside for wildlife habit and stream protection. It is worth restating, that the actively unstable areas within the Blowout profoundly affect stream morphology and sediment delivery, but occupy only a small part of the current landscape. Stabilized landflow terrain, on the other hand, is a dominant feature of this analysis area and occupies about 10,610 acres or almost one third of the total landscape.

Soil compaction fortunately, is not duplicated well in nature, except on grander scales, such as glacial and sediment loading. Consequently, man's activities can play a significant, cumulative, and detrimental role in this arena. The major source of most compaction (and also much disturbance) is ground based skidding equipment used during periods of higher soil moisture. Fortunately, unrestricted tractor yarding and tractor piling have not been considered options on those landtypes where sideslopes are gentle enough to support tractor usage for almost a decade. The silty nature of the fine grained soils, and evidence that significant soil moisture is available most of the year indicate that any type of unrestricted tractor yarding and piling (even low ground pressure during the summer months) could lead to unacceptable soil compaction and/or disturbance.

Restricted tractor yarding from predesignated skid roads or shovel yarding while operating on slash have been the primary methods of operation within the standard operating season (June 1 to October 31). Reducing the effective weight of the tractors, reducing the number of trips over a piece of ground, or confining equipment to rocked

roads, are all means to reduce the risk of soil compaction and displacement. Yarding over frozen ground, or over a deep, solid snow pack (24 inches of dense snow, or the equivalent) works well and has reduced soil disturbance and compaction. In addition, as a minimum mitigating measure, at the completion of harvest activities, tractor skid roads (existing or created) that are not part of the designated transportation system are generally subsoiled with a "Forest cultivator" or an equivalent winged ripper in order to return the site to near original productivity.

Considering that most sideslopes located within Blowout and Box Canyon are too steep for ground based equipment, that much of the harvest in the last decade was accomplished with cable systems instead of ground based operations, that many of the older tractor logged units are now beginning to actively loosen the soil through a variety of natural mechanisms, the effects from tractor usage in this basin are not cumulatively critical.

Roads provide access for a variety of management and recreational activities. The Blowout, typical of many West Cascades drainages, is relatively well roaded. Surprisingly, from a sediment generation and movement standpoint, roads have not had a significant effect on stream generated sediment and sediment budgets. Approximately 200 miles of system roads, spur roads and landings are present in the Blowout analysis area. A considerable majority of the road system is located on stable benches and flats, and many of the full bench sections were not severely sidecast. Assuming an average 40% sideslope and standard construction procedures, about two cubic yards of material is relocated for each foot of road distance constructed. This amounts to about 3,200,000 cubic yards of relocated material that has been moved in the last 40 years or so. As a comparison, the "Blowout Slide" is about 70 acres in size and about 45 acres are actively unstable and moving at the rate of 1 to 3 feet per year into the Blowout main stem. At an average depth of 45 feet (and the slide may actually average twice that depth), this same amount of yardage is being relocated at least annually. This becomes even more significant when you consider that hundreds of acres of actively unstable or potentially highly unstable terrain exist in this analysis area.

Floods as well as fires are catastrophic events that periodically impact the system. Evidence of large floods in 1861 and 1964 are relatively common along both the streams and associated upland areas. The recent 1996 storm is no exception, and both flood deposits and slope failure events are evident from this storm. However, in comparison to the other storms of record, the 1996 storm was generally much less significant than previous deluges, when considered from a slope stability and sediment generation standpoint. Perhaps one to two dozen failures (not all have been mapped) occurred from the 1996 event. Some were road related; some were unit related; and many were located within unmanaged old growth or naturally fire regenerated stands. Most were relatively small in size. Extensive field evidence is available to show that both the 1861 storm and the 1964 event caused major slope failures within the Blowout area, relocated channels, and changed stream terraces.

Flood events, as was previously discussed, transport or relocate large quantities of sediment from the uplands through the tributary and main channel system. Western Cascade volcanics weather and decomposed to a variety of different materials, depending on the chemical composition, grain size, and durability of the parent material. One component of that weathering is a variety of silt and clay size material. The smallest of these clays, called smectites, are commonly found in soils that display slump/earthflow features. Consequently, the Blowout has a higher percentage of this fine clay component than other watersheds within the North Santiam. It should be noted that this very fine fraction makes up only a very, very small part of the total sediment supply to the system, on the order of a few tenths of one percent at most. Smectite clays are primarily responsible for the persistent turbidity noted downstream in the reservoir. Whether you consider gravel, sand, silt or clay, the Blowout has been, currently is, and will continue well into the future to be a major source of sediment of all sizes for the North Santiam system.

c) Table: Comparison of Current and Reference Conditions: *What are the natural and human causes of change between historical and current erosion processes in the watershed?*

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Slope forming processes	In last several hundred thousand to million+ years ago, several glacial periods altered landscape in this watershed	Glaciation is not a dominant factor in erosion processes in the Blowout watershed today	Climatic changes have reduced area affected by glaciation	Global warming, which is influenced by human pollution, can reduce area affected by glaciation
	Since glaciation, slopes have formed and/or been re-shaped as a result of stream downcutting. Eroded material from this downcutting has been deposited in other locations thus changing the landscape	The rate of stream downcutting has increased in some areas	Removal of vegetation by fires increases peak flows which in turn can increase the rate of stream downcutting and the amount of erosion.	Removal of vegetation through timber harvest can increase peak flows, stream down cutting and erosion rates in a similar way to fires. Removal of down woody material on hillslopes and large woody material in stream channels can affect erosion and depositional processes
		The rate of stream downcutting has decreased in some areas	Natural re-growth and maturation of vegetation can reduce peak flows that result in less stream downcutting and erosion	Fire suppression has allowed vegetation to persist in places that previously had been subject to large scale fires. Tree planting can decrease the time needed to re-vegetate a site, which can in turn reduce peak flows and stream down cutting. Silvicultural treatment method, duff retention standards, large woody debris retention, and non-fire fuel treatment methods such as grapple piling can affect peak flows and stream downcutting

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Slope forming processes ***(continued)***	More recently slope instability in the form of: • slumps • earthflows • debris chutes has re-shaped landforms within this basin	Increase rate of slope instability	Fires aggravate instability by removing trees thus decreasing evapotranspiration rates which in turn increase water tables. This decreases soil strength and increases soil instability	Removal of vegetation through timber harvest in unstable areas. Sidecast of material from road construction Salvage and stream cleanout
		Minimize rate of slope instability	Vegetative growth increases evapotranspiration which reduces soil moisture and increases soil strength. In addition, root strength provided by vegetation helps minimize slope instability	Avoidance of unstable areas during timber harvest and road construction Geotechnical analysis of road location. End hauling road waste material. Retention of large woody material on hillslopes and in streams. Fire suppression which allows vegetation to persist on the landscape and help stabilize hillslopes.

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Sediment delivery	Downslope movement of soil mantel by creep or colluvial process, primarily under the influence of gravity, plays a role in sediment delivery	Rate of downslope movement has accelerated in some areas	Rate of movement is accelerated by large scale fire events that remove vegetation and down woody material from hillsides	Rate of movement is accelerated by timber harvest that removes vegetative cover and down woody material
		Rate of downslope movement has decreased in some areas	Vegetative growth and down woody material build up. Large wood material that has fallen on hillslopes or in stream channels can trap sediments	Fire suppression lessens the severity and area affected by wildfires, reducing erosion potential Management practices that include retention of down woody material reduce erosion. Reintroduction of structure to stream channels.
	Slope instability through: • slumps • earthflows • debris chutes are major sediment delivery systems in the watershed	Increases in soil instability in some areas	Fires accelerate instability by removing vegetation, thus decreasing evapotranspiration. This increases the water table, which in turn decreases soil strength and results in increased soil instability Peak flows/floods transport or relocate large quantities of sediment from the uplands through the stream systems. Natural slope instability	Timber harvest can aggravate instability in similar ways to fire. Sidecast of material during road construction contributes to slope instability Lack of road maintenance can result in plugged culverts that back up water which can wash out road segments.

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Sediment delivery (continued)	Slope instability through: • slumps • earthflows • debris chutes are major sediment delivery systems in the watershed *(Continued)*	Decreases in soil instability	Re-growth of vegetation, improves root strength and increases evapo-transpiration which can reduce soil instability. Large woody debris often controls size and extent of debris flows	Fire suppression has resulted in less acres being affected Implementation of management standards and guidelines to retain duff layer, retain down woody material, grapple piling, etc. Fuel loading control can reduce the intensity of fire effects on erosion and sedimentation

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Long-term soil productivity	Organic material contributes to soil nutrients	Loss of soil nutrients	Extensive unrestrained wildfire at high fuel loadings and low fuel moistures increases fire severity and consumes duff, down woody material and other organic matter. These fires cause soil damage and nutrient loss.	Slash burning done during periods of low soil/fuel moisture and/or with high fuel concentrations can consume duff, down woody material and other organic matter, resulting in soil nutrient loss
		Reduction in loss of soil nutrients	Natural build up of duff, woody material and other organic matter contribute to soil nutrients	Timber harvest with little or no slash treatment. Elimination of harvest in reserve areas allowing build up of duff, woody material and other organic matter. Changes in management practices that include duff retention standards, retention of down woody debris, and use of non-fire slash treatments like grapple piling Aggressive fire suppression efforts have lessened fire severity or reduced acreage burned Control of fuel loading by fire or through mechanical or manual method to reduce severity of wildfires

Geologic Characteristic	What Was it Like Historically	What Changed?	Natural Cause of Change	Human Cause of Change
Long-term soil productivity ***continued)***	This watershed has historically had fairly productive soils	Increased soil compaction reduces long-term soil productivity	Except for compaction as a result of glaciation, there are few natural process in which soil compaction occurs	Ground-based skidding equipment used during periods of high soil moisture causes soil compaction and affects long-term soil productivity
		Minimize soil compaction		Restrict use of ground-based yarding systems, log suspension requirements, seasonal operating restrictions, all can help reduce soil compaction and maintain soil productivity

II. PHYSICAL DOMAIN

B. Hydrology

1. Characterization: *What are the dominant hydrological characteristics (e.g. total discharge, peak flows, minimum flows) and other notable hydrological features and processes in the watershed (e.g. cold water seeps, ground water recharge areas)?*

The dominant hydrologic characteristics for the Blowout watershed are similar to other documented watersheds in the Western Cascades. Rainfall for the area, averages 80-120 inches per year, with intensities as much as 9 inches in 24 hours. These intensities can be expected one percent of the time each year *(National Weather Service 100 year, 24 hour rainfall intensity maps*). Intense precipitation is episodic in nature, and often generates peak flows, which are a major disturbance mechanism for stream channels and associated riparian areas.

