II. PHYSICAL DOMAIN

A. Geology

1. Characterization

*ii-1. *What **erosion processes**** are dominant within the watershed (e.g. surface erosion processes, mass wasting)?*

Downslope soil creep, as a result of freeze/thaw, root and animal disturbance, and gravity appears to play a predominant role in the more steady state, sediment delivery on the most steep sideslopes. Intermittent, intensive, and often large scale fire activity and the resulting vegetation removal undoubtedly accelerates these downslope processes. At a much slower rate, and over a longer period, stream erosion and deposition have shaped the lower portions of these drainages as major stream terraces have developed at various gradient control points along the main channel of the North Santiam.

Few areas of actively unstable or potentially highly unstable slump / earth flow terrain exist in these watersheds. Therefore, slope instability from slumps is not considered a major factor in this area. However, a few areas of critical highly dissected sideslopes with shallow, often debris chute prone soils (prone to landslides)can be found in this area. ***Map II-1*** shows actively unstable soils, potentially highly unstable soils and land types unsuited for regeneration harvest. The silviculturally unsuited areas (can not regenerate within five years), are included as they contain numerous rock outcrops, talus, and bare soil areas. These areas can be sites where debris chutes initiate.

The principal slide zones are found in the headwaters of Dry, Log and Tom Creeks. These slide zones display considerable natural, shallow, slope instability that appears to be related to the stand replacement fire and/ or flood events. Of some importance is the observation that most larger failure systems provide streams with adequate structure, either in the form of large woody debris and/or boulders.

* = core question and ** = core topic from the *Federal Guide for Ecosystem Analysis at the Watershed Scale* (version 2.2)

2. What values are associated with **geology?**

a. Natural geologic processes and their influences on the ecosystem are valued (i.e. the natural influence of erosion on species diversity).

b. Geologic resources have utilitarian and economic value (i.e. rocks to surface roads and decorative rocks for landscaping).

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

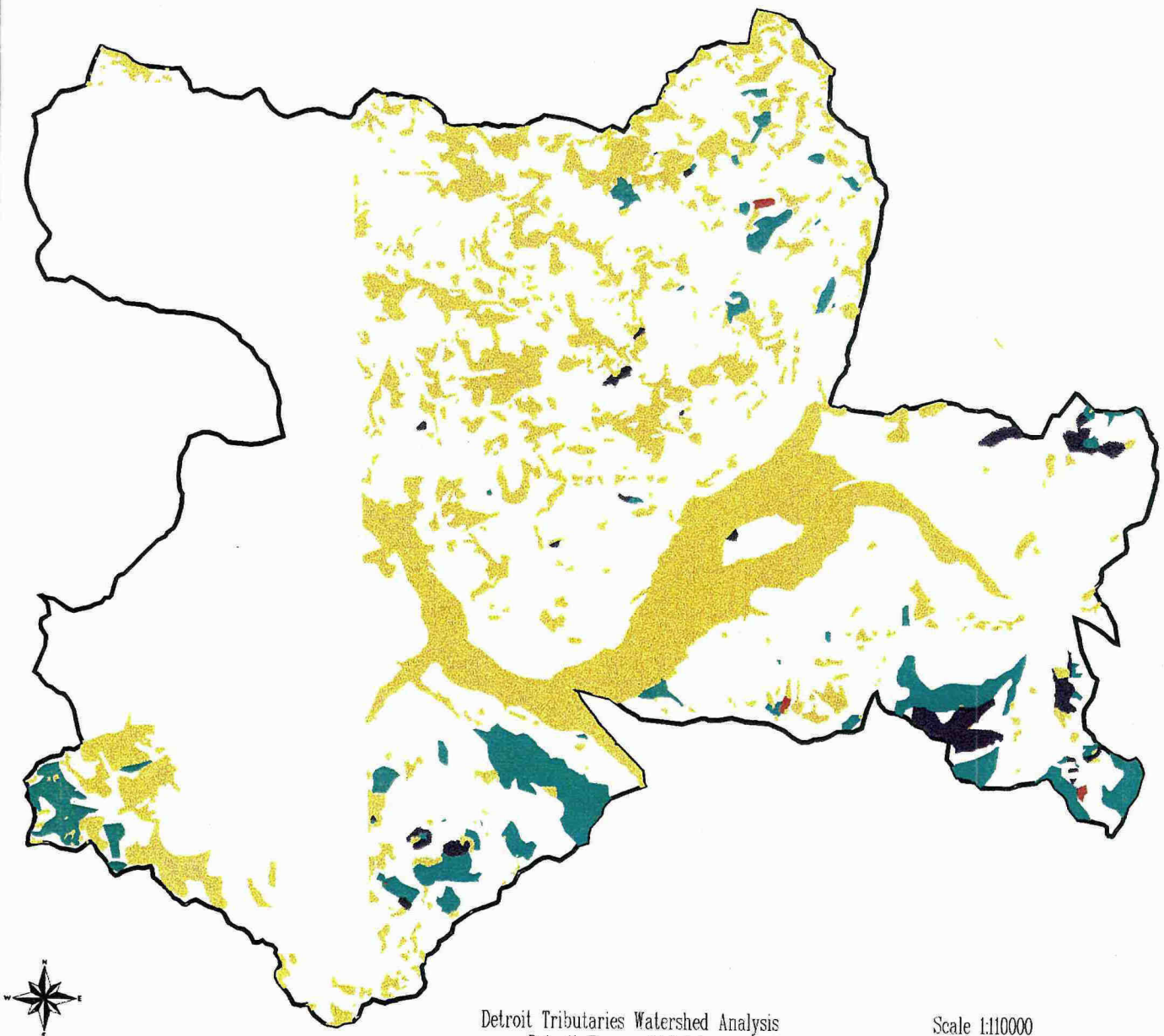
3. What are the highest priority issues or resource concerns associated with **geology?**

