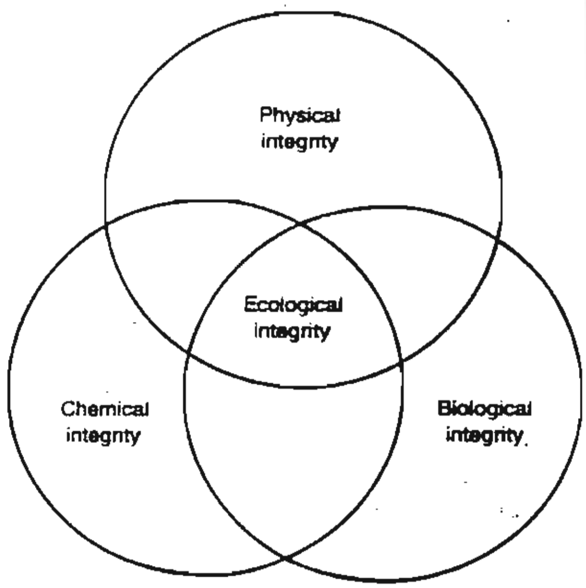
Section VII. N.

Umatilla National Forest

FINAL

WALL CREEK WATERSHED REPORT

PREPARED FOR THE WALL ECOSYSTEM ANALYSIS



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September 29, 1995

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LOCATION AND DESCRIPTION

Wall Creek, located near the town of Monument, Oregon, drains a 200 square mile watershed in the North Fork of the John Day River (NFJD) subbasin, and accounts for approximately 8 percent of the NFJD area. The watershed is located in the north-central portion of the subbasin, between Madison Butte, on the divide with Willow Creek to the north, and the town of Monument, Oregon, on the North Fork of the John Day River, to the south (Figure 1, Ecosystem Report). The confluence of Wall Creek is 22.5 stream miles upstream from the confluence of the North Fork with the main John Day River.

Wall Creek arises at an elevation of 4600 feet and flows east to south to the confluence with the NFJD River, at an elevation of 2060 feet. Major streams draining Wall Creek include Big Wall, Wilson, Little Wall, Skookum, and Swale Creeks. The Wall Creek watershed is divided into 16 subwatersheds which fall into 3 main tributary systems, Main Wall (24); Little Wall (25); and Skookum (26) (Figure 1).

SETTING

Wall Creek is located in the southwest part of the Blue Mountains Section of the Middle Rocky Mountains Steppe Province (National Hierarchical Framework of Ecological Units-USDA Forest Service, 1994). Wall Creek is on an east-west trending "arm" of the Blue Mountains (part of the Blue Mountain anticline), on an uplifted and tilted basalt plateau. Dominant geology is Miocene basalt with areas of Miocene tuffs (Picture Gorge basalt and John Day formation) overlain by Mazama ash.

The landscape setting is characterized by uplifted, moderately dissected plateaus with gently sloping uplands, steep escarpments, canyons, and depositional lands consisting of alluvial landforms in valley bottoms and along stream terraces. Elevations range from 2060 feet at the confluence to 5707 feet at Madison Butte (Figure 2).

(See Soils report for geology map and additional discussion)

FIGURE 1

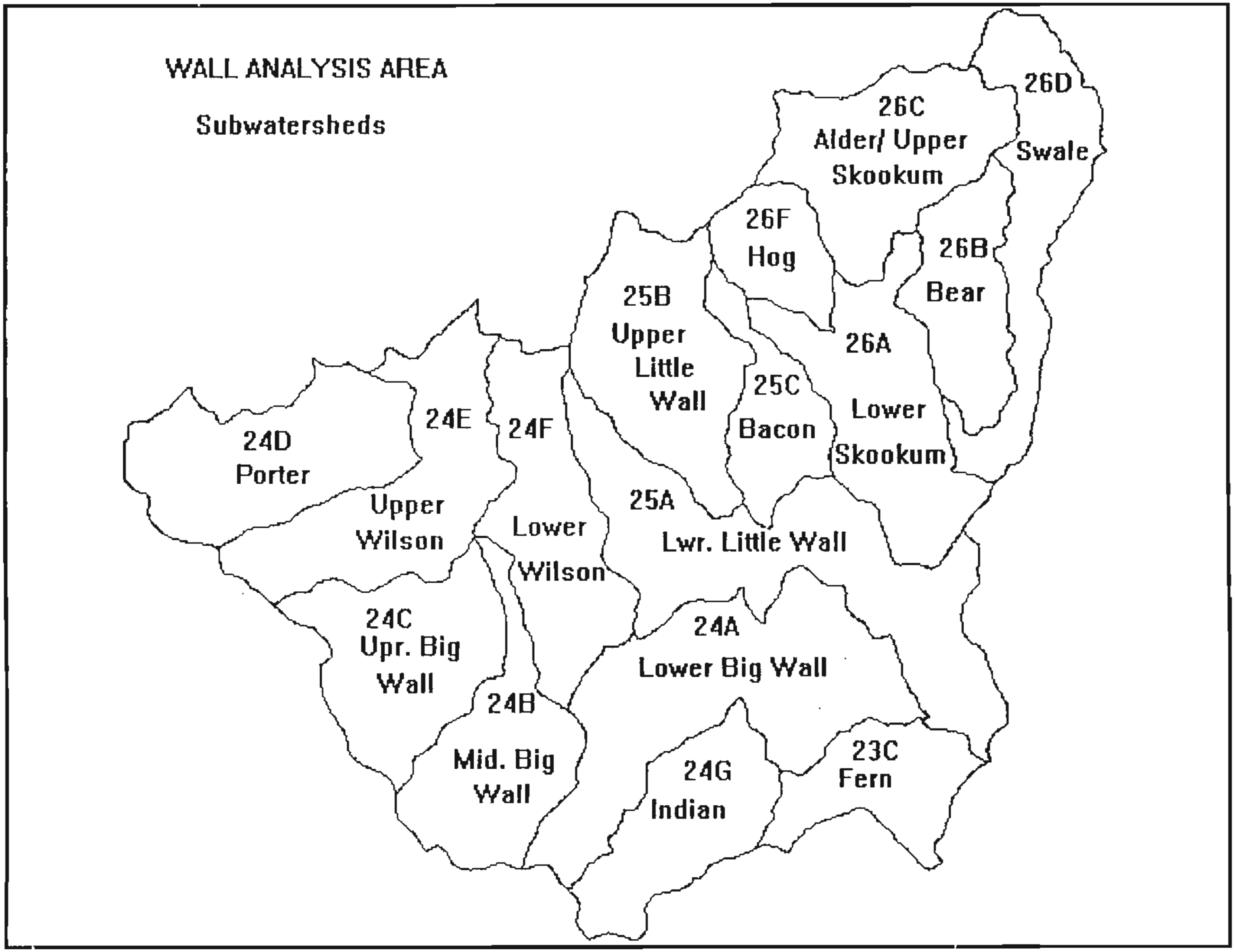
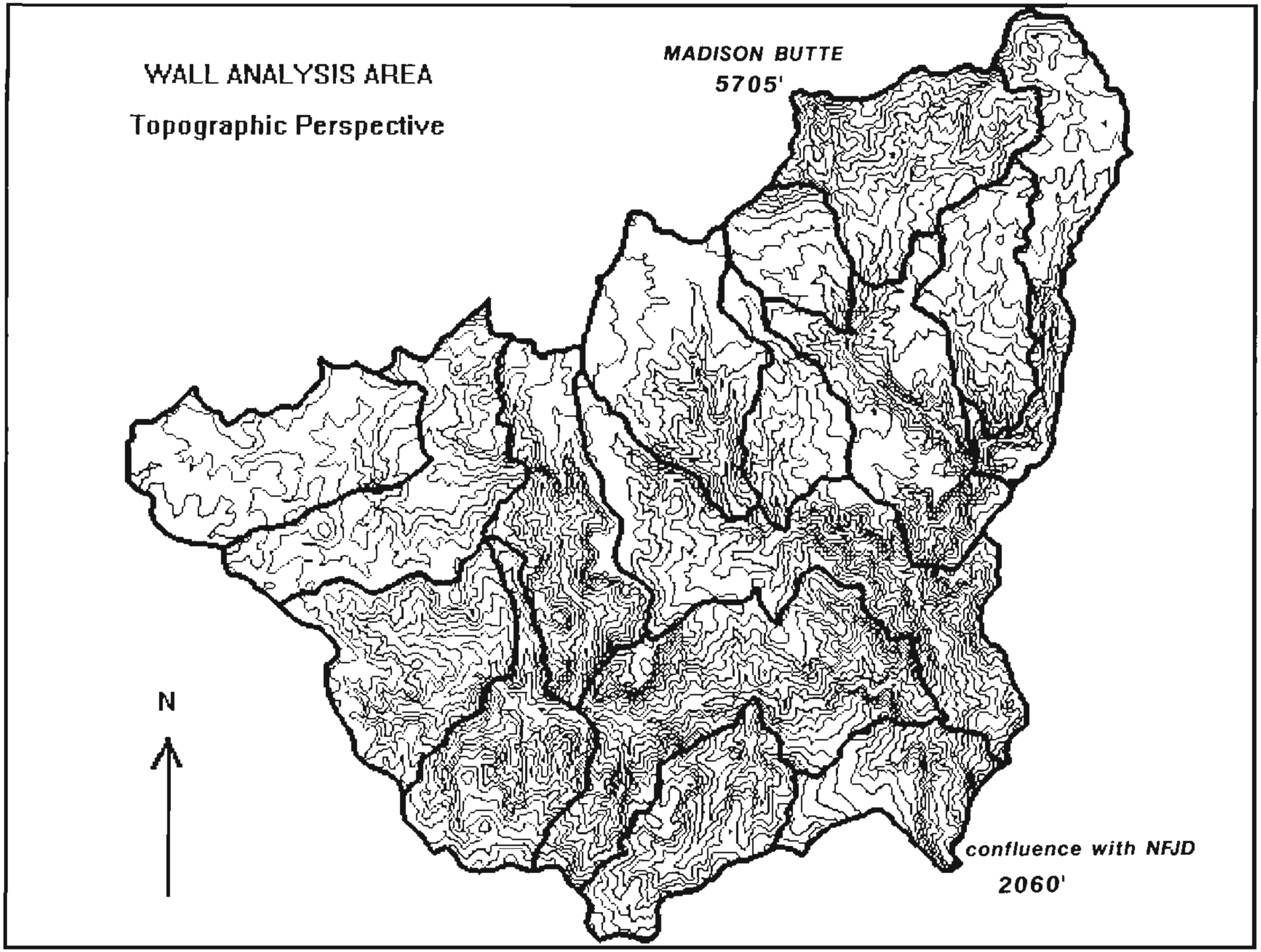

WALL ANALYSIS AREA
Subwatersheds
24D Porter
24E
Upper Wilson
24F
Lower Wilson
24C Upr. Big Wall
24B
Mid. Big Wall
25A
Lwr. Little Wall
25B Upper Little Wall
25C Bacon
26F Hog
26C Alder/ Upper Skookum
26D
Swale
26B
Bear
26A
Lower Skookum
24A
Lower Big Wall
24G
Indian
23C
Fern

FIGURE 2


WALL ANALYSIS AREA
Topographic Perspective
MADISON BUTTE
5705'
N
confluence with NFJD
2060'

CLIMATE AND HYDROLOGY

Wall Creek, in northeast Oregon, has an interior, continental climate controlled both by its regional setting and the orientation of the main ridge. The climate is characterized by generally low precipitation intensity, low relative humidity, rapid evaporation, many clear days, and a wide range in temperatures. The average minimum January temperature for the town of Monument is 21 degrees Farenheit (°F), and average maximum temperature for July is 90 °F. The east-west orientation of the main ridgeline, parallel to prevailing winds, presents a modest topographic obstacle to storms.

Annual precipitation in Wall Creek ranges from 13 inches in the lower elevations near the North Fork John Day River, to 30 inches in the highest elevations in the northeastern part of the watershed. Average for the watershed is about 23 inches. The distribution of monthly precipitation for Madison Butte and Monument (Figure 3) shows relatively low variability throughout the year. Precipitation maximums occur in early and late winter, and minimums during the summer months.

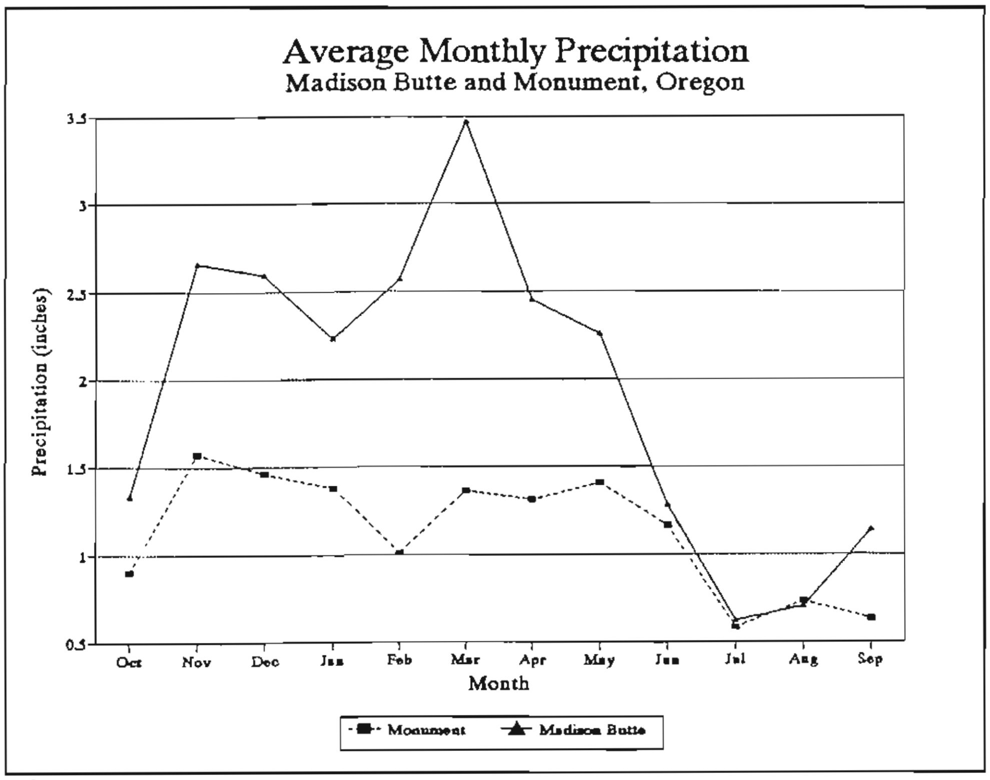


Figure 3

Precipitation occurs as a result of winter storms which are generally wide-area frontal systems with low precipitation intensity, and long duration. Isolated, higher intensity summer convective storms also happen in response to the heating of the land surface and the effects of variable topography.