The hydrology of the Blowout watershed is rain-on-snow dominated, as is much of the rest of the western Cascades. In the Cascade Range, ***peak flows*** generally occur during rain-on-snow events in the transient snow zone. For most of the rest of the Detroit Ranger District, the transient snow zone is estimated to occur between 1,500 and 4,000 feet elevation (Christner and Harr, 1982). The elevation range of the transient snow zone in the Blowout is 1,200 to 4,900 feet, differing slightly from Christner and Harr's figures, due to the orientation of the watershed to the dominant winter storm patterns. This makes the entire Blowout watershed subject to rain-on-snow events. As storm fronts pass through the North Santiam Canyon they are slowed by Coopers Ridge and Coffin, Bachelor, and Buck Mountains, resulting in precipitation in the Blowout watershed. Snow pack, melted by warm rain, delivers large volumes of water to stream channels and considerably increases stream flows. Depending on the extent of the air mass, isolated areas or regional areas can be affected, causing variation in increased peak flows around the watershed.

Minimum flows, in the Blowout, are regulated by water storage features which allow flow to persist during drought periods. Much of the summer time flow comes from water stored in the broad alluvial flood plain along the main channel of Blowout Creek and the glacial and colluvial soils found throughout the drainage. The alluvial material found along the Blowout is also a heat sink for solar radiation and so contributes to water temperature increases in the summer months as well. Other storage features include numerous ponds and wet areas scattered throughout the watershed.

Discharge: There have been no stream gauges on the Blowout in the past, so discharge rates have not been measured. A stream gauging station was installed in 1998 and will be operated by the U.S. Geological Survey. In the future, discharge rates will become available.

Cold Water Seeps: Earthflow activity in the watershed has resulted in numerous wetlands well distributed across the landscape. These wetlands are typically in the form of sag ponds and shallow ground water surface interfaces, and are either an extension of the riverine system or are isolated occurrences associated with geologic features.

Ground Water Recharge Areas occur in alluvial deposits, ponds, unstable areas containing sag ponds, and deep soils within the watershed.

2. *What do humans value that is associated with hydrology?*

Water storage and regulation systems; the amount and timing of water flow; and sediment budgets have ecological, economic and social value.

3. *What are the highest priority issues or resource concerns associated with hydrology?*

The highest priority hydrologic issue in the watershed is flow of water, especially peak flow and low flows.

4. *What and where are the management direction/activities, human uses, or natural processes that affect the hydrology?*

a. Current Conditions: *What are the current conditions and trends of the dominant hydrological characteristics prevalent in the watershed?*

***Peak flows*:** Rain-on-snow dominated landscapes are dependent upon regional and global weather patterns and their interaction with local topography. Due to the effect of east/west and north/south dominated ridge systems found in the Blowout, cold fronts passing over the area release precipitation, often in the form of snow. Later, when a warm front passes over the area, it can remove this accumulation of snow, rapidly generating peak flows. It is expected that this trend would continue in the future.

The first series of storms that come into the area, don't change the stream flow much, because of abundant water storage capacity in the basin. With later storms, once water storage areas are filled, or if intensities exceed infiltration rates, the system becomes more flashy (Ziemer, 1998).

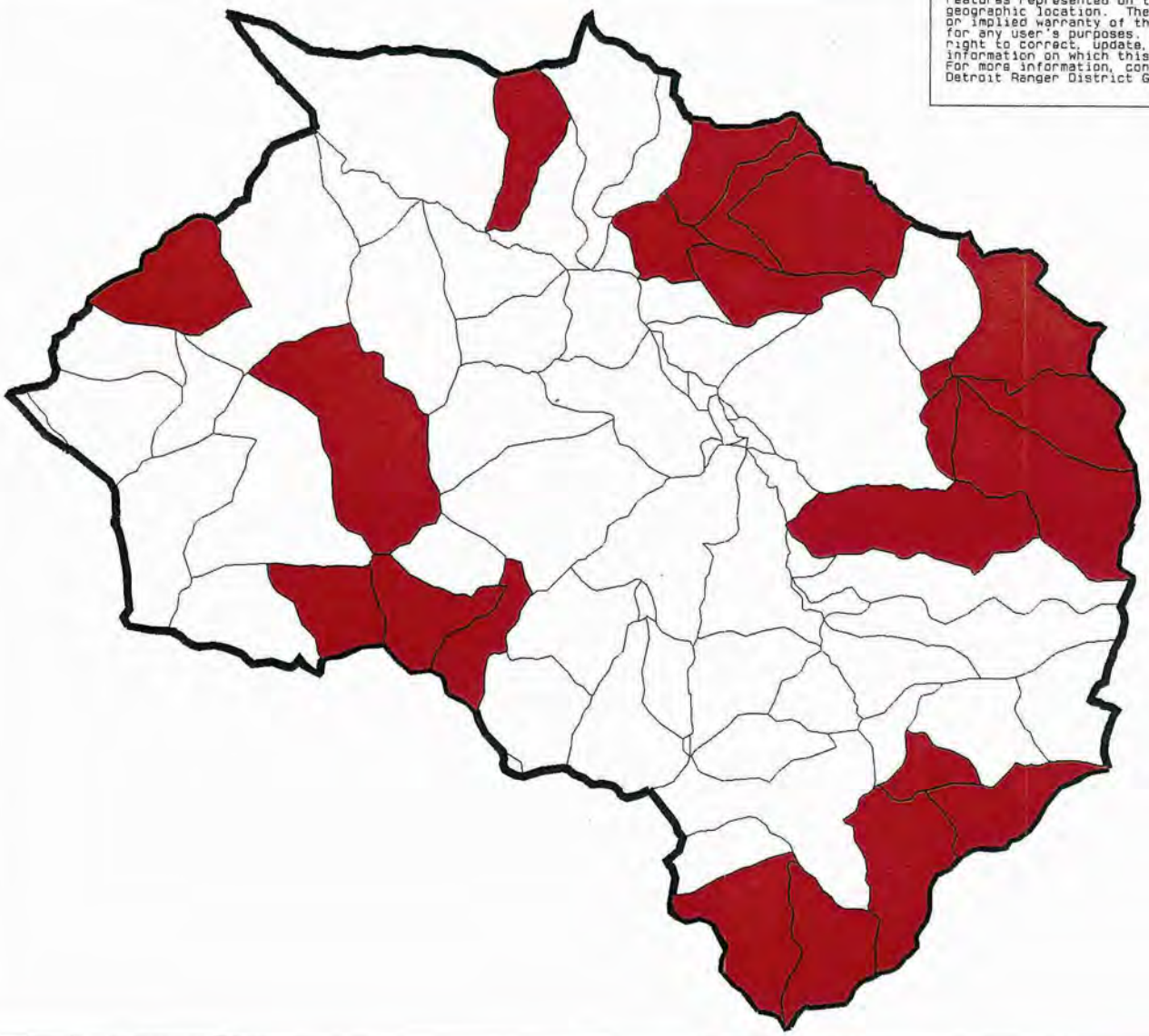
There is adequate upland water storage to provide year round flows in all named tributary streams, as well as, a lot of first and second order streams. Slump topography in some upland areas results in numerous ponds, seeps, wetlands, and high water tables in those areas. In fact, a unique feature of this watershed is the amount and distribution of wet areas.

Hydrologic Recovery is used to estimate the capability of timber stands to intercept snow, rain and wind and to assess the potential risk of adverse effects to stream channels and water quality from increases in peak flows during rain-on-snow events. For the Willamette National Forest, hydrologic recovery is calculated using the Aggregate Recovery Percent (ARP) method. Recommended midpoint ARP values have been assigned in the Forest Plan.

For each "Watershed Condition Type" defined in appendix E-10 to E-18 in the Forest Plan, there are adjustments to hydrologic recovery recommendations for ARP. The watershed condition types for surveyed channels in the Blowout tend toward types 5, 6, 7 and 8. For channel types 5 and 6, ARP is recommended to be, at or above, midpoint values in order to minimize streambank and streambed erosion. For channel types 7 & 8, ARP is recommended to be at least 5 percent above midpoint values, in order to minimize the risk of increases in peak flows and the associated risk of increases in stream channel scouring.

All planning subdrainages *(map #7)* within the analysis area are within 10 points of the Forest Plan threshold midpoints, some above the midpoint values and some below. When those planning subdrainages are broken into smaller units, for finer resolution and to better isolate problem areas, 21 of the 46 watershed areas are within ten points of ARP threshold midpoints in 1998. Because ARP values change over time and/or when harvest activities are implemented, these values will need to be periodically updated. Numerous channels within the area have shown or are currently showing signs of cumulative watershed effects including: Lost, Cliff, Blowout, Divide, and Ivy Creeks.

Planning Subdrainages That Do Not Meet ARP Recommendations



ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact
Detroit Ranger District GIS shop (503) 845-3366

Legend

Pdiv Exceeding ARP Threshold

Request 2023h

Scale 1:100000
08/28/00

Map # 7

The following subdivisions do not meet the hydrologic recovery (ARP) recommendations:

Planning Subdrainage	Division of Subdrainage	Recommended ARP	Actual ARP	Comments
78L Beard		75		Type 7 & 8
	78L.1	75	72	
	78L.1.1	75	72	
	78L.1.2.1	75	73	
	78L.1.3	75	62	
	78L.3	75	66	
	78L.1.2	80	78	
78M Divide		70		Type 7 & 8
	78M.1	70	66	
	78M.1.2	75	72	
78N Hawkins		70		
	78n.3	70	60	
78P Lost		70		Type 7 & 8
	78P.1	75	72	
	78P.3	70	51	
	78P.3.1	70	48	
78R Cliff		70		
	78R.2	75	75	
	78R.2.2	70	69	
	78R.2.3	70	50	
78T Box Canyon		70		
	78T.1	70	65	
	78T.3.3	70	57	
	78T.4	70	67	
78U Upper Blowout		70		
	78U.1	70	56	
	78U.1.1	70	61	
	78U.1.2	70	54	

**These were the most accurate ARP values available at the time of this writing. These ARP values will need to be updated periodically as watershed conditions change over time.*

As shown above, several areas do not meet the Forest Plan recommendations pertaining to hydrologic recovery (FW -093)(BMP-W-5). Both subdrainages and divisions of subdrainages that do not meet these recommendations, will be closed to additional roading and harvest activity, which disturbs canopy closure, until sufficient recovery occurs to reduce risk of increased peak flows and channel bank/bed erosion.

b. ***Reference Conditions:*** *What are the historical hydrological characteristics (e.g., total discharge, peak flows, minimum flows) and features (e.g., cold water seeps, ground water recharge areas) in the watershed?*

Historical peak flows, occurred much as they do now, during rain-on-snow events in the transient snow zone.

Evidence suggests that peak flows in this area were historically high in stage and frequency. High drainage densities reflect the historic abundance of runoff within the area.

The following table shows the top ten floods on record, within the Willamette system. Please note the 1996 February storm is not mentioned in this table. The flows recorded during 1996 were 85 percent of the flows recorded in 1964 and 83 percent of the flows recorded in 1921. This allows the reader to interpret the magnitude of the 1996 flood in relation to other historical flows.

Willamette System Floods

Chronology	Years Before Present	Interval
1964	30	30
1920	74	44
1901	93	19
1890	104	11
1881	113	9
1861	133	20
1849	145	12
1844	150	5
1843	151	1
1813	181	30

**Note these are the ten greatest flows on record. Other flows have occurred through time that have shaped the channels and valley floors.*

It is apparent from field investigations, that flows of smaller magnitude, shape and change the valley floor annually. The key to the amount of disturbance the flows have within the watershed, is the amount of large wood present, and the attachment of the stream channel to its floodplain.

In the past, large scale fires burned vast areas of the watershed stripping them of their vegetation. The removal of this vegetation, in combination with rain-on-snow events, resulted in increased volumes of water coming off the hillsides and entering stream systems. Because of the increased water volumes, high energy streams scoured steep v-shaped valleys. Their floodplains were minimal due to the incised nature of the valley floors and wet areas in depressions were scattered throughout the landscape. The Hawkins Creek area has a frequent fire return interval, so this area had more flashy flows, historically, than the rest of the watershed.

c. *Table: Comparison of Current and Reference Conditions: What are the natural and human causes of change between historical and current hydrological conditions?*

Hydrological Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Peak flows	Peak flows were higher in areas denuded by large scale fires. Lack of vegetation and increased snow accumulation allowed flashier runoff during rain-on-snow events in these areas.	Peak flows, as a result of large scale, stand replacing fires have been reduced.	Regrowth of vegetation in areas denuded by fires. Vegetation intercepts water and affects the amount delivered to streams during high flows.	Fire suppression limited the size of fires and allowed more vegetation to persists on the landscape.
		Peak flows show slight increases throughout the watershed rather than large increases in concentrated areas of high fire activity.	Areas of disturbance are distributed throughout the watershed. Natural recovery is constant and can be aided by silvicultural practices designed to speed up recovery.	Timber harvest units are smaller and more scattered across the landscape than large scale, stand replacing fires were. Acreage harvested is comparable to that burned.
		Increase in size of the smallest peaks occurring during the driest antecedent conditions, this effect declines as storm size and watershed wetness increase.	Weather patterns for the region cycle through a 17 year cycle of wet period and dry periods.	Timber harvest has removed vegetation on the same scale as historic fires but openings are smaller and distributed more evenly across the landscape than historic openings created by fires
	Regional weather patterns and topography influence peak flows which have been associated with rain-on-snow events in transient snow zone.	Increase in peak flows in localized areas	Fires and the resultant loss of vegetative cover/canopies can locally affect peak flows.	Timber harvest can affect snow intercept by removing tree canopies, thus accumulating more snow on the ground and impacting localized peak flows.
	Peak flows high in stage and frequency	Similar to historic times		

Hydrological Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Flood plain water storage	Storage occurred in large flood plains associated with the main stem of Blowout Creek.	Water storage in floodplain has been reduced in Blowout Creek.	Increased stream energies caused streams to downcut into alluvium, lowering the water table and reducing storage potential.	The location of Blowout Road has disconnected Blowout Creek with its floodplain thus affecting water storage capacities. Removal of large wood from the stream system resulted in increased energy to scour channel down through flood plain thereby reducing water storage.

II. PHYSICAL DOMAIN

C. Stream Channels

1. Characterization: *What are the basic morphological characteristics of stream valleys or segments and the general sediment transport and deposition processes in the watershed (e.g., stratification using accepted classification systems)?*

There are two distinct drainage systems in the area, streams that are tributary to Box Canyon Creek in the west, and streams that are tributary to Blowout Creek in the east. Both Box Canyon and Blowout Creeks drain directly into Detroit Reservoir, on the North Santiam River. Named streams within the area include Blowout Creek, Beard Creek, K Creek, Divide Creek, Hawkins Creek, Lunch Creek, Ivy Creek, Lost Creek, and Box Canyon Creek (*map #8*).

The analysis area is relatively steep and well drained as evidenced by stream densities of approximately 5.25 miles/sq. mile. Stream substrate material varies from bedrock to gravel and is dominated by boulder/cobble material in the lower valley reaches.

The following discussion will be stratified by landform block, as described in the Geology section of this watershed analysis.

Steep Canyon Area Landform Block (See Map 4)

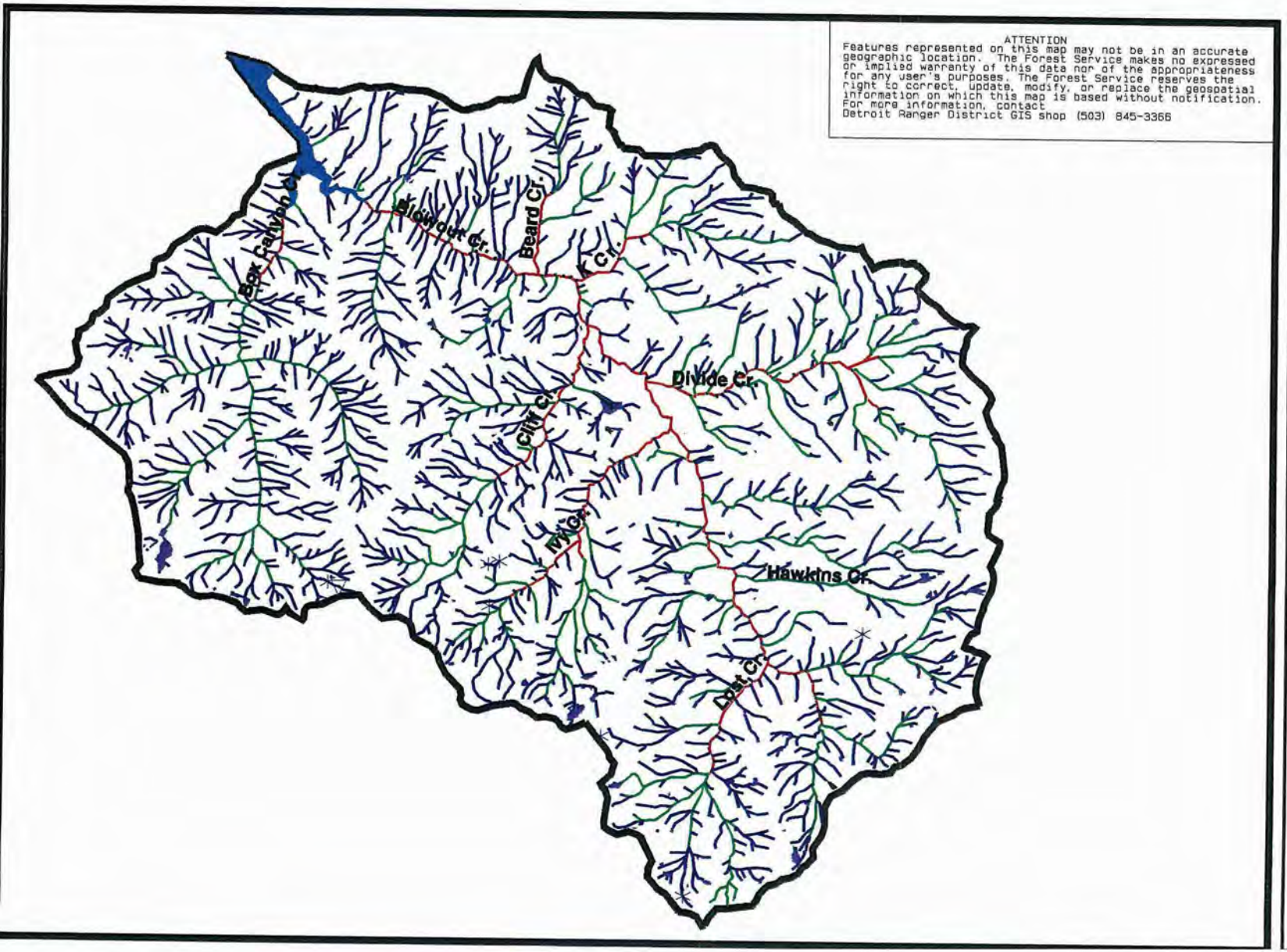
Box Canyon: Deeply incised parallel streams are found in Box Canyon, as evidenced by first to third order stream channels. This pattern of parallel streams is the result of high gradient channels draining glacially-formed slopes, that have been altered by erosion. The high gradient stream channels are associated with valley walls greater than 65 percent slope and contain channel bottom materials which are dominated by bedrock and boulders. These high energy stream channels exhibit very little sinuosity. The parallel streams join to form a dendridic pattern lower down in the drainage.