Wall Creek watershed has been divided into 16 subwatersheds for further description and analysis. Elevation zones within subwatersheds are an indicator of hydrologic regime (Table 1). Compared to other Umatilla National Forest watersheds, elevations are low. The precipitation regime is characterized as rain, and mixed rain and snow. Elevations that approximate these hydrologic regimes are as follows: below 3000 feet- rain dominated; 3000 to 4000 feet- mixed rain and snow (rain dom.); above 4000 feet- rain and snow (snow dom.); above 4500 feet- snow dominated (snow persists throughout the winter above this elevation). Using these elevation zones, the lowest elevation subwatershed, at the outlet, is classified as rain-dominated; most subwatersheds fall in the "mixed" zone; and 3 subwatersheds (24D, 26C, and 26D) have at least 30 percent of the area above 4500 feet, and are considered snow dominated.

Streamflow

There are no gaged streams in the Wall watershed so that precise information on streamflow is not available, however, there are several gages nearby that are useful for estimating flows in Wall Creek. These include the North Fork John Day River at Monument, the Middle Fork John Day River, and Camas Creek near Ukiah. In addition, records from crest stage gages active in the 1960's and 1970's, are available for small streams in several adjacent watersheds. And, a long term hydrology study site was established in 1992 on tributaries in Wall Creek, although data from these stations are not yet available (South End Hydro study).

Estimates of the average annual discharge were made for Wall Creek using annual runoff values from nearby gages extrapolated to Wall Creek (Table 2).

Estimated average annual (QA) discharge is based on unit area runoff (QFSM) from nearby gages, extrapolated to Wall Creek. This procedure provides an estimate of average discharge for the watershed. More detailed information on the climate of the NFJD can be found in the Camas Ecosystem Analysis report (Appendix H, Watershed Hydrology Report).

	WALL ANALYSIS AREA					08/01/95
	Physical Hydrologic Characteristics of the Wall Watershed					
		ELEVATION ZONES (% of SWS in Zone)			Dominant Hydro	
Subwatershed	**SWS #**	**<3000 FT.**	**3001-4000**	**>4000**	**Regime 1/**	**ASPECT**
Fern	23C	60	40	0	R	E,S
Lwr Big Wall	24a	31	61	8	MR	NE,E,SE
Mid Big Wall	24b	1	58	41	MR	NE,S
Upr Big Wall	24c	0	52	48	MR	E
Porter	24d	0	8	92	S	E
Upr Wilson	24e	0	28	72	S	NE,S
Lwr Wilson	24f	1	58	41	MR	S
Lwr Wilson	24g	7	75	18	MR	NE
Lwr Little Wall	25a	20	65	15	MR	SE,E,W
Upr Little Wall	25b	0	36	64	MS	SE
Bacon	25c	0	85	15	MR	S
Lwr Skookum	26a	6	83	11	MR	SE
Bear	26b	0	34	66	MS	S
Alder/Up Skook	26c	0	7	93	S	S
Swale	26d	0	23	77	S	S
Hog	26f	0	16	84	S	SE
		R	MR	MS/S		
1/ Hydro "Regime"	R=Rain, MR=Mixed Rain & Snow (rain dominant), S= Snow Dominant					
	MS= Mixed Rain & Snow (snow persistent), winter & spring runoff events					

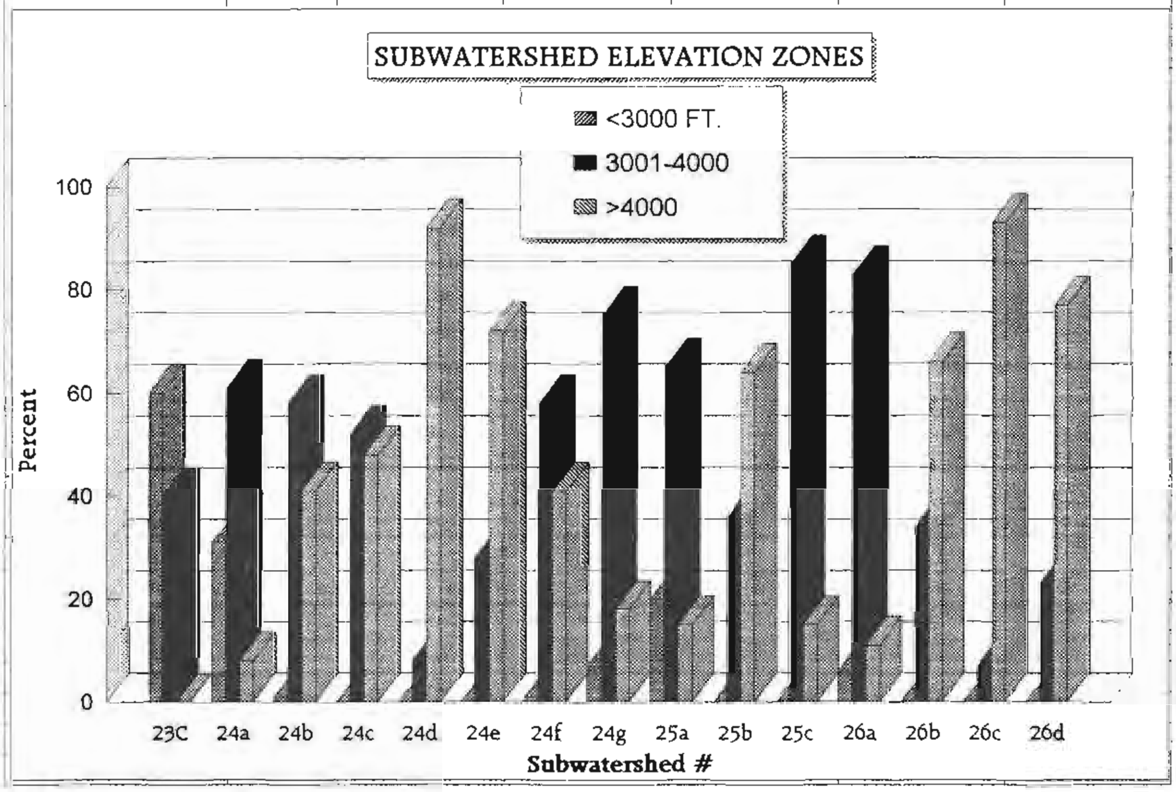


TABLE 2. Estimated Average Annual Discharge for Wall Creek

NAME	DRAINAGE AREA (mi^2)	AVE.ANN. PREC.(in)	MEAN BASIN ELEV. (ft)	FOREST (%)	QA	CFSM
Gaged Streams:						
Camas	121	24	4680	78	97	0.80
MFJD	515	23	4800	80	256	0.50
NFJD	2520	22	4580	70	1293	0.50
Wall Creek						
Wall	200	23	4200	70	80	0.40

Timing and Peak Flows

The lack of gaged data for Wall Creek limits precise determination of seasonal streamflow distribution, however data from nearby gaged watersheds show a seasonal runoff pattern of peak discharges in the period March through May. For Camas Creek, 66.1 percent of the runoff occured during these 3 months; for the Middle Fork of the John Day River, 62.8 percent of the runoff came during the 3 month period; and for the NFJD, 61.9 percent of the runoff occured during these 3 months. This shows a strong snowmelt contribution during spring for these gaged watersheds. Low flows occur in August and September.

Wall Creek, with lower average elevations, has less of the total runoff occuring as snowmelt during the spring period, with more runoff from fall, winter, and spring rain.

Variability of runoff within Wall Creek occurs as a result of watershed characteristics, climatic conditions, and management activities. Lower elevation subwatersheds are rain-dominated with early-season runoff, compared to higher elevation subwatersheds which retain snow into early spring and produce a small spring snowmelt peak. Consequently, peak flows in the Wall watershed are a "mixed bag". The largest runoff events are winter rain-on-snow with above freezing air temepratures and a above-average snowpack. These conditions existed in the winters of 1964 and 1975, and led to region-wide, record flooding, documented in numerous reports (Rothacher and Glazebrook, 1968).

Precipitation-runoff estimates for the subbasins in Wall Creek (upper Big Wall, Wilson, L Wall, Skookum, Swale) have not been made. This analysis would reveal spatial differences in peak flows, low flows, and overall variability in water yields.

For example, Wilson Creek is reported to have very high unit area runoff, and very low flows, a condition described as "flashy". Alder/Upper Skookum, in contrast, has higher elevations, a more persistent snowpack, a snowmelt peak runoff, and higher baseflows.

Peak flows are produced by a combination of climatic conditions and the physical character of the watershed. There are no recording gages in Wall Creek so that measurements of peak flow events are not available. Standard methods for determining flood magnitudes for various exceedance probabilities at ungaged sites were used to estimate peak flows for Wall Creek (Harris and Hubbard, 1983) (Table 3).

Crest gage data for the period 1959 to 1979 are available from 5 small catchments in the vicinity of Wall Creek. Crest gages, which record the level of the annual peak flow, were installed on many smaller streams in eastern Oregon as part of a cooperative program with the state highway department and the Forest Service. Crest gages provide information on the timing and magnitude of peak flow events and are useful for validating regional regression estimates, often used for design flow estimation, for example in bridge design and culvert sizing (Table 4).

TABLE 4
Crest Gages in the Vicinity of Wall Watershed
Causes of Peak Flows (number of events)

Station Name (Drainage Area in square miles)	Elevation (feet)	Years of Record	Winter ROS	Spring ROMS	Summer	Fall
Granite nr Dale (1.9 mi^2)	4130	11	6	4	1	0
Line Creek nr Lehman (2.3 mi^2)	4580	15	7	8	0	0
Willow nr Heppner (1.11 mi^2)	4310	19	6	11	0	1
Rock Cr trib Hardman (6.25 mi^2)	4100	14	8	6	0	0
Ives Canyon, nr Spray (2.73 mi^2)	2700	11	4	4	3	0

ROS = Rain on snow; ROMS = rain on melting snow

DISCHARGES FOR SELECTED FLOOD FREQUENCIES (cfs)

GAGE 2/	DA 3/	QA 4/	Q 0.5 5/	cfsm	Q 0.2	cfsm	Q 0.1	cfsm	Q 0.04	cfsm	Q 0.02	cfsm	Q 0.01	cfsm
Camas	121	96.9	1050	8.68	1590	13.1	1990	16.4	2560	21.2	3010	24.9	3500	28.9
MFJD	515	256	1590	3.09	2370	4.6	2900	5.6	3600	7.0	4140	8.0	4680	9.1
NFJD	2520	1293	8580	3.40	13500	5.4	17300	6.9	22600	9.0	27100	10.8	31900	12.7
Wall /l	200	80	865	4.33	1334	6.7	1670	8.4	2419	12.1	2453	12.3	2800	14.0

1/ Mean Annual Discharge estimated from unit runoff (cfsm, cubic feet per second er square mile) from nearby gages verified from rainfall- runoff equation (Farnes).

2/ Camas gage above Ukiah, MFJD = Middle Fork John Day, NFJD = North Fork John Day gage at Monument.

3/ DA = Drainage Area in square miles.

4/ QA = Mean Annual discharge in cubic feet per second (cfs).

5/ Return intervals: 0.5 = 2 years, 0.2 = 5 yrs., 0.1 = 10 yrs., ... .01 = 100 yrs.

WATER QUALITY INFORMATION

One of the principal issues in the Wall watershed analysis is water quality which is not at optimum levels. Low summer flows, loss of riparian vegetation, water storage and withdrawal, and changes in channel structure cause elevated stream temperatures in many tributary streams and in main Wall Creek. High stream temperatures and low dissolved oxygen, along with channel changes have degraded the aquatic habitat and may be affecting resident and anadromous fish populations. These conditions also exist in the North Fork John Day River both above and below the confluence with Wall Creek.

Management of water quality is the state's responsibility, through the Clean Water Act (CWA). State regulations define the beneficial uses to be protected and identify numeric and narrative criteria necessary to protect these uses. Additional policies include a Memorandum of Understanding with the Forest Service which identifies the Forest Service as a "Designated Management Agency" responsible for meeting the goals and objectives of the CWA on Forest Service lands. The responsible state water quality management agency, Oregon Department of Environmental Quality (DEQ), also prepares periodic assessments of the status of water bodies in the state. The 1988 Oregon Statewide Assessment of Nonpoint Sources (NPS) of Water Pollution began a process for identifying categories of pollutants, the current status of water bodies, and developed a process for identifying Best Management Practices (BMP's) for contol of NPS pollution. DEQ is currently preparing a list of Water Quality Limited streams; those that do not meet current water quality standard, with emphasis on the water temperature standard.

Designated beneficial uses in Wall Creek include private domestic water supply, irrigation, livestock watering, anadromous fish passage, salmonid fish rearing, salmonid fish spawning, resident fish and aquatic life, wildlife and hunting, fishing, and aesthetic quality.

Water quality criteria include numerical values for temperature, turbidity, pH, dissolved oxygen, and bacteria. Narrative standards prohibit the presence of "deleterious materials" in amounts harmful to uses.

The 1988 Statewide assessment identified Wilson Creek, Big Wall Creek, and Little Wall Creek as having severe water quality problems (A1) from a variety of pollutant types including low dissolved oxygen, nutrients, and low flow. Beneficial uses affected included cold water fish, wildlife, stockwatering, irrigation, and aesthetics. Probable causes included riparian disturbance, erosion, changes in flow, loss of thermal cover, and withdrawals (DEQ, 1988).

Forest Service monitoring of water temperatures in the Wall Creek watershed began in 1989 (Figure 4). Monitoring consistently shows water temperature problems on most of the major tributaries in the watershed (Table 5). Summer water temperatures do not meet current basin standards (68°F) on main Wall Creek, Wilson Creek, Little Wall Creek, and Swale Creek. Skookum Creek and Wilson above Bull Prairie Lake are the only major streams that meet the basin standard. Alder Creek and upper Wilson meet the proposed standard of 64°F.

A "vulnerability assessment" identifies waterbodies that are vulnerable, or have the potential for adverse response to disturbance activities, where adverse response is defined as exceedance of water quality criteria (USDA, 1995). Under this definition, most of Wall Creek is vulnerable. Watershed conditions that have contributed to elevated stream temperatures include: removal of streamside shade through harvest and road construction, and changes in channel structure towards wider and shallower channels through multiple sources which include livestock grazing. Inherent watershed character of low precipitation, low flows, and high evaporation rates establish a narrow "margin of safety", or higher vulnerability.

Reference conditions for stream temperatures, to determine the capability of streams in Wall Creek, are not readily available. Measurement of water temperatures were taken as part of a 1963 Oregon State Game Commission stream survey, which was conducted in mid July. Afternoon water temperatures taken at the time of the survey were as follows: lower Wall was 80°, mid Wall was 72°, Little Wilson was 60°, Wilson was 70°, Little Wall was 70°, Lovlett Creek was 60°, Skookum was 68°, and Swale was 64°. These observations indicate similar temperature distributions over a 30 year time span. A second potential source of reference for stream temperature capabilites are riparian exclosures on main Wall, lower Wilson, Little Wall, Bacon, and Swale Creeks, which were installed in the early 1990's. Recording thermographs located in the vicinity of these areas should be evaluated for trends in peak summer water temperatures in future years.