The fourth and fifth order streams make up the named streams in the watershed. Rosgen channel types for streams in this area range from Aa+ to B type channels *(see description of Rosgen channel types, chart #1*). The diversity of the channels is the result of lack of valley development.

Headwater channels have some sediment storage capacity in pools and backwater areas because of channel structure such as logs and boulders, but this structure is minimal here. Sediment storage capacity decreases as streams transition into the valley wall regions, where high energy streams transport sediment through to Box Canyon Creek and Detroit Reservoir.

Debris torrents have and continue to play an important role in the first and second order stream channels in this area. Failed material, from debris torrents, builds up

Blowout WA
Streams, Lakes, Ponds and Wet Soils



ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact
Detroit Ranger District GIS shop (503) 845-3366

Legend

- Wet Soils
- Lakes
- Marshes
- Class 1 Stream
- Class 2 Stream
- Class 3 Stream
- Class 4 Stream
- Marsh
- Springs
- Ponds

Request 2023i

Scale 1:100000
08/28/00

Map # 8

Rosgen's Channel Typing

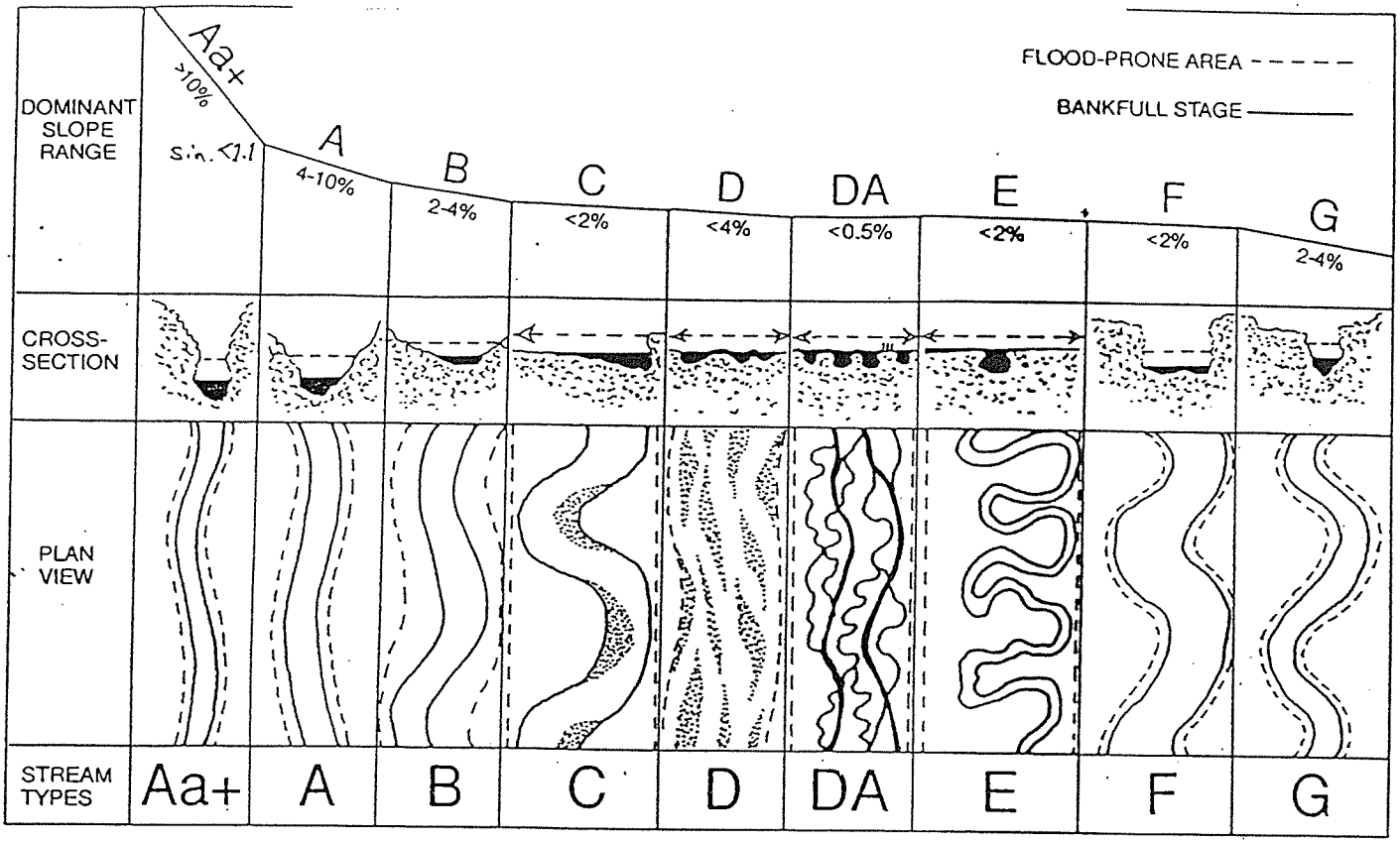
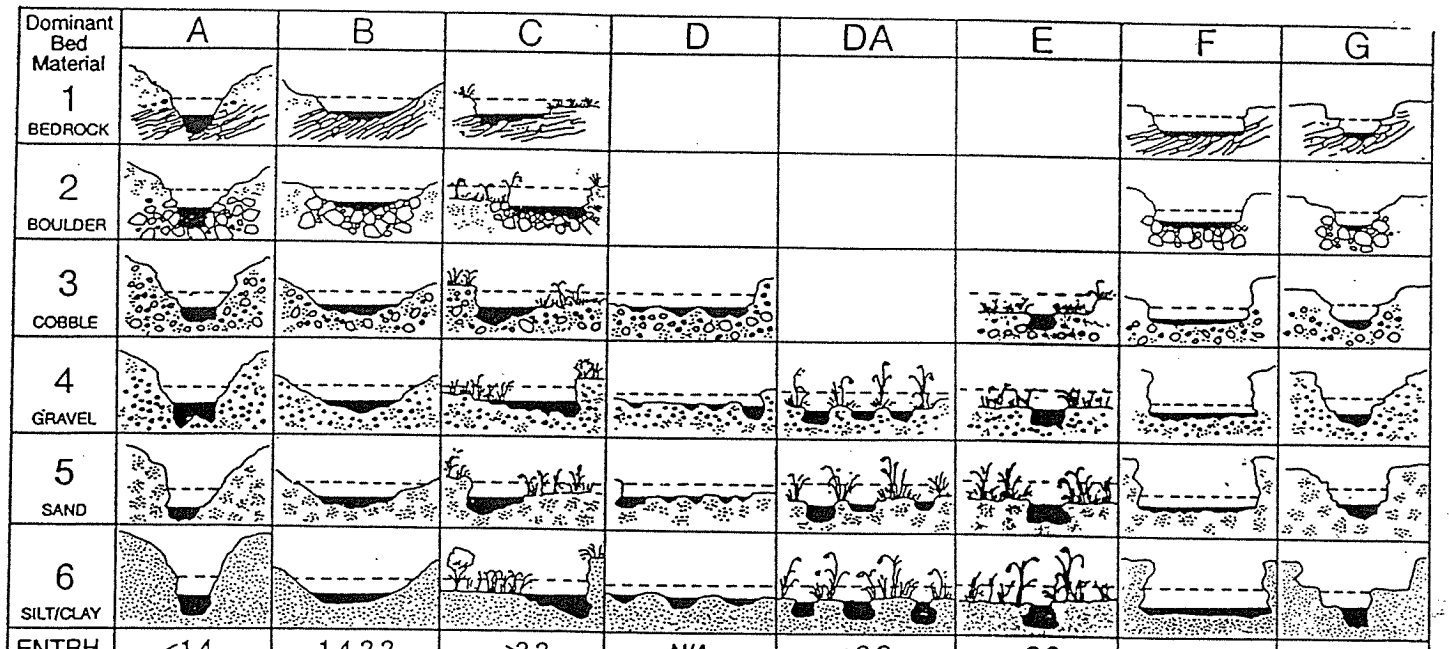


Figure 2. – Stream types: gradient, cross-section, plan view (adapted from Rosgen 1994). Original drawings by Lee Silvey. Courtesy of Catena Verlag.



	A	B	C	D	DA	E	F	G
ENTRH.	<1.4	1.4-2.2	>2.2	N/A	>2.2	>2.2	<1.4	<1.4
SIN.	<1.2	>1.2	>1.4	<1.1	1.1-1.6	>1.5	>1.4	>1.2
W/D	<12	>12	>12	>40	<40	<12	<12	<12
SLOPE	.04-.099	.02-.039	<.02	<.04	<.005	<.02	<.02	.02-.039

Figure 3. – Cross-section view of stream types (adapted from Rosgen 1994). Original drawings by Lee Silvey. Courtesy of Catena Verlag.

Chart #1

Rosgen's Channel Typing - Classifications

Stream Type	General Description	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Landform/Soils/Features
Aa+	Very steep, deeply entrenched ,debris transport streams.	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with/deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition and/or residual soils. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate w/occasional pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad,well defined floodplains	>2.2	>12	<1.4	<.02	Broad valleys w/terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channel. Riffle-pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<.04	Broad valleys with alluvial and colluvial fans. Glacial debris and depositional features. Active lateral adjustment, w/abundance of sediment supply.
DA	Anastomosing (multiple channels) narrow and deep with expansive well vegetated floodplain and associated wetlands. Very gentle relief with highly variable sinuosities. stable streambanks.	>4.0	<40	variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition w/well-vegetated bars that are laterally stable with broad wetland floodplains.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplain. Highly sinuous with stable, well vegetated banks. Riffle-pool morphology with very low width/depth ratio.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	<12	>1.4	<.02	Entrenched in highly weathered material. Gentle gradients, with a high W/D ratio. Meandering, laterally unstable with high bank-erosion rates. Riffle-pool morphology.
G	Entrenched "gulley" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	.02 to .039	Gulley, step-pool morphology w/moderate slopes and low W/D ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials; i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

Chart #2

small terraces within the third and fourth order stream channels. These terraces are then occupied during peak flows, which alter their shape and create riparian areas.

Transitional Area Landform Block and Slump and Glacial Landform Block

The Transitional Landform Block and the Slump and Glacial Landform Block exhibit geological differences, so they have been separated into two discussions in the geology section of this document; however, stream channels in both landform blocks are similar so they will be discussed together here.

Stream channels in these landform blocks exhibit a dendridic pattern and tend to be incised due to convex slopes.

Channel morphology, in this area, has been greatly influenced by earthflow activity. High energy first and second order streams have little sediment storage capacity and tend to have bedrock-boulder channel bottoms. A long history of fires, especially in the Divide and Hawkins Creek areas, coupled with timber harvest, have removed vegetation, leaving streams without an adequate supply of large woody material to provide structure and store sediments. These areas generate increased peak flows and a landscape that is more susceptible to debris torrents. This fire-peak flow- debris torrent scenario greatly influenced channel development in this area, in part by its lack of large wood to hold sediments. These stream channels tend to act like pipes and pump sediments through to higher order stream channels.

Third and fourth order streams in these landform blocks are more typical of those of other western Cascades watersheds. These stream channels transport sediment down narrow valley bottoms that are occasionally interrupted or confined by earthflows. At the toes of the earthflows, channel roughness and gradient increase forming a stepped channel, as evidenced in longitudinal profiles of these streams.

The types of sediment and depositional processes prevalent in these landform blocks are closely associated with channel types. Sediments are ***transported*** through Rosgen type G headwater channels (*very steep gully like features*) and continue to be transported through Aa+ channels(*steep gradients, narrow channels with little sinuosity*) and B channels (*moderate gradients, channel widths and sinuosity*). Sediments are then ***deposited*** when they reach Rosgen type C channels, with their lower gradients and wider more sinuous channels. The main stem of Blowout Creek is a type C channel for limited segments, below the Beard Creek confluence.

These stream channel bottoms historically contained a high percentage of exposed bedrock and large boulders. Debris torrent activity in headwater areas and earthflow activity have historically kept Cliff, Blowout, Lost, Ivy, and Divide Creeks loaded with structure. Most of the fine sediments are being transported out of the system. Small discontinuous terraces are present in channel backwater areas, and confluences.

Past management activities have mimicked the effect of fires on sedimentation in Blowout streams, but on a somewhat smaller scale. This management-induced sedimentation was the result of: clearcut and shelterwood harvests where vegetation was not retained along stream courses; roads that were sidecast; broadcast burning practices that included late summer and early fall burns; and removal of large woody material from hillsides and stream courses as a result of yarding of unmerchable material (YUM) yarding and stream cleanout. Many of these activities are no longer practiced, but the effects are still evident.

Morphological characteristics of stream valleys: Historically, sediment transport and depositional processes were the result of peak flows and erosion. After fires burned an area, erosion-generated sediments loaded stream channels. These sediment-loaded channels were later flushed out during peak flows. Though episodic in nature the effects of peak flows on stream channels were long lasting.

The amount of large woody material, that acted as sediment traps, in stream channels fluctuated with fire intensities. High intensity fires consumed large woody material, while low intensity fires recruited woody material into stream channels. The amount of wood also varied with the topography. Steeper, V-shaped valleys, such as those in the Hawkins Creek, retained less wood than wider valleys. These V-shaped valleys acted as chimneys, drawing fire through them, and consuming the woody material in the stream channels.

Channels formed under peak flows became very resistant to change as high energy streams scoured out fine sediments, and left large boulder and bedrock dominated channel bottoms. These substrate allow for sediments to move through the system rather than be deposited.

Depositional areas are mainly associated with larger order streams that are generally lower gradient and lower energy. They also are associated with the amount of large woody material in the stream channels. The streams in depositional areas, generally had wide valley bottoms and lots of downed wood to trap sediments.

2. *What values do humans place on stream channels?*

Stream channels and their associated flood plains are an important part of the ecosystem and also have aesthetic value to humans.

3. *What are the highest priority issues or resource concerns associated with stream channels?*

Channel bank stability and protection of headwall areas are high priority issues in this watershed.

Channel bank erosion and associated sediments, as a result of peak flows, are a concern in this area.

In some parts of the watershed, there is a concern about stream channels being disconnected with their floodplains.

Monotypic, diversity-poor stream channels, resulting from the 1964 flood and past management activities are of concern in this watershed.

The effects of the 1996 storm on channel conditions, and whether upland forest management influences were outside the natural range of conditions is also a concern.

4. *What and where are the management direction/activities, human uses, or natural processes that affect the stream channels?*

a. *Current Conditions: What are the current conditions and trends of stream channel types and sediment and deposition processes prevalent in the watershed?*

The current morphological characteristics of stream valleys in the Blowout watershed are similar to historic conditions. The basic stream patterns and channel gradients are largely influenced by geology, so have not changed a great deal since the reference time frames, 100 years ago.

One of the greatest impacts on stream sediment and depositional processes, is a century of fire suppression that has reduced debris torrent frequencies, as well as, the amount of surface erosion. This in turn, has reduced the amount of sediment introduced into the stream channels.

Both sediment and large woody material are necessary components for proper stream channel and floodplain interactions. Surface erosion upslope from stream channels is generally less today than in historic times because fire suppression has allowed vegetation to persist on hillslopes, thus minimizing erosion. There have been management activities, in the past, that generated sediment on par with some fires, such as harvest where no riparian vegetation was left, roads that were sidecast, and removal of large wood, but these activities are no longer practiced.

Generally speaking, timber harvest, over the decades, has removed vegetation on a similar order of magnitude to fires, but because of several factors such as: *selectively placing harvest units out of erosion-prone areas; harvest units generally being smaller in size than stand-replacing fires; harvest units being dispersed throughout the watershed rather than being concentrated in one part of the watershed like a fire; and more recently the retention of vegetation adjacent to stream channels,* harvest has not generally resulted in surface erosion to the same extent that large scale fires once did. Reduction in erosion rates have reduced the sediment available to stream channels to rebuild floodplains.

In many areas, there is an increase in the buildup of down woody material as a result of years of fire suppression. In addition, channel vegetation is increasing in areas where fires have been excluded. In larger streams, however, the converse is true, woody material has been removed as a result of timber harvest.

In all subdrainages and all channel types, large woody material plays an important role in the metering of sediment through stream channels. In the absence of wood, sediment is transported uninterrupted through the system. When large wood is present, sediment is pulsed from wood accumulation to wood accumulation, thus increasing the time sediment remains in the stream channel.

Currently streams exhibit high energy levels, just as they did historically. Today; however, in some streams where large wood has been removed through timber harvest, sediments move more quickly through the system than they once did. Here, the reintroduction of large wood can help store more sediments, so the streams can function as they once did.

Another observation regarding stream channels, is that vegetation allowed to persist on upland slopes because of fire suppression, has tended to reduce the intensities of peak flows over historic conditions.

b. Reference Conditions: *What were the historical morphological characteristics of stream valleys and general sediment transport and deposition processes in the watershed?*

Historically, sediment transport and deposition processes were a result of peak flows and erosion. After a fire burned an area, erosion-generated sediments loaded stream channels. These sediment-loaded channels were later flushed out during peak flows. Sediments pulsed through the system, from one accumulation of large wood to another, over a relatively long period of time. Though episodic in nature, the effects of peak flows on stream channels were long lasting.

Fire: Fires created substantial disturbances in this landscape dotted with unstable areas, resulting in many hill slope failures. These hill slope failures introduced large amounts of sediment into streams. In turn, these sediment-rich stream systems either widened their valley floors, creating additional hill slope instability, or incised their valley floors, creating channel bank instability, depending on the dominant weather patterns at the time.

Riparian vegetation then invaded the valley floors, hill slopes, or channel bank areas, and through time, helped stabilize the areas. Those areas not stabilized provided diversity of plant species within the riparian zone.

Fire intervals are estimated to be 80 to 275 years (REAP, 1993) in the Blowout study area. This allowed ample time, between fire episodes, for trees to grow to sufficient size to provide a source of large woody material for riparian areas. In addition, fires in riparian zones tended to burn less intensively than upslope fires because of increased moisture in these areas. The result was an abundance of large woody material in riparian areas, which was important to stream systems for energy dissipation and sediment storage. This energy dissipation, reduced the transport ability of the water, so sediment and organic debris were retained in the system. It also resulted in the creation of abundant pool habitat within the stream system and numerous back water areas. Old side channels are still visible within certain valley floor segments in the watershed.

Typically streams would have had diverse channels with multiple side channels, storage areas with abundant pools, and intergravel flows behind large accumulations of large woody material. In headwall areas and at the toes of earthflows, stream energies would have been high, but they would have been less outside of these areas. Large woody material would have been abundant, with adequate size and mass to span smaller valley floors.