In summary, water temperatures are not meeting state water quality standards and are likely jeopordizing beneficial uses. Causes for elevated water temperatures include a harsh climate, channel conditions that expose more channel area to heating (discussed in Stream Channel section), and management activities that have reduced streamside shade and exacerbate inherent conditions. Most of the streams in Wall Creek are vulnerable to climatic conditions of drought, the lingering effects of severe

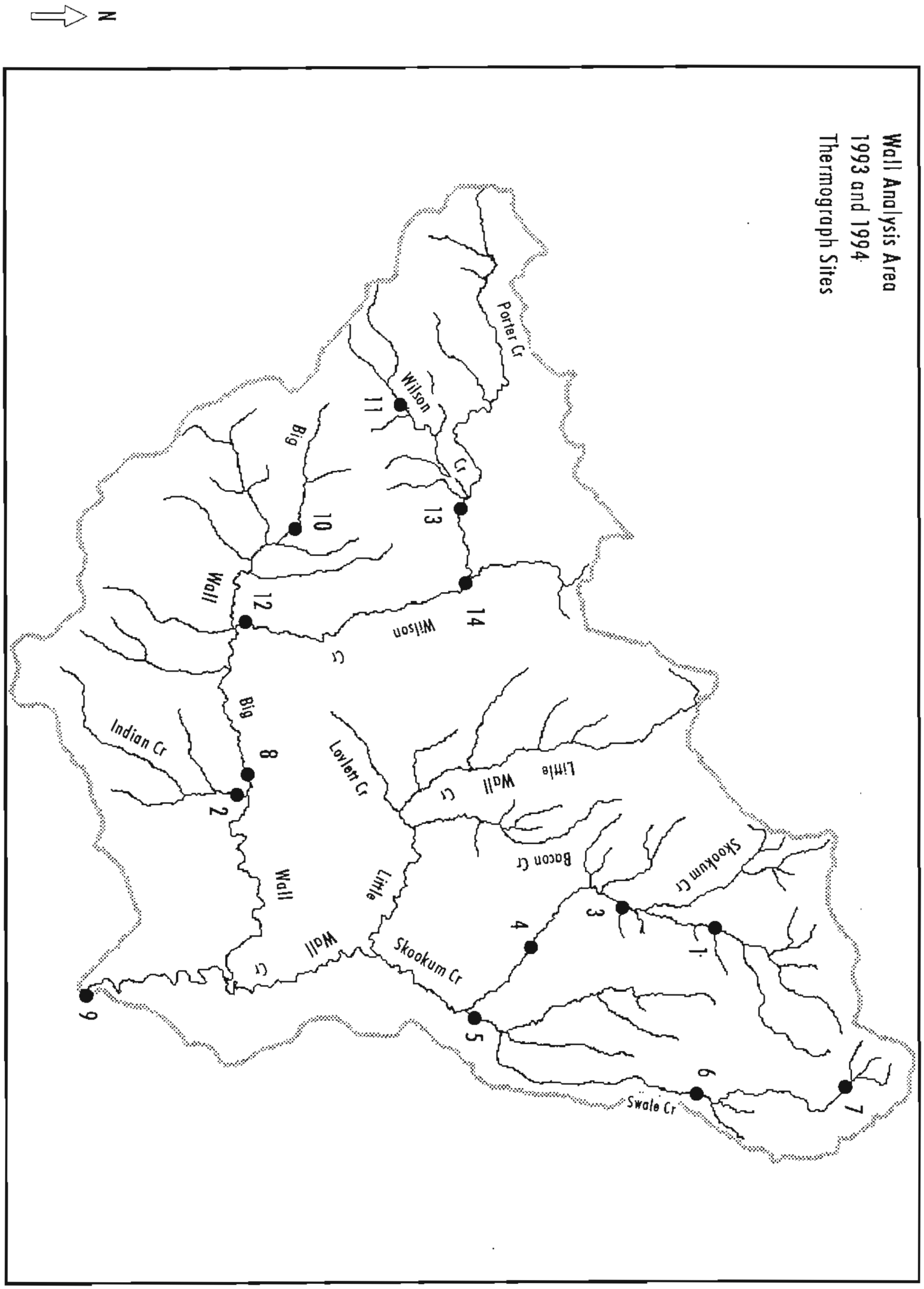

N
Wall Analysis Area
1993 and 1994
Thermograph Sites
Porter Cr
Wilson Cr
Big Wall Cr
Wilson Cr
Indian Cr
Lovlett Cr
Little Wall Cr
Bacon Cr
Skookum Cr
Skookum Cr
Little Wall Cr
Swale Cr
1
2
3
4
5
6
7
8
9
10
11
12
13
14

FIGURE 4.

Station #	Station name	Huc #	5th	Legal	7daymax93	7daymax94	Elevation
1	Alder Cr	17070202	26	T06S R27E S02 SWSE	61.0	66.5	4020
2	Indian Cr lower	17070202	24	T07S R27E S33 NWNE		72.0	2760
3	Skookum Cr below Alder	17070202	26	T06S R27E S14 SENW	64.0	69.9	3580
4	Skookum Cr lower reach	17070202	26	T06S R27E S25 NESW	67.9		3080
5	Swale Cr above Skookum	17070202	26	T06S R28E S31 SWSE		69.8	3040
6	Swale Cr middle reach	17070202	26	T06S R28E S09 NWNW	75.1	84.2	4280
7	Swale Cr upper reach	17070202	26	T05S R28E S30 NWNE	68.6		4710
8	Wall Cr @ Forest Bndry	17070202	24	T07S R27E S29 SESE	75.9	80.4	2680
9	Wall Cr above NFJD River	17070202	23	T08S R28E S18 NENE	83.4	77.6	2060
10	Wall Cr upper reach	17070202	24	T07S R26E S21 NESE	68.1	69.1	3400
11	Wilson Cr above Bull Prairie	17070202	24	T07S R25E S12 SESW	63.4	64.6	4450
12	Wilson Cr above Wall Cr	17070202	24	T07S R26E S25 SWSW	73.7	80.0	3040
13	Wilson Cr below Bull Prairie	17070202	24	T07S R26E S07 SWNE	73.1	75.8	4000
14	Wilson Cr middle reach	17070202	24	T07S R26E S02 NWNW	70.3		3600

flood events, and the continual, chronic effects of streamside roads, livestock grazing, and early seral riparian vegetation.

As part of CWA requirements, once streams are identified as Water Quality limited (on the 303(d) list), a process of prioritization begins for developing basin recovery plans. It is no longer suffucient to maintain current conditions. To meet the restoration goals of the CWA, additional steps must be taken. A restoration plan should be developed that identifies specific actions and timelines for achieving water quality objectives.

WATER RIGHTS

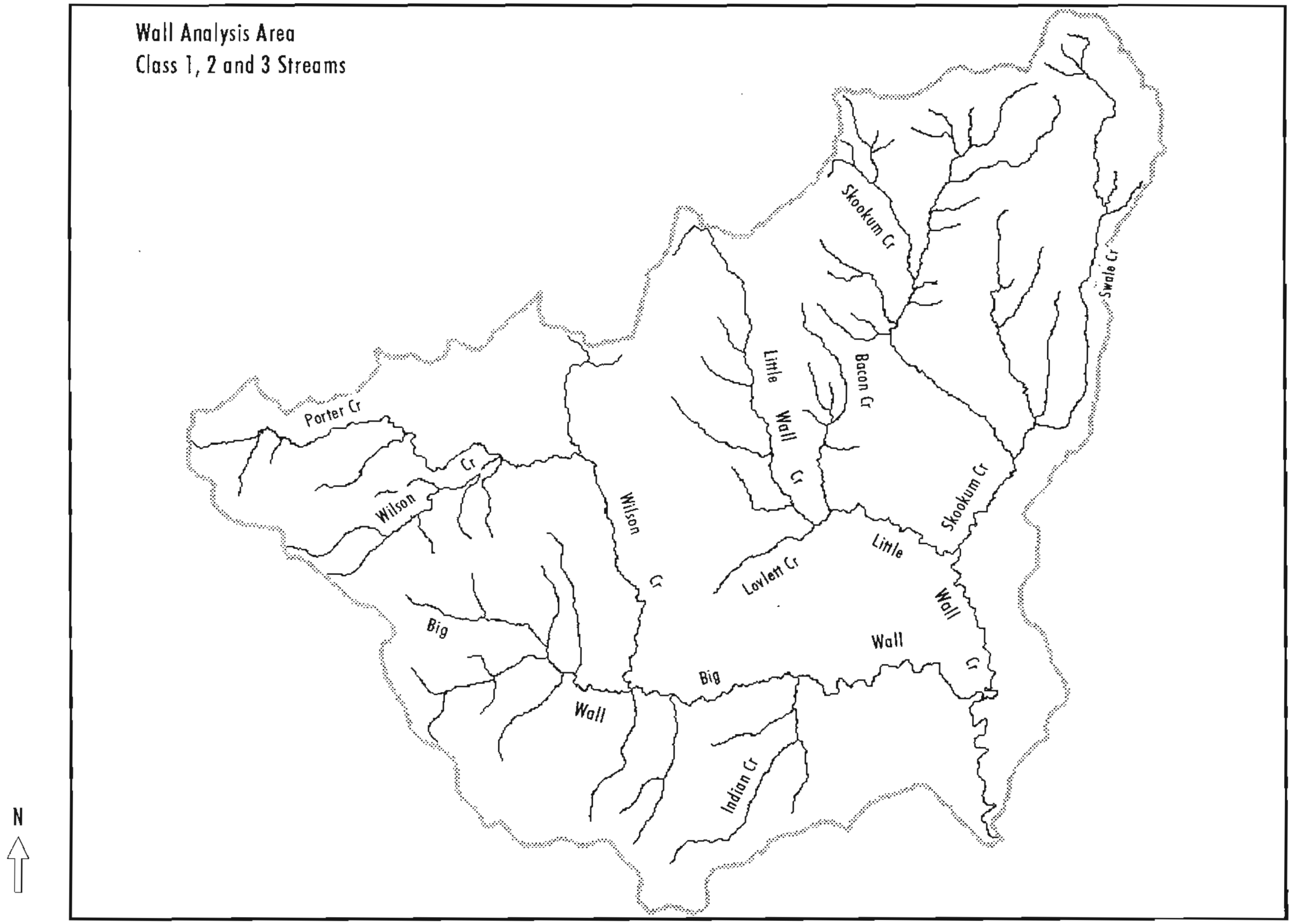
Water rights for irrigation, livestock watering, fish and wildlife, residential, and storage rights are held by private individuals, the state, and the federal government in the Wall Creek watershed. As of 1986, a total of 17.3 cfs (does not include storage) of the flow of Wall Creek has been appropriated (OWRD, 1986). This represents approximately 22 percent of the average discharge of Wall Creek (estimated at 80 cfs). Irrigation withdrawals generally occur in the summer months, however, when streamflows are below average, so that the proportion of the flow that may be withdrawn for out-of stream uses is much higher.

The protection of beneficial uses can present conflict; while protecting one beneficial use another may be adversely affected, which is often the case with consumptive and instream water uses. In Wall Creek, fish and wildlife are alloted 2.0 cfs of the flow, which represents 2.5 percent of the average annual flow, while irrigation water rights at 15.2 cfs account for 19 percent of the average annual flow. For a low flow estimate of 5 cfs, the entire flow of the river could be withdrawn for irrigation. A second conflict arises with water storage for livestock watering. There are many permitted ponds and reservoirs in the Wall watershed. On the National Forest, there are 200 developed ponds and reservoirs used for watering livestock in the summer months. These sites are likely to be contributing to elevated water temperatures by exposing more surface area to the sun. Evaporation and seepage losses may also be reducing low flows although rate estimates are needed to determine the importance of this process.

STREAM NETWORK

Accurate maps of stream networks are needed for watershed assessment and resource planning. The stream network is the transportation and routing system for the watershed. Runoff, sediment, chemicals, heat, and vegetation collected by the tributaries, are transported downstream into the main channel for delivery at the outlet to the NFJD river. The path is not continuous in space or time, for example, sediment is deposited

FIGURE 5.


Wall Analysis Area
Class 1, 2 and 3 Streams
Porter Cr
Wilson Cr
Wilson Cr
Big Wall
Big Wall Cr
Little Wall Cr
Bacon Cr
Skookum Cr
Skookum Cr
Swale Cr
Little Wall Cr
Lovlett Cr
Indian Cr
N

in channel banks and behind obstructions and may not be remobilized for several years, or until a flow event of great enough magnitude. And, the intermittent part of the stream system expands and contracts seasonally and year to year in response to variable climate and watershed conditions. The pattern and extent of the stream network provide insight into watershed function.

An evaluation of existing Forest databases for mapped streams shows the following distribution of stream miles by stream class for Wall Creek as compared to Forest averages (Figure 5, Table 6). Intermittent streams, not shown on the map, account for 75 percent of the total miles of stream in the Wall watershed, higher than National Forest averages. Field verification of intermittent channels showed more miles of stream in the field compared to Forest databases, and changes in the location of many intermittent segments. Intermittent streams have important on-site values including riparian vegetation that provides habitat for a variety of birds and mammals, a moderating influence on local climate, and buffering of high flows.

TABLE 6
Stream Miles by Class - Wall Creek compared to National Forest

	WALL CREEK		UMATILLA FOREST	
Class	Miles	Percent	Miles	Percent
I	96.3	12.9	1037.3	10.5
II	10.5	1.4	405.3	4.1
III	76.9	10.3	2382.4	24.2
IV	564.2[1]	75.4	6040.0	61.2
	747.9	100.0	9865.0	100.0

1 Corrected intermittent miles from field sampling

Total miles of stream and estimated acres in Riparian Habitat Conservation Areas (RHCA), excluding bogs, seeps, and springs, are reasonable estimates for planning purposes. Assuming average widths for stream classes, approximately 14 percent of the Wall watershed should be managed in RHCA's. However, the variability in accuracy of Forest GIS stream maps is a caution to project teams; time should be allowed to inventory planning areas to determine actual distribution and condition of intermittent streams. A detailed report "Verifying Intermittent Channels" is included as an attachment.

STREAM TYPES AND RIPARIAN AREAS

Classification systems organize objects into groups based on similarities or relationships. Two such classification systems are available and should be used in comprehensive assessments of Forest stream-riparian systems. Such an assessment was not completed as part of this analysis. Rosgen's stream classification system is useful for describing stream channel form and predicting response (Rosgen, 1994), and the draft Mid-Montane Wetlands Classification of the Blue Mountain Forests (Crowe and Clausnitzer, in draft) is available for classifying vegetation community types and associations. The wetlands system incorporates aspects of the physical environment such as elevation, valley type, gradient, soils, and Rosgen stream class.

At the broad level, stream types can be broken out by the longitudinal profile of the stream, and the valley form. Stream profiles for Wall Creek and its tributaries are straight (eg. Wilson), convex (eg. Little Wall), and stepped (all). The shape of the profile reflects geologic control, with layers of interbedded basalt having different erosion rates. Valley forms are generally V-shaped or trough, and narrow (<200' wide).

Common stream types in Wall are associated with landscape position, in the upper watershed, the gentle terrain of Porter Creek, Upper Wilson, and upper Swale, stream types include C, E, and B. In headwater areas, geologic breaks, and in steep tributaries to the canyon streams, are A and B-type channels (lower Porter, Indian Creek, lower Little Wall, lower Skookum, and lower Swale). Some reaches are entrenched, G-type channels, with small terraces evident (lower Wilson). And a few low gradient meadows have reaches of E-type channel (upper Swale).