Earthflows: Earthflows affected stream channels in several ways. If the earthflow contained sufficient large woody material, the roughness of the woody material tended to slow the migration of the flow, so its distribution downstream was minimal. Earthflow flats were established upstream of accumulations of woody material and the stream channel occupied either intergravel space or meandered on the flats. Energy increases in the stream channel occurred as a result of the change in gradient at the toe of the earthflow. These increased energies often resulted in the removal of finer materials and the creation of higher gradient channels. Sometimes earthflows resulted in the development of a waterfall, after which the stream channel would lose its energy as it passed through the falls. If the material was alluvial in nature, as opposed to colluvial, intergravel flows could develop and the stream channel, at low flow periods, would run subsurface.

Earthflows sometimes scoured stream channels to bedrock, depending on their speed and viscosity. These bedrock reaches, for a short time, contained over-steepened upper channel banks. Woody material was recruited into the stream channel, from these over-steepened channel banks, and colluvium was collected. This process rebuilt the diversity within the channel.

Earthflows also created smaller channels along their margins or on their flow faces. Wetland areas were created, as sag ponds associated with these flows, or as a result of the flows on the landscape.

Floods: Large flood events in 1964 and 1965 moved tremendous amount of large woody debris into Detroit Reservoir and set up log jams in the Blowout

stream system. Several years before and after these flood events, the Forest Service removed log jams, and virtually all other large woody debris from streams, through the use of tractors. These projects cleaned out the Blowout stream channel from the private boundary near the Road 10 bridge, up to a series of waterfalls just below Hawkins Creek. This work was intended to reduce the damage to downstream roads and bridges during high flow events.

In a large part, because of these stream cleanout projects, the 1964-65 flooding eroded large amounts of stream bank and side slope materials. Short sections of Road 10 were almost completely washed away and large riprap was not able to prevent the damage. Recent surveys have shown flood terraces, with dominant stands of red alder dating back to 1965-70, in all major stream systems in the basin.

In 1996 a smaller magnitude storm (30-50 year return interval) occurred. Recruitment of channel bank material allowed aggregation to occur throughout most of the watershed. Large pulses of sediment, sometimes referred to as sediment waves, moved through the 4th and 5th order channels. Earlier efforts to reintroduce wood into Blowout, Ivy and Divide Creek decreased the stream energy enough to reconnect portions of the channel with its historic flood plain. Stream channel elevation was raised from these pulses generating upper channel bank slope failures. These failures provided additional sediment to the channel.

Management: Prior to management, there was generally an abundant supply of down woody material within the riparian areas in the Blowout analysis area.

When logging first began in the drainage, harvest units were generally clearcut from stream bottom to ridgetop, but only the highest quality logs were utilized. Timber was abundant, so rotten or partially rotten trees were left on the ground. In addition, shattered pieces and chunks from trees that broke when they were cut down, were left on the ground so large woody material was still abundant across the landscape.

In later years as philosophies changed, utilization and slash treatment methods resulted in less down woody material being made available in riparian areas. Fire was used to reduce logging slash, so that trees could be planted more easily. More uses were found for wood, and the value of the wood increased, so utilization standards changed. Low quality logs, that used to be left on the site, became useable as chip material. Woody material was cleaned out of streams. Salvage operations started keying in on riparian areas due to higher quality and larger size trees. This was most evident after the 1964 flood, in which an entire timber sale was developed to remove down woody material from riparian areas.

There is evidence that numerous intermittent, non fish bearing streams, were used early on as skid roads. Interception of flow by these skid trails resulted in the development of new intermittent streams.

Stream channels responded to the lack of large woody material, by slowly incising valley floors and removing finer material from their substrate, thereby creating long riffle reaches of cobble. Rapid downcutting did not occur because of the shear volume of sediment being transported. Streams within the lower valley reaches of the watershed became disconnected from their flood plains and back water and nutrient rich areas were lost. Stream complexity and diversity diminished and riparian vegetation became dominantly hardwoods.

During peak flows, flood plains absorbed most of the stream energy. The lack of large wood in the floodplains caused the energy to be released against the standing vegetation and the adjacent hill slopes. This release of energy generated additional hillslope and channel bank failures, increasing the sediment loads.

Road locations, reduced floodplain areas by channelizing flows and disconnecting streams with their flood plains. This resulted in increased channel energies and led to channel bank instability.

Summary: The watershed has experienced numerous earthflows because of inherent instability. Fire and management activities have altered the landscape and have created a condition for increased peak flows that has resulted in hillslope failures and channelbank instability. Historically, the stream systems would have been somewhat buffered by the large woody material present within the stream system. Management; however, has reduced this buffering effect and has created high sediment, high energy stream systems that are currently incising their valley floors and recruiting sediment from channel banks.

The riparian areas have historically been impacted by fire, and in recent times by management. Management activities have resulted in removal of large woody debris, a critical component of the hydrologic system. Numerous channels are still adjusting to this removal. In addition, the size of trees in the riparian areas is currently relatively small, so replacement of large instream wood is not expected to occur in the near future. Augmentation through the use of silvicultural tools would aid the vegetative growth within the riparian reserves to provide bigger trees for large woody debris recruitment of instream structure within 50 years.

c. Table: Comparison of Current and Reference Conditions: *What are the natural and human causes of change between historical and current channel conditions?*

Stream Channel Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Morphological Characteristics	Basic stream patterns and channel gradients are largely influenced by geology	Similar to historic conditions with minor influences from roads	Gravity causes water to flow downhill.	Road systems intercept surface water and route it differently than natural hillslopes.
Sediment and depositional processes	Sediment and depositional processes were the result of peak flows and erosion that generally occurred during rain-on-snow events.	Similar to historic conditions with minor influences due to created openings.		Roading and timber harvest have created openings that can locally influence peak flows and therefore sediment and depositional processes in the localized area.
	Historically abundant sediment reached stream channels, especially after large scale fires	Less sediment reaches stream channels now than did historically.	Re-growth of vegetation results in reduced erosion	Fire suppression has allowed vegetation to persist on the landscape. This reduces erosion. Timber harvest removes vegetation, but generally in smaller areas and more scattered about the watershed than historic fires did.
	Sediments that reached stream channels were flushed out during peak flows over a relatively long period of time	Sediments flush out of the system more quickly now than they did historically	Without large woody material in the channel to deflect the water, both stream energies and water velocities have changed.	Stream cleanout, past removal of large woody material from streams, removed structure that held sediments. Salvage and harvest adjacent to stream channels, that removed trees that might have fallen into streams to replenish large woody material there.

Stream Channel Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Floodplain/ stream channel interactions	Historically there was abundant sediment and large woody material in stream channels	Surface erosion is currently less than in historic times, so there is less sediment available to streams to rebuild their floodplains.	Re-growth of vegetation has reduced surface erosion.	Fire suppression allows vegetation to persist on hillslopes, so there is less erosion to contribute sediment to stream channels. Harvest practice changes such as leaving down woody material, retaining riparian vegetation, etc. reduce erosion generated sediments reaching stream channels. Selective placement of harvest units outside erosion-prone areas. Harvest units smaller than fires and more distributed across landscape thereby minimizing erosion-generation sediments reaching stream channels.
	Sediment and large woody material created very complex stream channels and floodplains. Stream flows occupied their floodplains on a regular basis.	Reduction in floodpain area due to decrease in sediment and large woody material	Vegetative cover and the associated root systems helped to stabilize hillslopes and as a result reduced surface level soil failures.	Road locations in historic floodplains have caused channelization of stream flows. This channelization has increased stream energies and caused downcutting. Without sediment to build floodplains, streams became disconnected with floodplains.

Stream Channel Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Sediment metering through stream channels	Historically sediment was pulsed through the stream system from large woody accumulation to accumulation. The sediment remained in the system for relatively long periods of time. There was abundant sediment storage	In some areas there has been a reduction in the amount of large woody material in stream channels, so sediments are transported more quickly through the stream systems than they were historically. Sediment storage is also reduced	Large scale fires can remove large woody material that helps meter sediments.	Removal of large woody material from stream channels through stream cleanout programs Timber harvest and salvage adjacent to stream channels, thus removing future large wood supply.
		Increase in large woody material in some areas	Re-growth of vegetation along stream channels.	Fire suppression has allowed vegetation to persist on landscape in areas that might have been more prone to fires historically .

Stream Channel Characteristic	What was it like historically	What changed?	Natural Cause of Change	Human Cause of Change
Stream energies	High stream energies	Similar to historic conditions		
	During peak flows floodplains allowed water to spread out and helped to absorb stream energies	Floodplains disconnected from stream channels so they don't absorb stream energies like they once did.	Increased stream velocities promote stream channel downcutting.	Roads adjacent to streams channelized streams and reduced floodplain areas.
	Abundant large woody material in streams for energy dissipation and sediment storage Energy dissipation reduces transport ability of streams Sediments remained in system longer.	Less large woody material to dissipate stream energies	Root strength of hillslope vegetation helps to minimize slope failures that deposit large wood in stream channels.	Stream cleanout Salvage of trees adjacent to stream channels that might have contributed to large wood instream channels. Without wood, there is less channel roughness and less to dissipate stream energies.
Stream Channel Diversity	Abundant pool habitat and backwater areas. Diverse channels, multiple side channels and large woody material accumulations	Fewer pools and side channels due to disconnection of stream channel with floodplain. Less sediment and large woody material recruitment from slope failures.	Increased stream velocities create monotypic streams. Vegetation has helped to stabilize slopes that might have failed in the past and deposited large woody material in stream channels.	Removal of large wood from stream channels and stream channelization.
	Log jam development	Reduced upslope failures	Less woody material in stream channel results in less chance of a log jam forming	Salvage along stream courses and removal of large wood from stream channels.
	Overall diversity	Streambank and hillslope erosion	Revegetation of hillslopes results in greater stability.	Stream cleanout and log jam removal

II. PHYSICAL DOMAIN

D. Water Quality

1. Characterization: *What aquatic-dependent beneficial uses occur in the watershed?*

Beneficial uses dependent on aquatic resources in this watershed are: domestic water; resident and anadromous fisheries; downstream fisheries; aquatic non-fish species; riparian dependent species; water-related recreation; hydroelectric power, agriculture and water-related fire suppression and road maintenance needs.

- Water, from both Blowout and Box Canyon Creeks, flows directly into Detroit Reservoir on the North Santiam River, which serves as a **domestic water** supply for several downstream municipalities including Salem, Stayton, Aumsville, Sublimity, Lyons, Mehema, Mill City, and Gates.

- **Fisheries** are found in much of the Blowout and Box Canyon stream systems.

- Streams downstream of Detroit and Big Cliff Dams support an **anadromous fishery** resource, however due to the dams only resident fish are currently in the Blowout watershed.

- **Aquatic non-fish species** can be found in all waters within the basin.

- **Riparian-dependent species** occur along the edges of water bodies in the watershed.

- A high percentage of the **recreation use** in the Blowout watershed is related to water and riparian areas. Dispersed recreation sites are generally located within riparian areas and near water sources in this watershed. In addition, the Blowout arm of Detroit reservoir extends into the watershed and receives quite a bit of boating use because it is relatively sheltered from wind.

- Periodically water from the Blowout watershed is used for **fire suppression and road maintenance**. Small access roads have been built to selected streams, and pump chances have been developed at these sites, to provide water when needed for fire suppression and road maintenance.

What water quality parameters are critical to these beneficial uses?

Water quality parameters critical to beneficial users are temperature and type and timing of sediment input.

Temperature: As is typical in the western Cascades, water temperature controls the type and distribution of aquatic species in the watershed. The primary influence on water temperatures in this watershed is solar radiation. This influence can be modified to a large degree by vegetative canopies shading stream courses. The degree to which shading occurs has a significant influence on stream temperatures.

Sediment: Sediment movement through the watershed is critical for various aquatic, domestic, and recreation resources. The timing, type and amount of sediment have varied effects on beneficial users, including the following:

- Mixing of sediment with water causes it to become turbid, thus affecting the cost of treatment for domestic water supplies. In order to meet State drinking water standards, turbidity must not exceed 10% above the background level for the watershed. The City of Salem uses a slow sand filtration water purification system which cannot effectively filter water in excess of 10 NTU's. If there is too much turbidity in the water at their intake point near Stayton, in the past, the City had to shut down their water system and use alternative water sources until the turbidity level dropped. Now they must pre-treat their water and remove sediment prior to running it through the sand filtration beds. This costs them extra money, but allows the system to remain operational during periods of high turbidity.

- Measuring 10% above background levels assumes records of adequate length and sampling frequency have been collected throughout the range of the hydrograph. This is not the case for the Blowout streams. In October of 1998 a United States Geological Service (U.S.G.S) gauge was established on Blowout Creek. This gauge will provide flow and turbidity data. Once a record is established, the background restriction will be considered. Currently Best Management Practices (BMP's) are implemented to meet this requirement as agreed to by Department of Environmental Quality, Environmental Protection Agency, and the Forest Service in 1988.

- The timing of fine sediment input can influence reproduction success of certain aquatic species if it occurs during critical times, such as egg incubation.

- Coarse bedload deposition can result in plugged culverts and damage to transportation systems.

- Deposition of appropriate-sized sediment can create spawning habitat for various aquatic species.

- Fine grain deposition from streams, creates beaches for recreation, and rich farmland for agriculture.

- Deposition of sediment can contribute to floodplain creation and development of habitat for riparian dependent species.

As illustrated above, sediment can have both positive and negative impacts on various resources. Thus supporting the critical nature of sediment movement, and its properties; (e.g. turbidity; bedload, mode of movement, suspended) as a water quality parameter.

2. *What do humans value that is associated with water quality?*

Water and water quality have life-sustaining and economic, aesthetic, and recreational value.

3. *What are the highest priority issues or resource concerns associated with water quality?*

The highest priority water quality issues are **water temperature, type and timing of sediment input** into streams, turbidity and domestic water use.

Lack of large woody debris in stream channels, from past management and fires, has reduced stream channel storage capacity for sediment. Because of this, more sediment is transported through the stream system today, during a hydrologic event, than in historic times. This may impact downstream users and eventually the storage capacity of Detroit Dam.

Stream temperatures within Blowout Creek and some tributaries exceed State Water Quality standards for about three months out of the year. Blowout Creek is currently listed as a State Water Quality limited stream; 303d listed.

4. *What and where are the management direction/activities, human uses, or natural processes that affect water quality?*

a. **Current Conditions**: *What are the current conditions and trends of beneficial uses and associated water quality parameters?*

Water for domestic use is generally of moderate quality in the Blowout watershed. Under normal conditions turbidity in the Blowout averages less than 5 NTU's. During episodic storms, especially those that increase peak flows like rain-on-snow events, hillslope and channel bank failures increase sediment input into streams, temporarily reducing water quality, by increasing turbidity in the range of 25 to 85 NTU's. (***Note;*** *these turbidity levels are taken from grab samples taken during storm events.*)

Large native earthflows, that occupy portions of the Blowout landscape, can affect the quality of waters produced. Streams encountering these earthflows mobilize material, increasing water turbidity and reducing water quality. Episodic in nature, the temporary reduction in water quality rises along with rising waters. Once this sediment is flushed out of the watershed, water quality returns to previous conditions, under normal flows. Domestic water users downstream of Detroit and Big Cliff dams, have not historically been affected by these pulses of sediment because of the metering of these sediments by the dams.

During the 1996 water year, a flood event flushed a lot of new sediment into Detroit Reservoir, and stirred up existing sediment, resulting in turbid waters flowing out of Detroit and Big Cliff dams for several months. This condition, coupled with tighter requirements adopted by the State of Oregon and reduced the acceptable level for turbidity in raw drinking water (*the condition of water before being placed in distribution lines and treated*), heightened concerns of several downstream communities when turbid waters flowed past their water intake systems and they had to rely on alternate water sources for domestic use. Prior to the installation of a pre-treatment facility, the sand filtration system used by the City of Salem could become clogged with sediment during periods of high turbidity, so City officials were particularly concerned with the source(s) of the persistent turbidity. A study of reservoir sediments (*North Santiam River Turbidity Study, 1996-1997*) showed the major culprit in the persistent turbidity to be ultra fine clays, or colloidal materials, called smectite clays. In the Blowout area, sources of these clays are failure zones of earthflows, weathering, and geologic erosion of weak volcanic ash deposits. These types of soils are found scattered throughout Blowout watershed.

The Willamette National Forest has entered into a Memorandum of Understanding with the City of Salem, Army Corp of Engineers and the Bureau of Land Management and is working closely with the City of Salem to address water quality concerns.

Temperature: Since 1980 steam temperature data has been collected on Blowout Creek and its tributaries. During this time, temperatures in excess of Oregon State Water Quality Standards of 58° F degrees, have been recorded on Blowout, Ivy, Divide, Cliff, and Hawkins Creeks. Stream temperatures have reached as high as 72° degrees F and are commonly within the 68° to 70° F degree range throughout the summer.

Surveys of main stem, named streams using Level II protocol have shown that the canopy closure over stream reaches averages 24 percent. This cover provides minimal shade to the streams and is of critical importance in contributing to high stream temperatures. Without shade, solar radiation reaches alluvial deposits along stream courses, which act as heat sinks during the summer months, transferring solar energy to the water and increasing stream temperatures.

An example of stream temperatures increasing as a result of lack of shade, can be seen in Lost Creek. Here the water runs over a section of bedrock, where there is relatively little shade, and stream temperatures rise several degrees as the water flows over this reach of stream. The biggest influences on stream shade, and therefore stream temperatures, are fires and timber harvest. Both of which, remove vegetation and can therefore affect the amount of shade along stream courses.

Sediment / Turbidity The analysis area contains areas of highly unstable ground which produce earthflows that contribute large volumes of sediment to stream channels. In addition, past management practices and fires have resulted in far less woody material in some streams channels than was present historically. This lack of woody material reduces the sediment storage capacity of these stream channels, resulting in more sediments being transported through the system more quickly, during hydrologic events today, than in historic times. Furthermore, less woody material decreases channel roughness and increases stream energies. This generates greater mobilization of sediments and contributes to larger alluvial deposits.

Roads also have the potential to influence stream sediment. Depending on other disturbance mechanisms and slope stability, roads can influence the size and frequency of debris slides or other sediment input delivery mechanisms into stream channels. One important example in the Blowout watershed is road 1012 820, where material that was excess to the road construction was "sidecast" over the edge of the road. This "sidecast" material is uncompacted and tends to fail on a regular basis, sending sediment down slope into stream systems.

Road densities give an indication of the potential risk of various road-related sediment input delivery mechanisms. The following chart shows road densities by planning subdrainage. The higher the density the higher the risk.

There are several other examples of roads in the Blowout being constructed across unstable sections of ground. These unstable areas have naturally resulted in debris slides and sediment in the stream channels, but the roads often exacerbate the problem.

Additionally, roads that are used during wet weather, as many in the Blowout have been, tend to produce additional sediment to the streams.

For these reasons, a measure of road densities will give an indication of the potential risk of debris slides and increase sediment rates to stream channels in the study area. The following chart shows road densities by planning subdrainage.

Road Densities by Planning Sub-Drainage		
Planning Subdrainage	**Miles of Road**	**Road Density Miles per Square Mile**
78L Beard	30.5	3.63
78M Divide	29.25	4.18
78N Hawkins	18.62	4.14
78P Lost	17.88	4.54
78Q West Side Ivy	22.18	3.58
78R Cliff	20.18	3.75
78S Southside Blowout	6.86	2.04
78T Box Canyon	28.19	2.73
78U Upper Blowout	16.31	4.55
Other Misc.	0.15	2.87
Totals	190.12	Ave.= 3.58

What and where are the "303d" water quality limited water bodies within the watershed?