Many miles of Wall Creek and its tributaries are not in optimum condition. Unstable banks, incised channels, long continuous high-gradient reaches, are common features. A variety of factors have contributed to channel disturbance, including past flooding, roads within floodplains, livestock grazing, and riparian harvest. These are the same factors contributing to water quality degradation. The physical channel system is clearly linked to water quality and to riparian function. Stream types vary in their sensitivity to disturbance and in their recovery potential (Rosgen, 1994). Riparian vegetation also varies by site conditions. This knowledge can contribute to a restoration strategy that prioritizes streams for restoration activities, identifies reasonable timeframes for response, and identifies appropriate species for replanting.

Reference areas for desired channel conditions are rare in the Wall watershed, however, several streams within Wall could serve as benchmarks for comparison as follows: for smaller north-aspect tributaries, Little Wilson Creek; for high elevation, south aspect streams, upper Swale Creek; and, for mid-basin south aspect streams, lower Skookum. These streams possess attributes such as cooler water, narrower channel form, and riparian vegetation that may be used in development of site-specific riparian management objectives, monitoring response and recovery, and design of restoration projects.

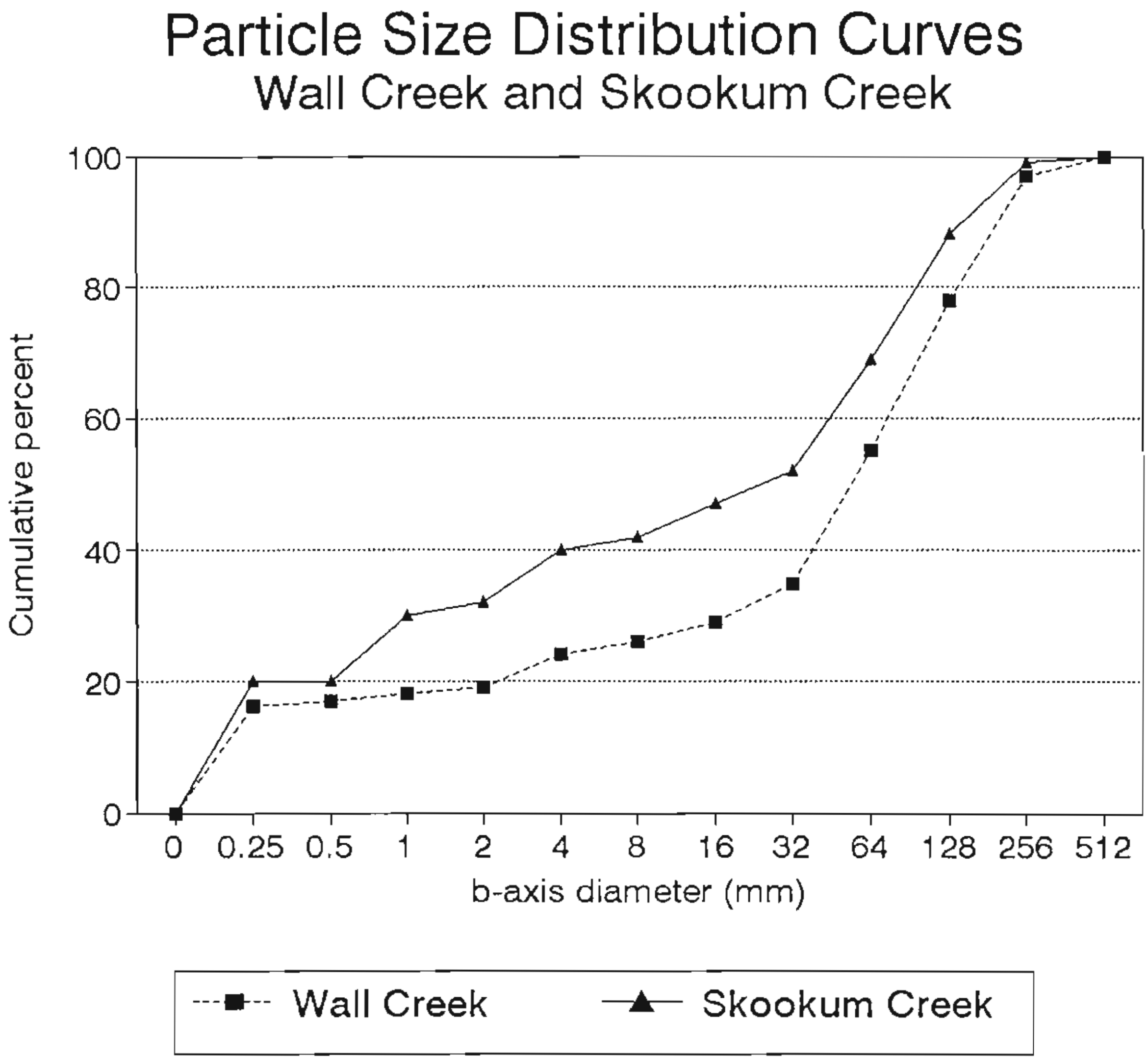
Two long term channel reference reaches were established on Wall Creek at the Forest boundary, and Skookum Creek at the Forest boundary, for intensive monitoring of channel conditions and response. Briefly, these channels exibit contrasting characteristics, in part due to past disturbances. Both are relatively low gradient channels but Wall Creek is wider and shallower and has a coarser bedload, compared to Skookum Creek. Contributing factors include valley bottom roads and livestock grazing in Wall Creek, where Skookum has no valley bottom road and is more inaccessable to livestock. The condition of riparian vegetation is another key to channel conditions; both streams have Torrent sedge (*Carex nudata*) within the active channel but in Wall Creek the coverage is far less than in Skookum. The sedges' physical function is to retard high flows, trap fines, and build the floodplain. The distribution of particle sizes in these two streams further illustrates the important role this riparian species plays in channel function (Figure 6). This knowledge will be critical for the development of appropriate riparian restoration projects.

See the Fisheries discussion for more information on physical aquatic habitat, and the Botanical discussion for information on riparian vegetation and restoration.

DISTURBANCE PROCESSES

A variety of disturbance processes influence the character and response of Wall Creek. The dominant disturbance processes are: the occurence or absence of fire, past floods and current vulnerability to flooding, and the magnitude and extent of erosion. Fire history and current conditions are described elsewhere. Flood histories have not been reconstructed, however the role of past flooding was briefly described. It is likely, given current conditions in the watershed, that channels are more vulnerable to peak flow events. The dominant erosional process in the watershed is surface erosion. Mass erosion is a minor process though occasion slumps do occur in the watershed. Channel bank erosion rates are generally high, accelerated by loss of vegetation, road locations, and trampling from grazing. Other disturbance processes include the work of beaver and possible effects of extirpation, effects of big game, and windthrow. These processes have more locally variable effects on watershed condition and were not investigated in any depth.

FIGURE 6.



Particle Size Distribution Curves
Wall Creek and Skookum Creek
100
80
60
40
20
0
Cumulative percent
0
0.25
0.5
1
2
4
8
16
32
64
128
256
512
b-axis diameter (mm)
Wall Creek
Skookum Creek

WATERSHED CONDITION ASSESSMENT

Evaluation of watershed condition is part of the integrated Wall Ecosystem Analysis. This report identifies key processes and functions related to water quality and aquatic habitat, and provides background information that is part of the overall assessment. Key indicators for watershed condition include stream and road densities, Equivalent Clearcut Acres, and maximum summer water temperatures.

Stream systems were previously described. Generally, stream densities are lower than the average for the Forest, reflecting a more arid climate. Road densities are generally high, in many cases at or nearly at a one to one ratio with streams (Table 7). The effects of high road densities are described elsewhere (see Fisheries report). Subwatersheds with a high road:stream ratio (>=0.90) are: 24B, 24D, 24E, 25B, and 26B.

Equivalent clearcut acres (ECA) were calculated for the 16 Wall Creek subwatersheds as part of assessing watershed condition (Table 8). The ECA method was adapted for the Umatilla National Forest and uses local recovery curves (Ager, 1991). ECA is an indicator of cumulative hydrologic effects of timber harvest. Hydrologic effects from timber harvest are likely in the Wall watershed which has a transient snow zone between approximately 3000 and 5000 feet. Mid winter rain-on-snow and spring rain-on melting-snow are both peak flow mechanisms in the watershed.

Overall, calculated ECA/Roads (percent of forested, National Forest land) were relatively low but so was confidence in the absolute numbers, given the quality of data (over 60 percent of the harvest acres were missing prescription data for the years 1969 to present). As such, the values should be used only for relative comparison and ranking. Subwatershed with the highest values (greater than 10 percent) were: 24D, 24G, 25B, and 26D.

Mortality of trees can also affect peak streamflow. Maps of dead and dying trees show high mortality in the Swale subwatershed (26D) which also has high ECA/Roads (Figure 7). The combination of these facors could lead to higher peak flows and channel response downstream.

Stream temperatures at the outlets of subwatersheds reflect the cumulative effects of timber harvest, roads, and livestock grazing, previously discussed. All but two subwatersheds have documented high water temperatures. For purposes of a watershed condition assessment, 23C, 24A, 24E, 24F, and 26D, have peak summer water temperatures over 70°F, indicative of extreme conditions for aquatic life.

TABLE 7. Streams and Roads in the Wall Watershed

SWS	Area (mi^2)	Stream Miles	Density[a]	Road Miles	Density	Ratio[b]
23C	7.7	32.2	4.2	*	*	*
24A	21.3	63.1	3.0	19.9	.9	0.32
24B	11.5	48.4	4.2	43.9	3.8	0.91
24C	12.8	60.0	4.7	47.9	3.7	0.80
24D	14.0	44.1	3.2	44.2	3.1	1.00
24E	14.6	52.1	3.6	50.8	3.5	0.98
24F	12.9	52.7	4.1	37.0	2.9	0.70
24G	10.2	44.5	4.4	33.9	3.3	0.76
25A	21.3	64.3	3.0	42.6	2.0	0.66
25B	13.9	49.5	3.6	47.8	3.4	0.97
25C	6.4	28.0	4.4	21.0	3.3	0.75
26A	14.1	59.5	4.2	26.7	1.9	0.45
26B	8.4	37.5	4.5	33.8	4.0	0.90
26C	13.7	53.0	3.9	28.7	2.1	0.54
26D	12.1	48.0	4.0	34.0	2.8	0.71
26F	5.2	25.5	4.9	14.1	2.7	0.55

a miles per square mile b roads:streams * missing data

In sum, many subwatersheds in Wall Creek have sustained moderate to severe impacts to watershed function. The impacts are across the landscape from the uplands, to midslopes, to valley bottoms. Effects include altered rates of interception, evapotranspiration, infiltration, and runoff rates. Although many changes were not quantified, the evidence is substantial. Overall, the present conditions of streams and riparian areas in Wall Creek reflect climatic and geologic controls and the history of landuse.

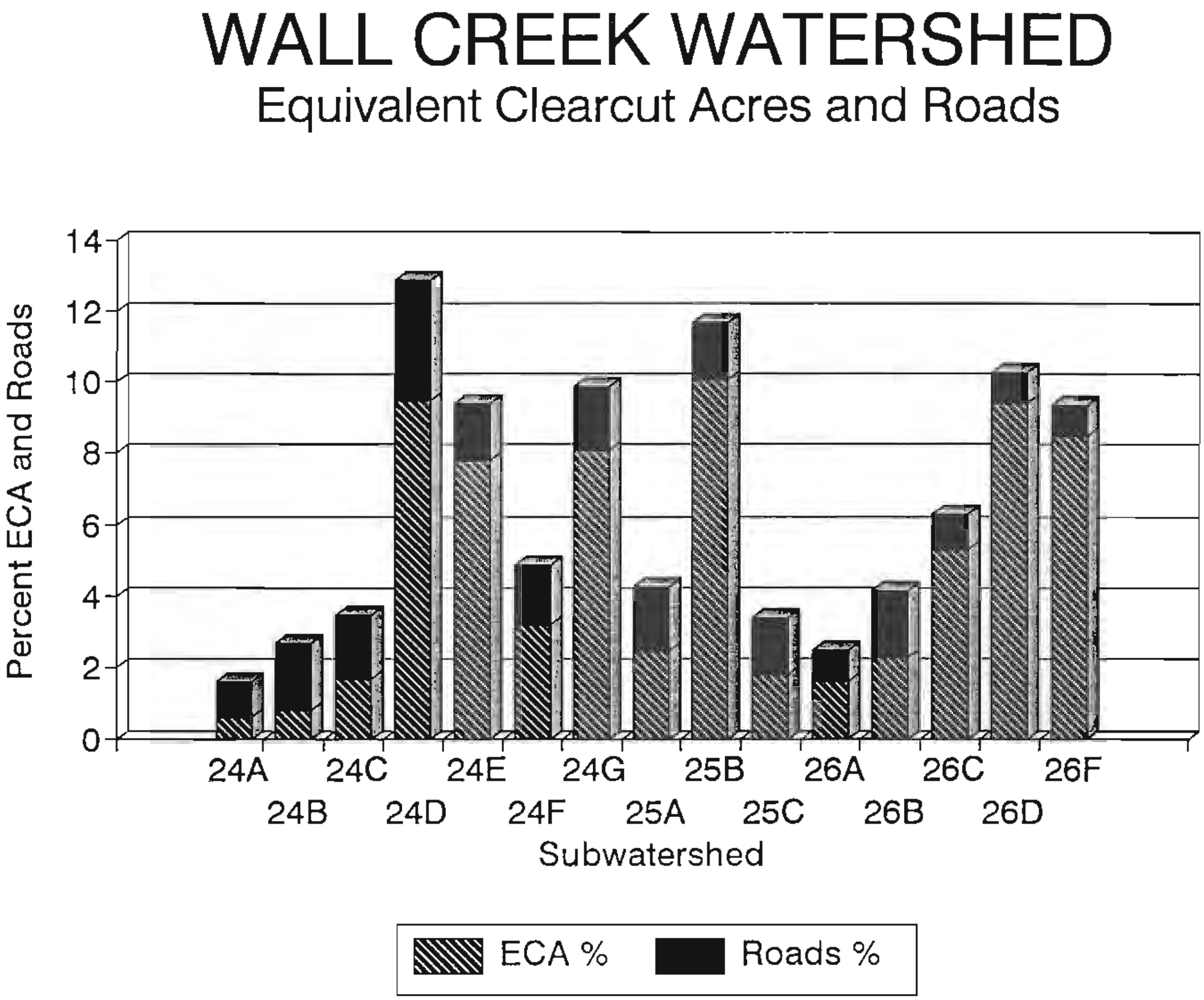
REFERENCE CONDITIONS

Reference areas, for water temperature and channel conditions, are not readily available. Prior surveys conducted by the Forest Service (1989 to present) and Oregon State Game Commission (1963) provide benchmarks of conditions at the time of the survey. Repeating these surveys with comparable methodologies could allow for estimation of system adjustment and response over time. Analogous areas for comparison are rare, though several candidate reference streams were previously identified. Stream channel reference reaches were established on two streams in 1995; Wall Creek at the Forest boundary,

TABLE 8.