Currently Blowout Creek is listed as a 303d water quality limited stream in the Blowout watershed. The District is currently writing a Water Quality Management Plan to establish total maximum daily loads (TDML) for the basin. Temperature is the primary parameter for which the TDML is created.

b. Reference Conditions: *What were the historical water quality characteristics of the watershed?*

Riparian and aquatic resources were the major beneficial uses in historic times. Turbidity and stream temperatures were the water quality characteristics that had the greatest influence on these resources.

Historic water quality characteristics are difficult to determine quantitatively due to the lack of sufficient data. Even with the data available, characterizing the watershed can only be done on how the system is operating today. Upon reviewing the records one needs to remember climatic changes that have occurred since this period of record, as well.

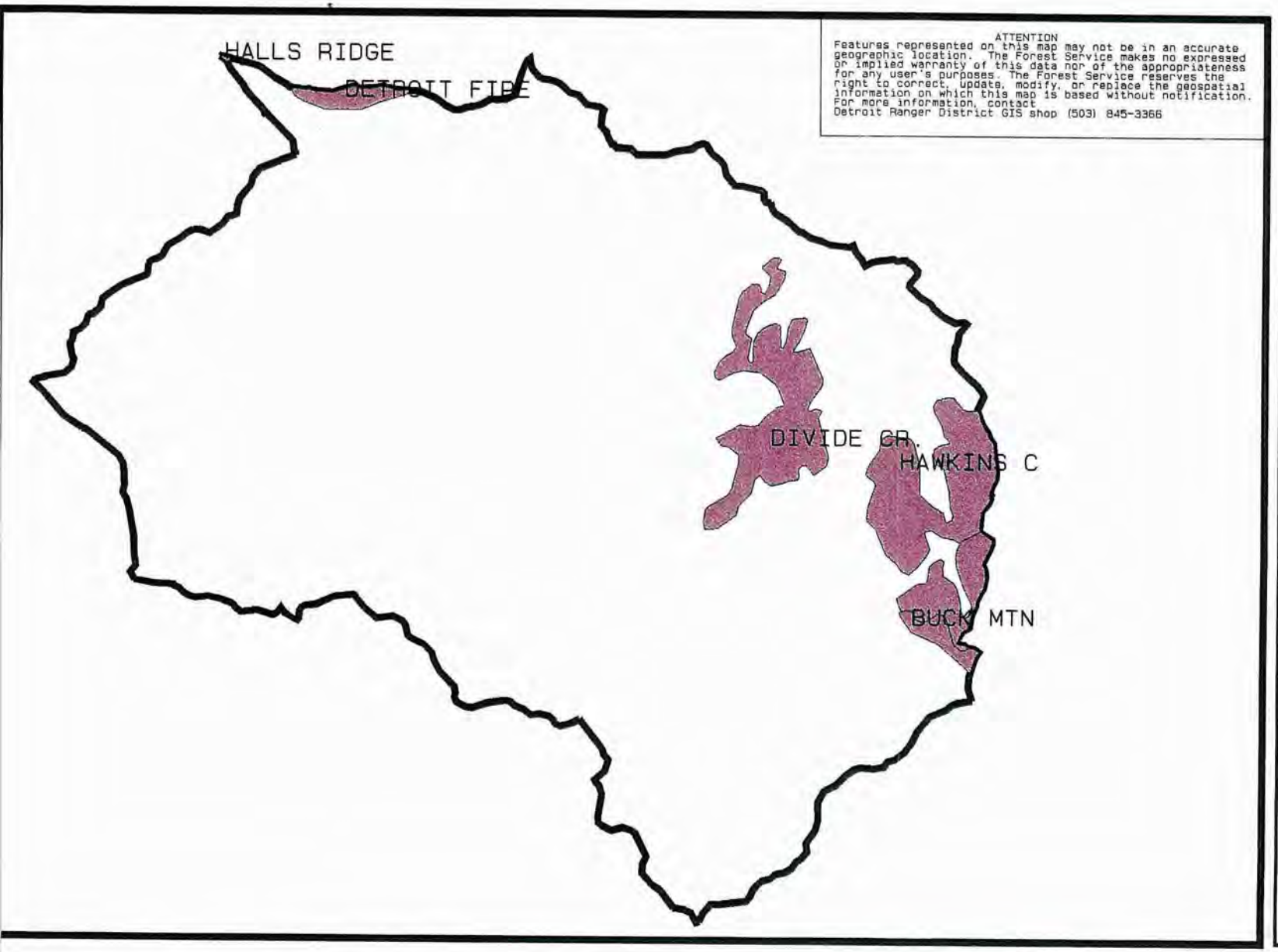
Temperature: It is likely that historic water temperatures for Blowout Creek were somewhere near the 58° F standard, currently used by the State. This assumption is based on anecdotal evidence of people who worked in the area many years ago, as well as, evidence of temperature moderation as vegetation grows back and begins shading stream channels that were previously unshaded as a result of vegetation removal. This temperature assumption, however, recognizes that immediately following flood events a recovery period would occur until such time that vegetation could reoccupy stream sides.

In the past, fires were the major influence on the amount of vegetation on the landscape, especially on south and west aspects, which were most prone to fires. The amount of vegetation influenced stream shade and affected stream temperatures.

Turbidity: Turbid waters are caused by sedimentation, resulting from disturbances on the landscape. One major historic disturbance mechanism was fires. Map #9 shows the extent of disturbances caused by fires in the watershed. After a fire, sediments moved through stream systems in pulses, creating short term impacts. Sediment particle size depended upon the sediment source and location. First through fourth order streams contained boulder to clay size particles that were mobilized during storm events and fifth and greater order streams moved cobble to clay size particles. The difference between the two, related to the amount of woody material present to increase channel roughness and reduce stream energies.

Historically, sediment was temporarily trapped by large woody debris in the stream channels and was later transported through the stream and valley systems during major hydrologic events.

Blowout WA
Fire History



ATTENTION
Features represented on this map may not be in an accurate geographic location. The Forest Service makes no expressed or implied warranty of this data nor of the appropriateness for any user's purposes. The Forest Service reserves the right to correct, update, modify, or replace the geospatial information on which this map is based without notification. For more information, contact Detroit Ranger District GIS shop (503) 845-3366

Legend

Fire

Request 2023j

Scale 1:100000
08/28/00

Map # 9

C. Table: Comparison of Current and Reference Conditions: *What are the natural and human causes of change between historical and current water quality characteristics of the watershed?*

Water Quality Parameter	What was it like historically	What Changed	Natural Cause of Change	Human Cause of Change
Beneficial Uses	Historically beneficial uses included fish, aquatic non-fish, and riparian dependent species	Additional beneficial uses have been added such as domestic water use, water-related recreation, hydro-electric power generation, agricultural and industrial water uses, fire suppression and road maintenance. These additional uses have affected water quality requirements.	Growth of human population	Demographic changes have affected water use/needs. Blowout streams now contribute to beneficial uses that were not of concern historically.
Stream Temperatures	Historically stream temperatures increased in areas following large scale fire disturbances and flood flows.	Blowout, Ivy, Divide, Cliffs and Hawkins Creeks stream temperatures are significantly above Oregon State Water Quality Standards of 58 for about three months in the summer	Solar radiation reaching surface water and alluvial deposits warms water.	Timber harvest, road construction and human ignited fires have removed vegetative shading near stream channels allowing more solar radiation to reach water and warm it.
	Both cooling and heating potential of surface water is a result of solar radiation but has been moderated historically by shade from vegetative canopy adjacent to stream channels.	Vegetation that provides shade adjacent to stream channels has been removed in some areas, thereby allowing stream to warm.	Lightning-caused, stand replacing fires, removed vegetative shading adjacent to stream channels allowing more solar radiations to reach water and warm it.	Same as above

Water Quality Parameter	What was it like historically	What Changed	Natural Cause of Change	Human Cause of Change
Stream temperatures (continued)	Both cooling and heating potential of surface water occur is a result of solar radiation but has been moderated historically by shade from vegetative canopy adjacent to stream channels. (Continued)	Vegetation that provides shade adjacent to stream channels has grown back in some areas, resulting in cooler stream temperatures than when large scale fires removed vegetation in these areas historically	Vegetative regrowth	Fire suppression resulted in smaller fires and retention of more vegetation. More shade for streams, allowed less solar radiation to reach the water and has moderated stream temperatures. Retention of riparian reserves has helped to moderate stream temperatures.
Turbidity	Turbidity has historically been caused by disturbances on the landscape. Peak flows have eroded toes of earthflows and fire has resulted in increased surface erosion.	Reduction in the acreage of large scale fires has reduced surface erosion potential; removal of large woody material from stream channels increased stream velocities and resulted in erosion of the toes of earthflows.	Fire disturbances contribute to surface erosional.	Fire suppression has reduced that acreage of large scale fires and has minimized surface erosion that resulted from these disturbances. Stream cleanout reduced sediment storage capacity in streams and increased stream velocities. Timber management and road construction have caused erosion that has resulted in turbid waters in streams.
	Turbidity increases during episodic events, especially those that increase peak flows like rain-on-snow events.	Lack of stream diversity increased stream energies.	Weather patterns, earthflows, soil instability and stream energies.	Timber harvest and road construction generated sediments can contribute to turbidity increases during peak flows.

Water Quality Parameter	What was it like historically	What Changed	Natural Cause of Change	Human Cause of Change
Turbidity (continued)	Historically turbidity rose quickly and then subsided relatively quickly	Turbidity rises quickly and subsides in stream channels, but when the waters reach Detroit Reservoir turbidity can persist for relatively long time intervals during some storm events (i.e. Floods of 1996 and 1964)	Very small particle size clay called smectites are generated from some soil formations in this watershed when streams downcut through those soil types. These particles do not settle out of suspension readily and cause turbidity increases.	Detroit dam held suspended smectite clays from peak flow events which did not settle out readily in the reservoir. This in combination with the intake point at the dam, resulted in persistent turbidity in the North Santiam River following the 1996 flood event.