Subwatershed	Watershed Acres	National Forest Acres	Forested NF Acres	1995 ECA	ECA Percent	Road Acres	Road Percent	Combined Percent
23C	4889	0	0	0	0	0	0	0
24A	13644	5988	5048	29	1	60	1	2
24B	7366	7082	6893	58	1	132	2	3
24C	8186	8186	7803	132	2	144	2	4
24D	8973	3928	3173	300	10	133	3	13
24E	9336	4439	4220	331	8	153	2	9
24F	8257	6396	4772	152	3	111	2	5
24G	6510	5695	4707	382	8	102	2	10
25A	13635	6987	6449	160	3	128	2	4
25B	8919	8746	7335	741	10	143	2	12
25C	4088	4036	3717	68	2	63	2	3
26A	9048	8612	7422	118	2	80	1	3
26B	5381	5381	4050	93	2	102	2	4
26C	8770	8770	8747	461	5	86	1	6
26D	7734	7734	6696	632	9	68	1	10
26F	3314	3119	2983	255	9	28	1	9

FIGURE 7.



WALL CREEK WATERSHED
Equivalent Clearcut Acres and Roads
Percent ECA and Roads
0
2
4
6
8
10
12
14
24A
24B
24C
24D
24E
24F
24G
25A
25B
25C
26A
26B
26C
26D
26F
Subwatershed
ECA %
Roads %

considered to be in poor condition, and Skookum Creek at the Forest boundary, considered to be in good condition. Periodic resurvey of these stations, and establishing others, will allow for comparison between reaches over time. Additional reference areas include livestock exclosures constructed in the early 1990's on Bacon Creek, Little Wall, lower Wall, lower Wilson, and Wall above Wilson.

RECOMMENDATIONS FOR MANAGEMENT

Many appropriate actions for management of the Wall watershed to improve watershed conditions have and are being implemented on the National Forest. These include changes to livestock grazing allotment plans, delineating riparian buffers in timber sales, minimum standard road construction, and habitat improvement projects. These measures have and will continue to provide for improvement of conditions. Establishing the effectiveness of these and other measures, and identifying reasonable goals are still, however, important matters for investigation. Given the limits of a physical system challenged by a harsh climate, the residual effects of past management, improvement in the physical components of Wall Creek will continue to be slow. For example, stream channels respond over time frames of 100's of years, with the effects of the last major storm event, probably 1964 or 1974, still evident. Given the current status of water quality, which is defined broadly as including the chemical, physical, biological, and habitat condition of streams in the Wall watershed, additional measures to improve conditions are warranted.

Collectively, the best available technologies for control of nonpoint source pollution are called Best Management Practices, or BMP's. They are the most practical and effective means for prevention or reduction of pollution to levels compatable with water quality goals (MacDonald, 1991). These include administrative decisions, preventative measures, and restorative actions. The process is not complete until monitoring establishes BMP effectiveness. Some specific recommendations have been compiled by subwatershed and are included in the Wall Ecosystem Assessment. The strategy of the Ecosystem Assessment was to interweave issues, and prioritize recommendations by subwatershed. The following are intended to augment those recommendations.

Watershed Inventories

For non fish-bearing streams, generally Class IV streams, begin **integrated riparian-stream channel surveys** using interdisciplinary teams and existing vegetation and channel classification systems. Apply findings in project planning (silvicultural, range, fisheries, recreation, etc.) and as part of watershed restoration project design. Initiate **coordinated watershed restoration inventories** by priority watershed, to identify restoration needs and develop projects.

Monitoring

Maintain temperature recording thermographs on key tributaries in Wall Creek. Analyze years of record for variability and trend. Assess the effectiveness of livestock exclosures. Assess the effectiveness of instream structures. Develop an interdisciplinary team to write a study plan for the South End Hydro study, based on findings from the Wall Ecosystem Analysis.

Coordination

Participate in the NFJD Basin Council. Communicate the results of this analysis, and management actions that may result, internally and externally.

Restoration

Restoration planning must be placed in context of the North Fork subbasin which has high priority for restoration in the state of Oregon. Improvements in Wall Creek would be consistent within this larger framework. The Water Quality Limited status of The North Fork John Day River, and the existing condition of Wall Creek further warrants the development of a comprehensive watershed restoration plan for Wall Creek. Elements of the plan should include the following as general guidelines, following additional recommendations provided in the Wall Ecosystem analysis report.

Roads - reduce road densities in priority subwatersheds, remove streamside roads, improve crossings (armor fords or replace with bridges or culverts), "upgrade" roads for the future: move towards low maintenance roads that disperse surface flow, minimize road erosion.

Riparian areas and stream channels - maintain riparian exclosures, plant appropriate species such as Torrent sedge (*Carex nudata*) in lower Wilson Creek, lower Wall Creek, and lower Little Wall. Evaluate ponds for alternative watering systems. Evaluate Bull Prairie reservoir for alternative discharge through base outlet.

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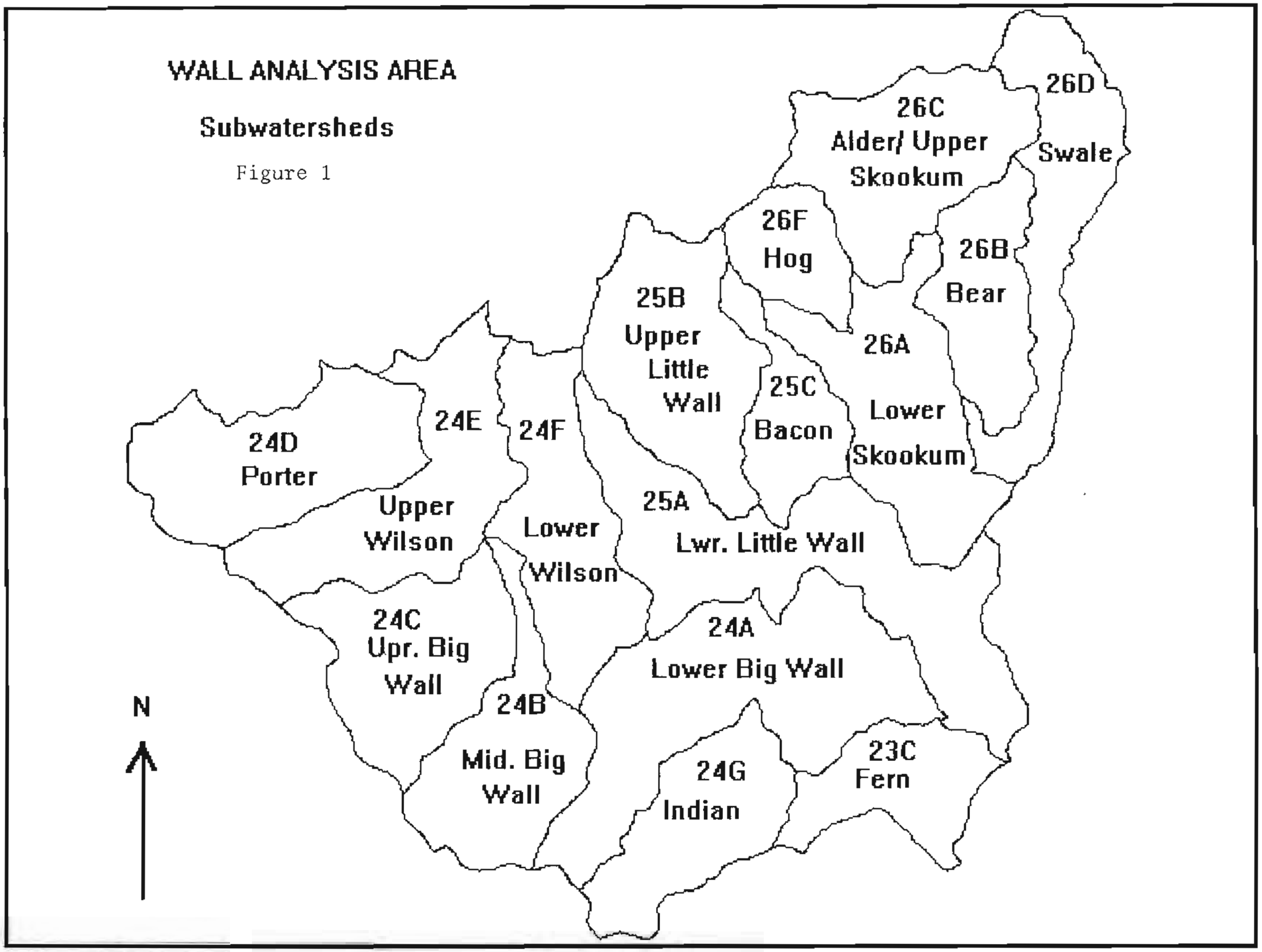
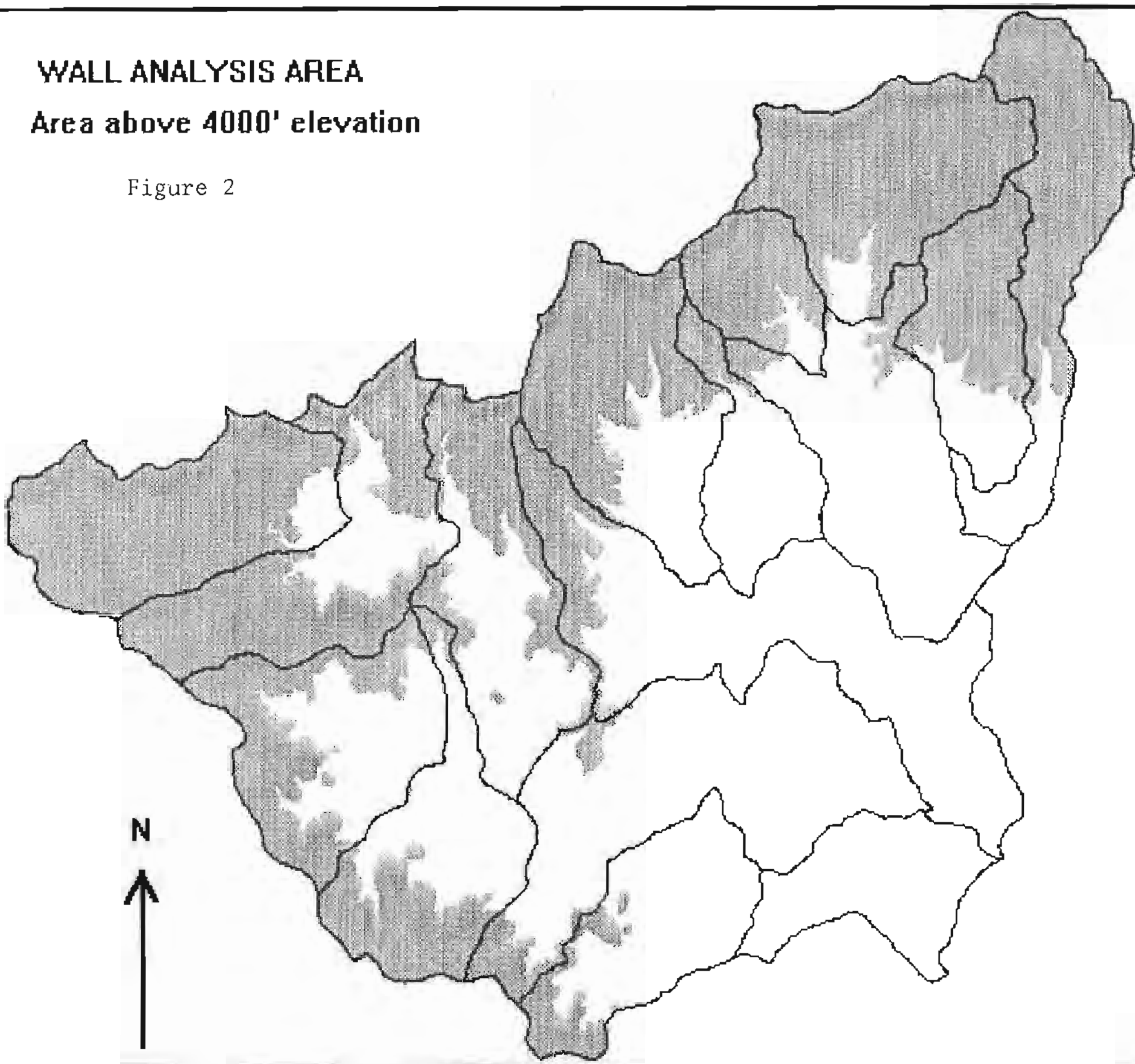

WALL ANALYSIS AREA
Subwatersheds
26C Alder/ Upper Skookum
26D Swale
26F Hog
26B Bear
25B Upper Little Wall
26A Lower Skookum
25C Bacon
24D Porter
24E
24F
Upper Wilson
Lower Wilson
25A Lwr. Little Wall
24C Upr. Big Wall
24A Lower Big Wall
24B Mid. Big Wall
24G Indian
23C Fern
N

Figure 1

WALL ANALYSIS AREA

Area above 4000' elevation

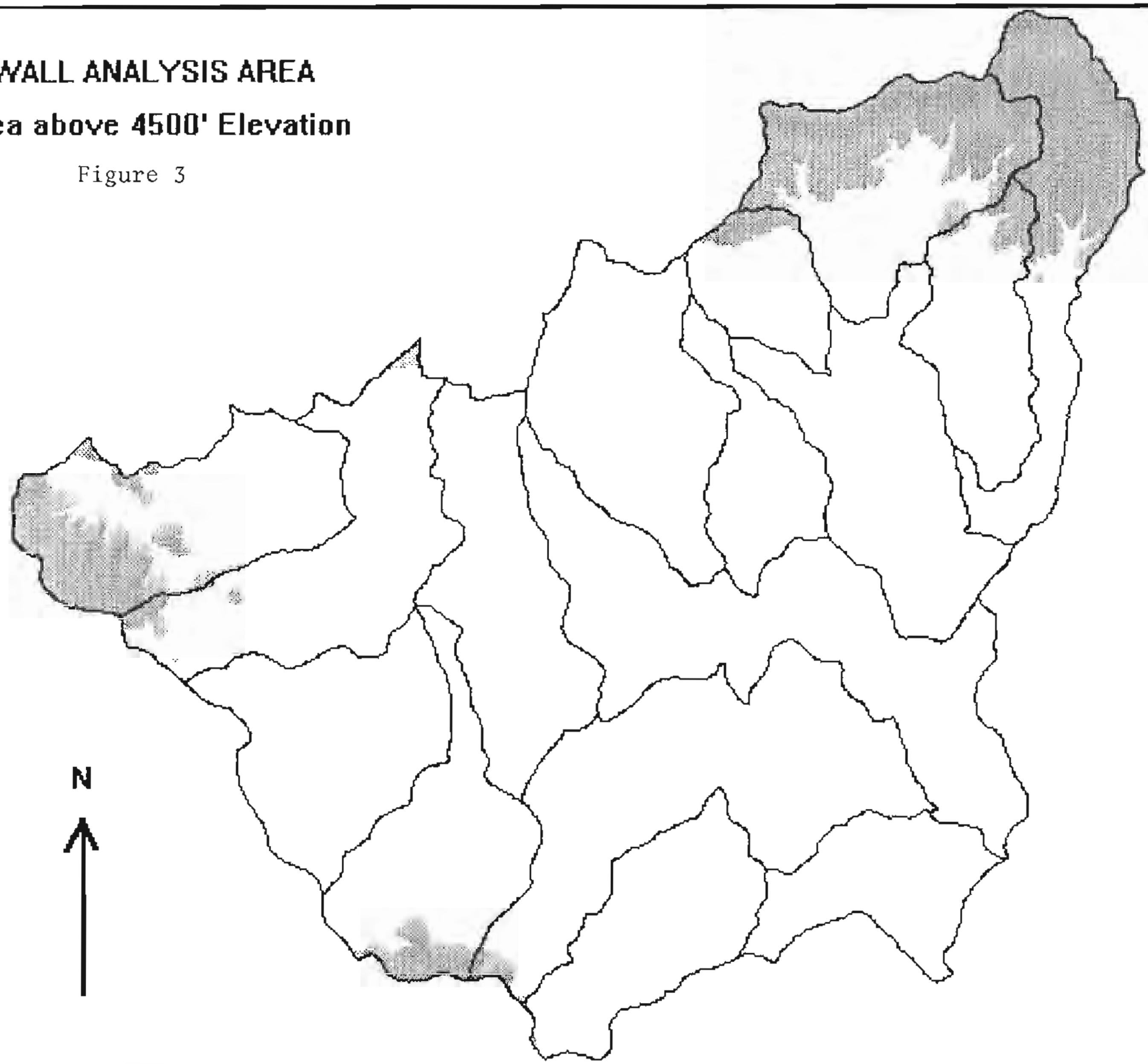
Figure 2



WALL ANALYSIS AREA

Area above 4500' Elevation

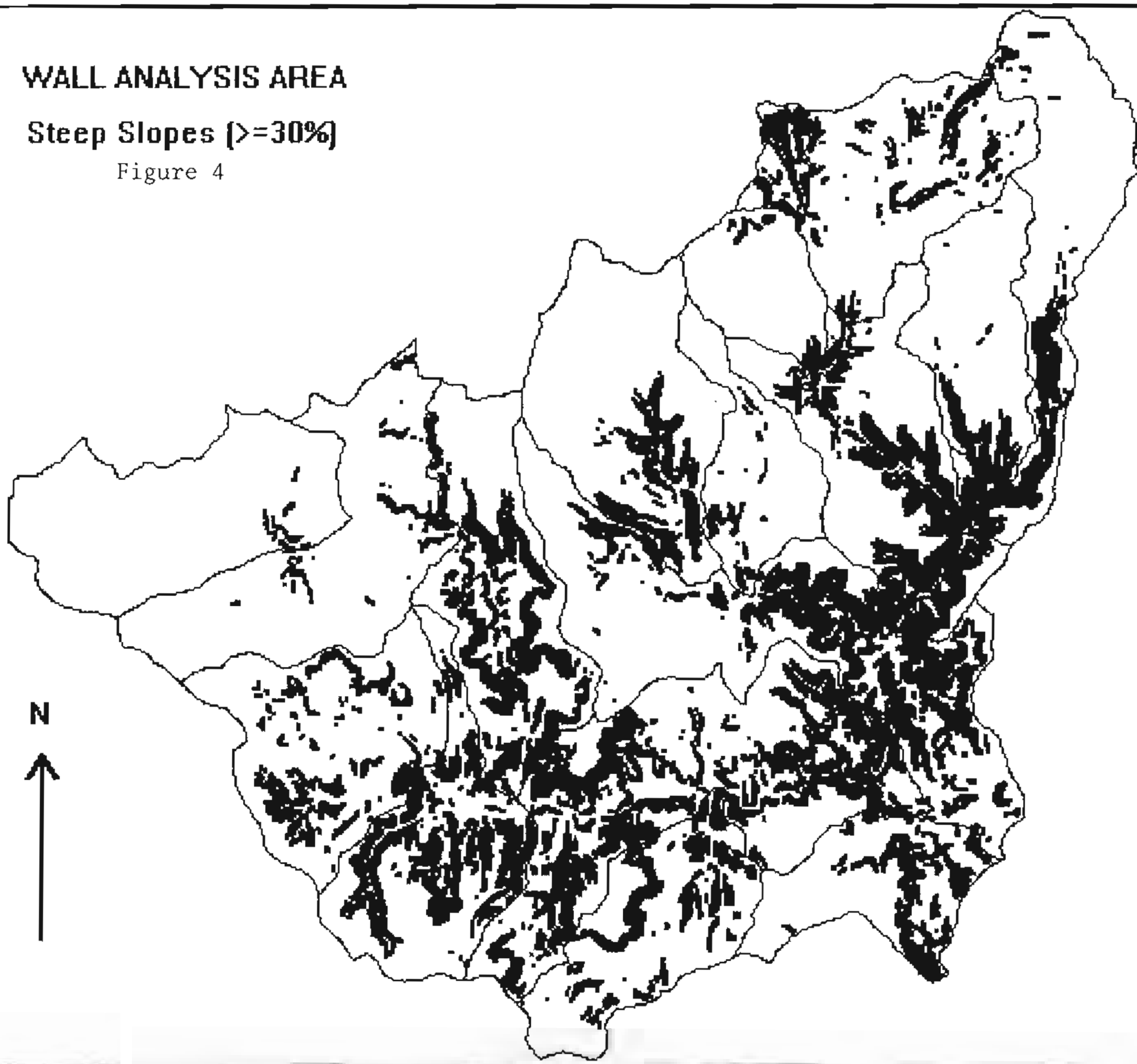
Figure 3



WALL ANALYSIS AREA

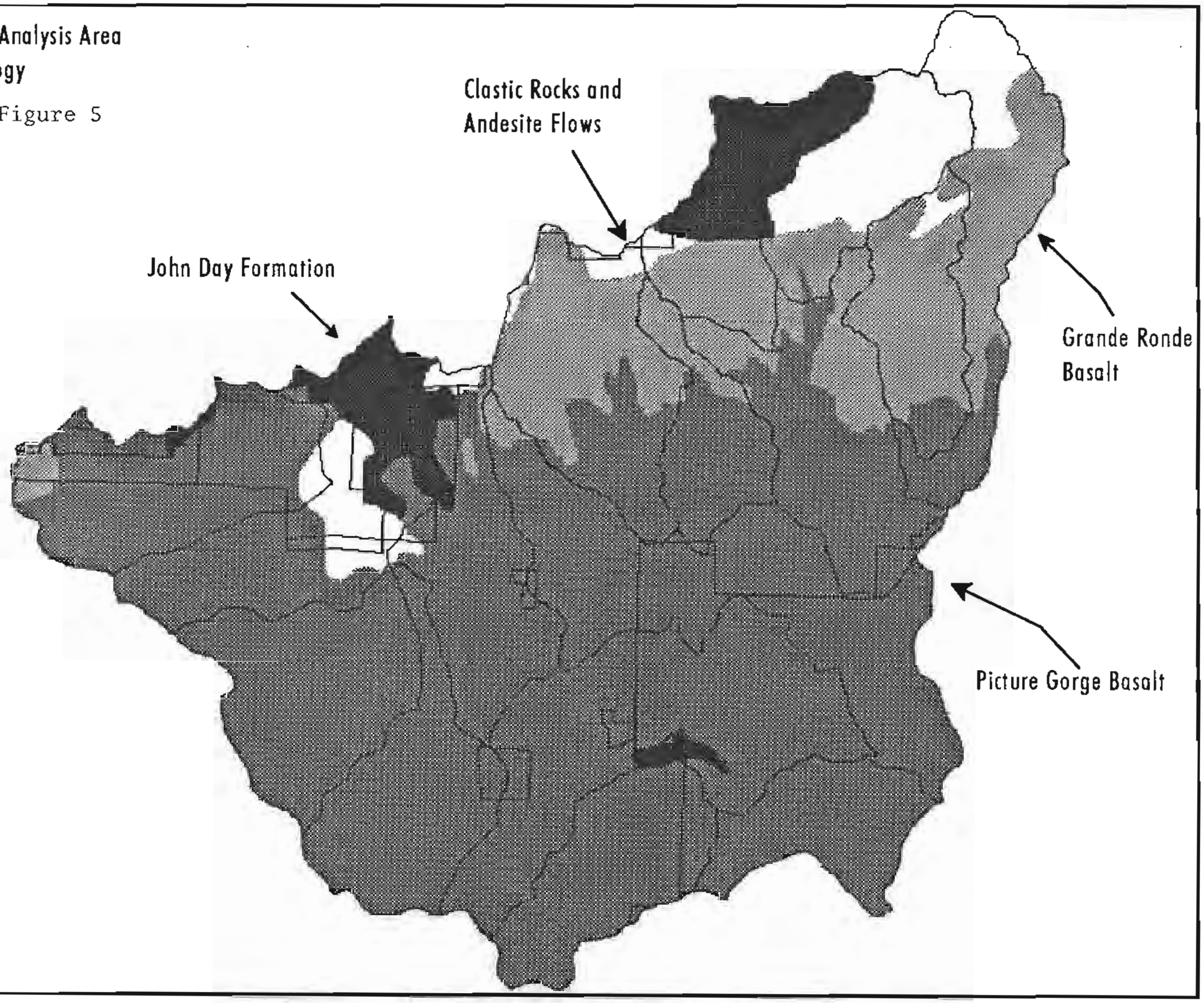
Steep Slopes (>=30%)

Figure 4



Wall Analysis Area
Geology

Figure 5

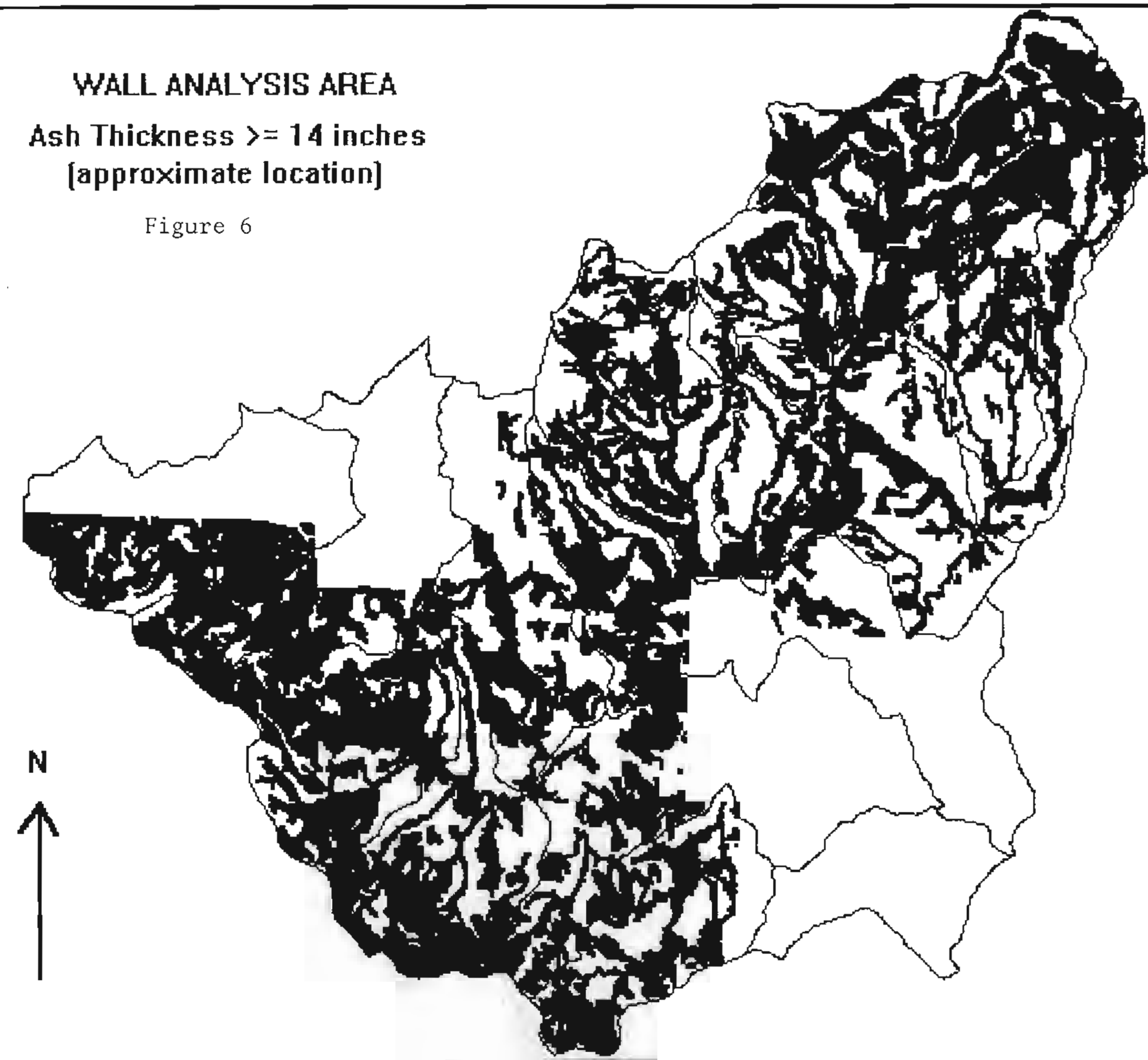


N

WALL ANALYSIS AREA

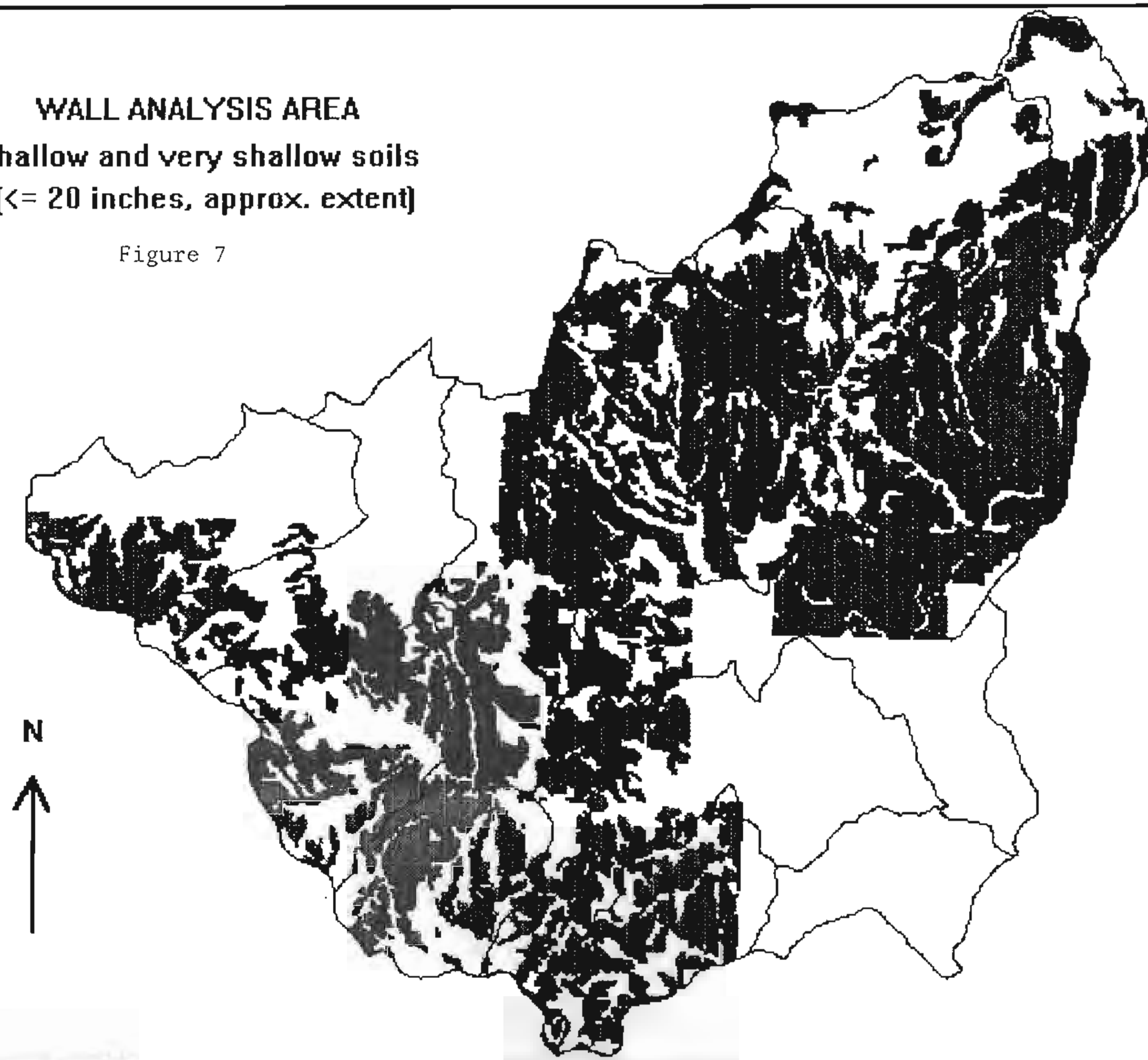
Ash Thickness >= 14 inches
(approximate location)

Figure 6



WALL ANALYSIS AREA
Shallow and very shallow soils
(<= 20 inches, approx. extent)

Figure 7



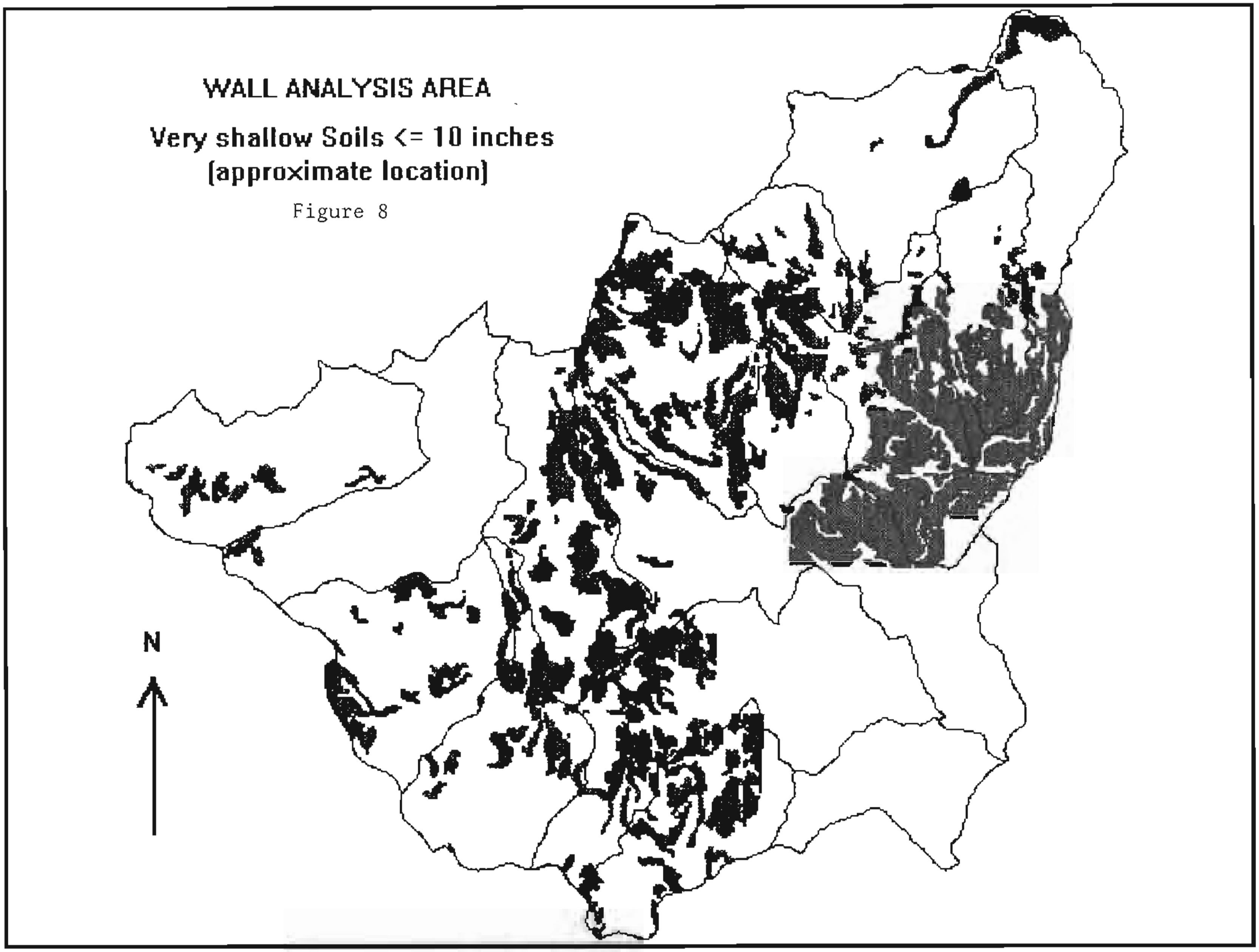
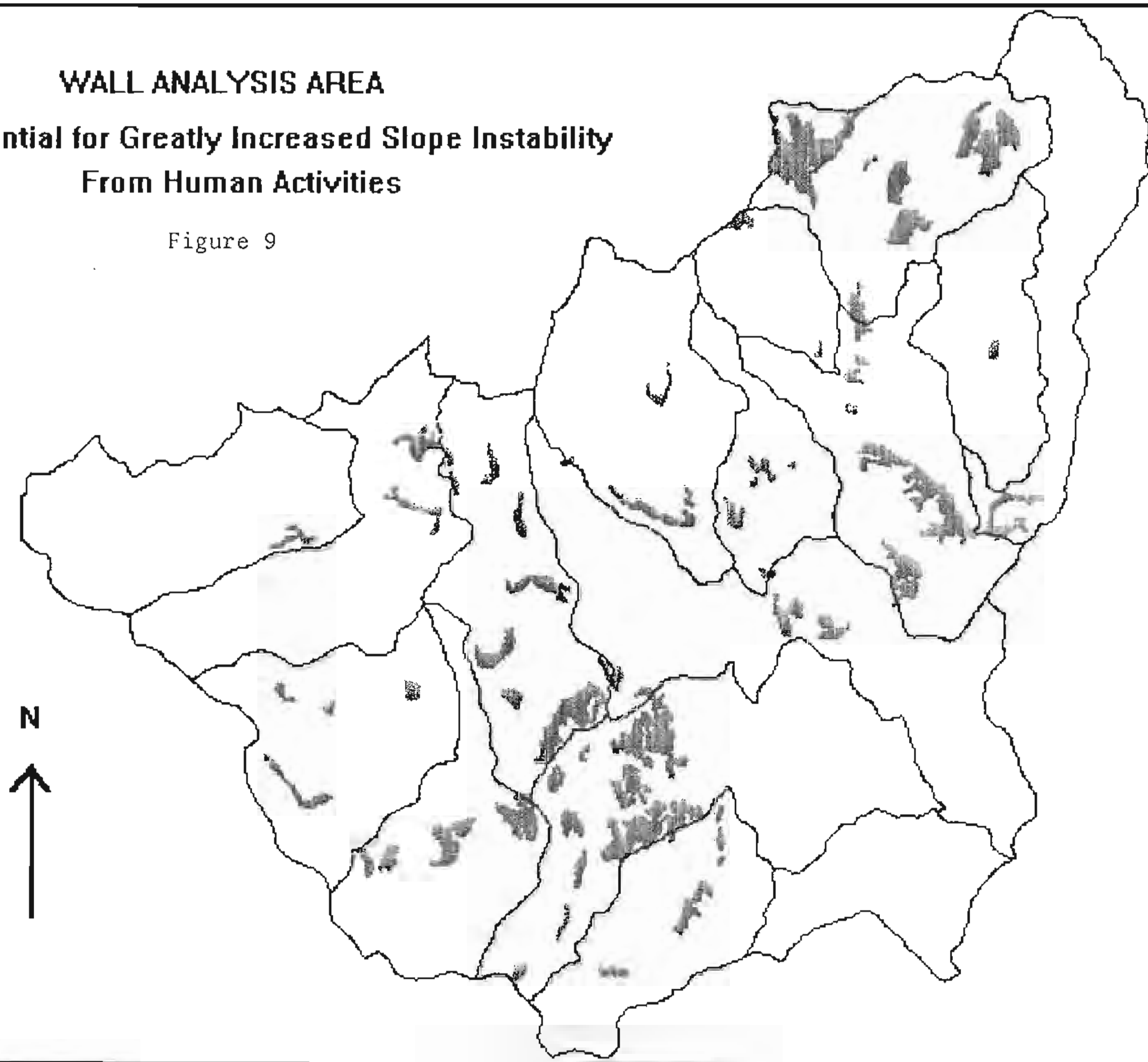

WALL ANALYSIS AREA
Very shallow Soils <= 10 inches
(approximate location)
N

Figure 8

WALL ANALYSIS AREA

Potential for Greatly Increased Slope Instability From Human Activities

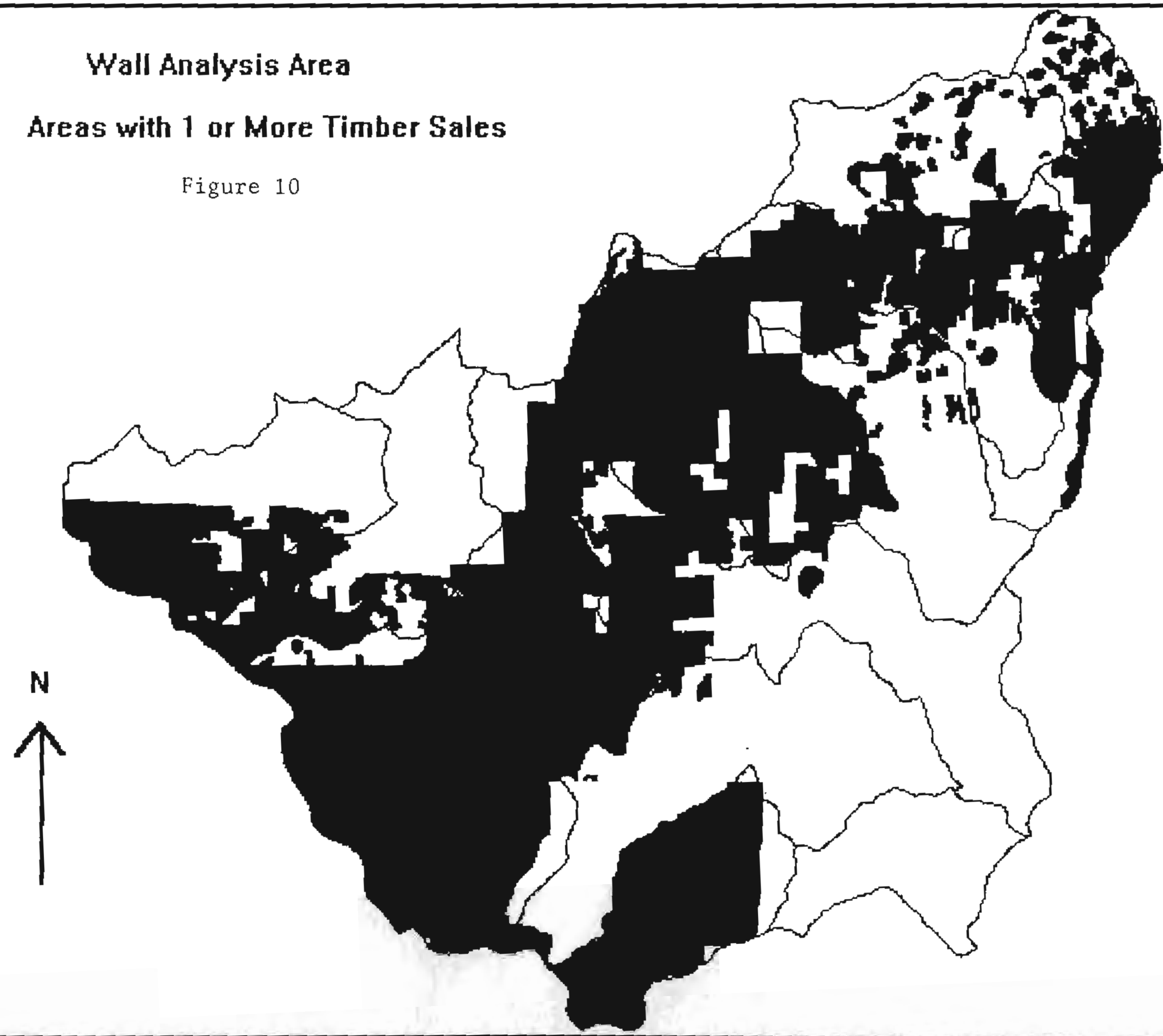
Figure 9



Wall Analysis Area

Areas with 1 or More Timber Sales

Figure 10



Wall Analysis Area

Areas with 2 or More Timber Sales

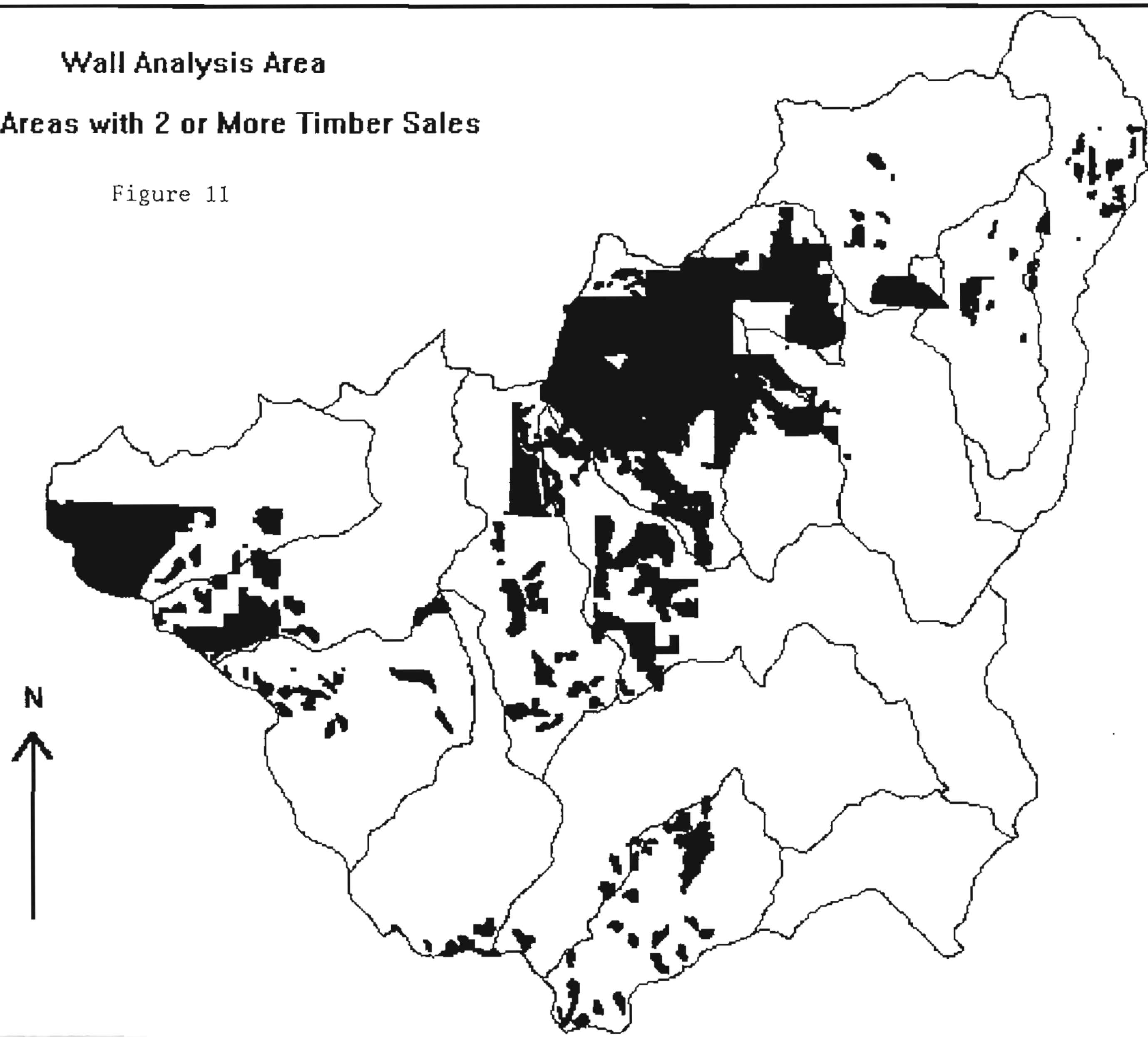
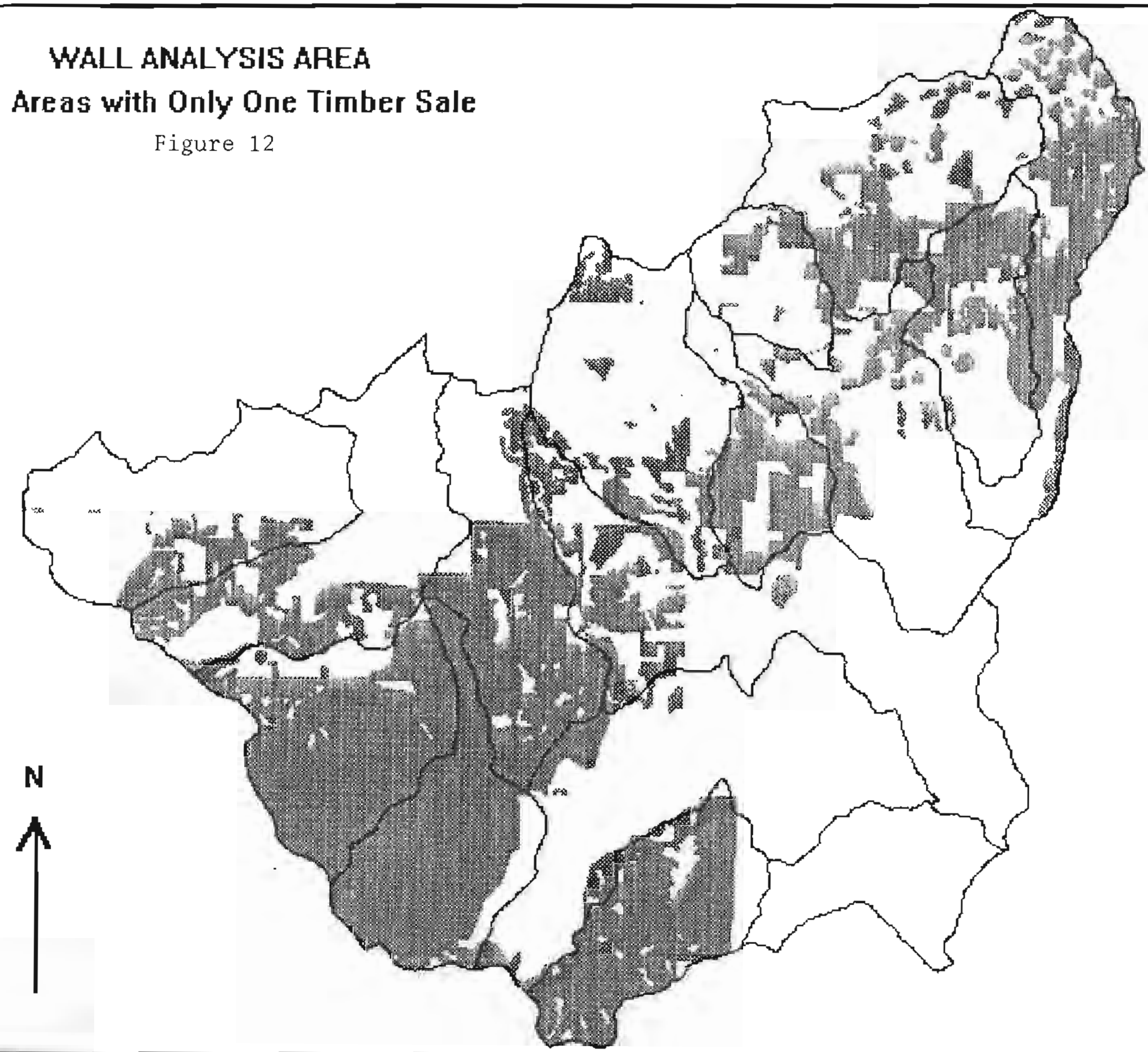


Figure 11

WALL ANALYSIS AREA
Areas with Only One Timber Sale

Figure 12



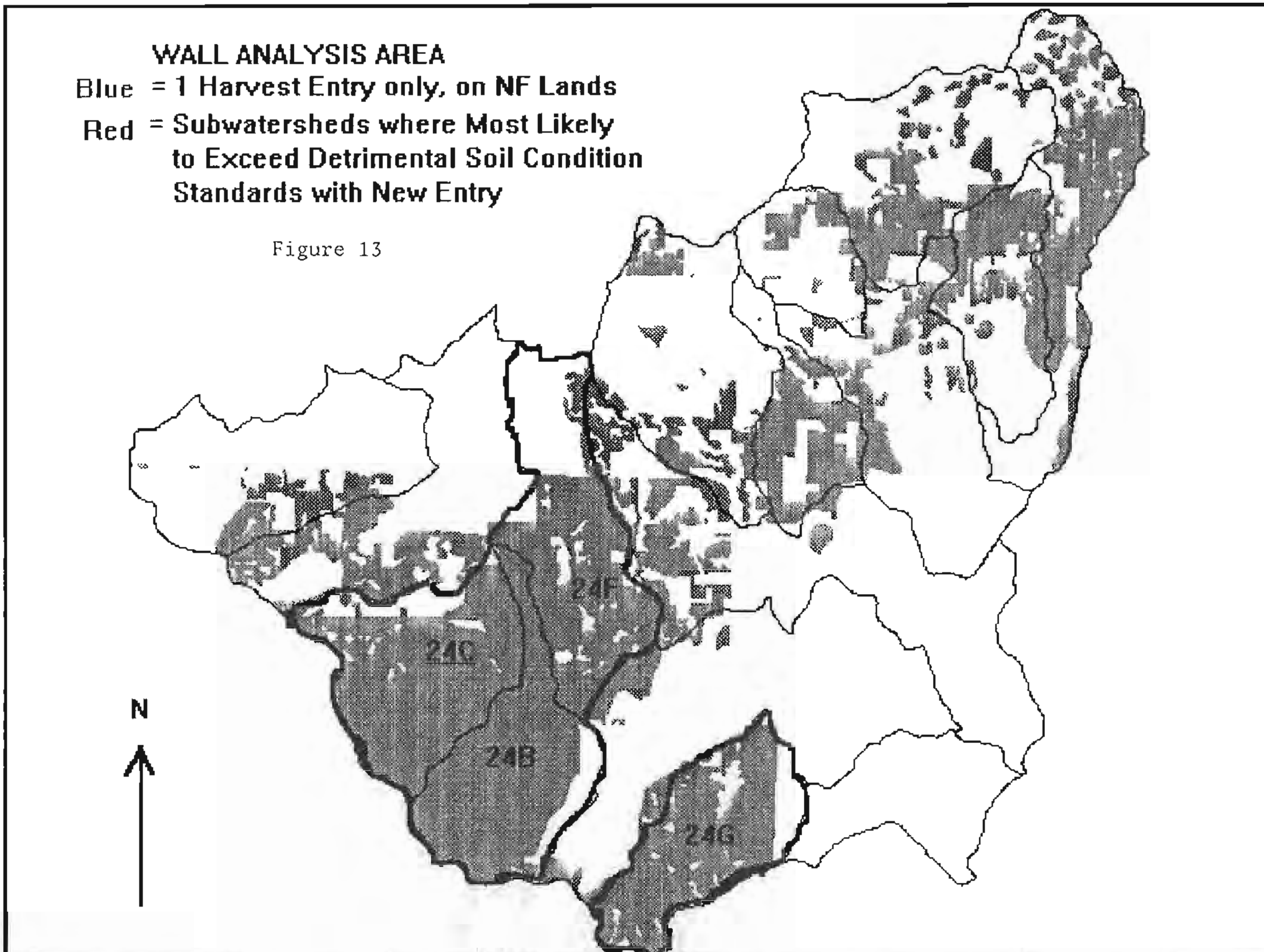

WALL ANALYSIS AREA
Blue = 1 Harvest Entry only, on NF Lands
Red = Subwatersheds where Most Likely to Exceed Detrimental Soil Condition Standards with New Entry
24F
24C
24B
24G
N

Figure 13

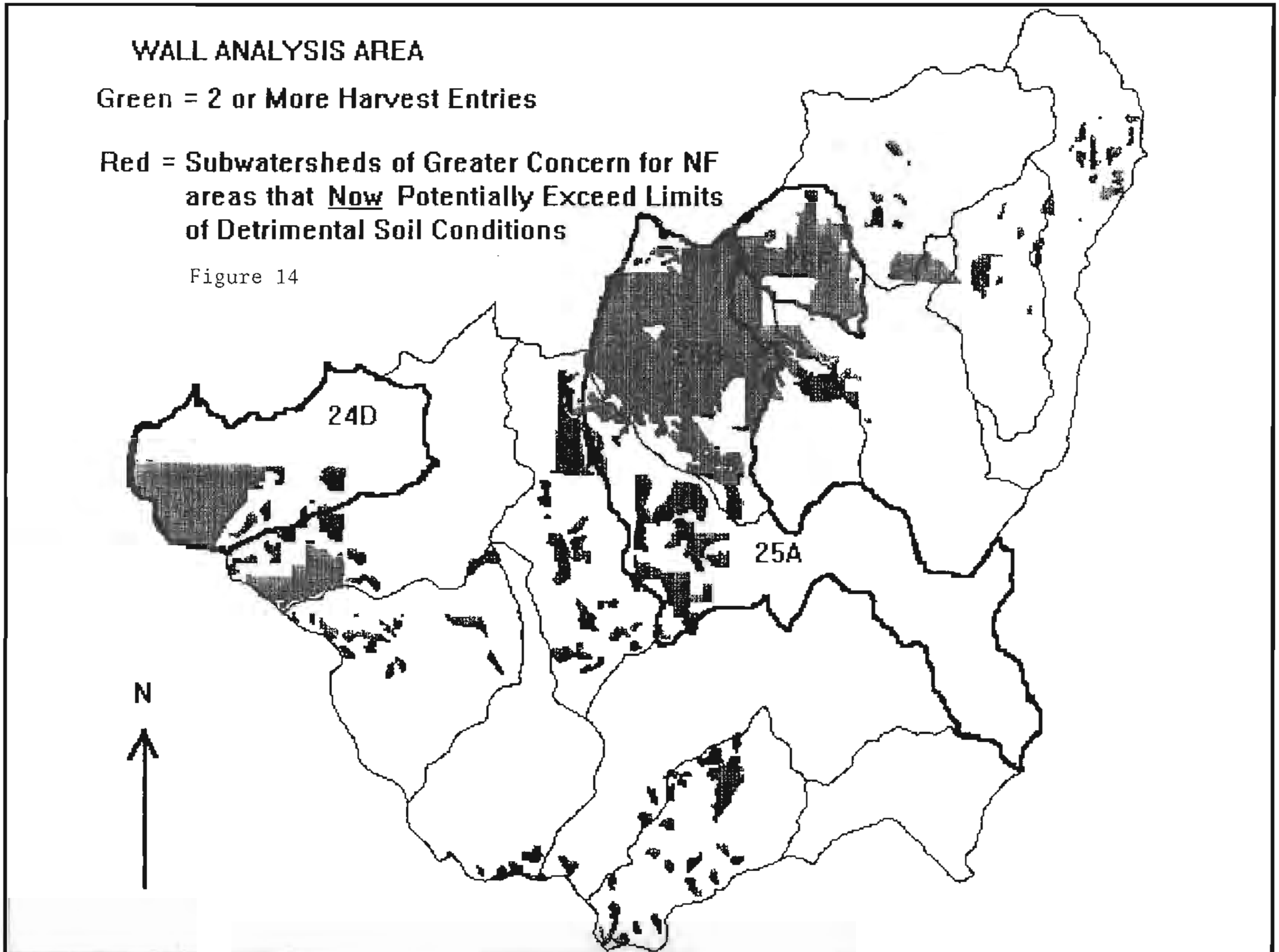

WALL ANALYSIS AREA
Green = 2 or More Harvest Entries
Red = Subwatersheds of Greater Concern for NF areas that Now Potentially Exceed Limits of Detrimental Soil Conditions
24D
25A
N

Figure 14

WALL ANALYSIS AREA

Estimated Extent of Subsoilable Area with High Percentage Detrimental Compaction (Within 2 or More Timber Sales)

Figure 15