a. Whether current **erosion processes**** that are dominant in the Detroit Tributary watersheds 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 Detroit Tributary watersheds during the recent flood events and whether the number and types of landslides were outside the range of natural conditions that might be expected in such a storm event.

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

Unsuited/Unstable Soils



Legend

- Silviculturally Nonregenerable
- Actively Unstable
- Potentially Highly Unstable
- Stable and Productive Landflows

Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
10/03/97

MAP II–1

a. Current Conditions

*ii-2. *What are the current conditions and trends of the dominant erosion processes prevalent in the watershed? *Where have they occurred or are they likely to occur?*

Soil displacement occurs with three separate timber harvest activities: yarding, slash treatment, and road building and maintenance.

Yarding and Slash Treatment: Little or no evidence can be found to indicate that yarding and slash treatment activities have resulted in detrimental soil displacement or off site soil movement of any significant degree for most harvested units on Federal land in the analysis area. Willamette National Forest monitoring efforts over a number of years have consistently shown that off-site sediment movement from units where appropriate suspension and duff retention standards have been implemented, has been very low, especially compared with natural disturbance events such as wildfire. Those conclusions were again reinforced with field observations for this investigation. To be sure, detrimental soil displacement from railroad logging and tractor skidding likely resulted from the harvest areas along the North Santiam River and French Creek decades earlier, but these areas have long since vegetated over and completely stabilized. Much of that area is now under the Reservoir. On the remainder, overland flow, indicative of compaction, or gullying of the ephemeral and intermittent channels was not often found in the field reconnaissance on the older plantations.

Road Construction and Maintenance: Approximately, 198 miles of road currently exist in the basin. They range from a double lane, paved U.S Highway (Hwy. 22) to grown over tracks that are difficult to walk along. Many miles of roads have been constructed on stable benches and flats, but numerous sidecast roads segments from past harvest activities (see reference condition) are also present. Road construction standards have varied over time and range from complex sidecast construction to narrow lanes laid lightly on the land.

Although it is difficult to equate, current displacement of soil from roads constructed under more recent, stricter specifications, and downslope creep from colluvial processes (as they effect the streams) are probably of the same order of magnitude when considered in approximately the same time frames and viewed over the entire study area.

b. Reference Conditions

*ii-3. *What are the historical **erosion processes** within the watershed (e.g. surface erosion processes, mass wasting)? *Where have they occurred?*

Road construction was the dominant sediment relocation during the early 1900's through the 1970s. Some road segments were built without regard to sediment impacts to streams. Roads were located without consideration for steep sideslope slough situations; excess excavation was sidecast directly into stream channels; little heed was given to long term maintenance needs. Most of these situations have stabilized over time; some have been assisted with the help structural walls, sidecast pullback, or revegetation programs. Some occasional sites still persist and produce higher than desirable levels of off site sediment movement. However, these are localized problems that require correction. For the most part, sediment production and erosion have approximately returned to pre-harvest levels.

Natural rates of downslope sediment movement from colluvial processes are higher than generally expected. Soil movement from road construction may be higher initially, but tends to drop off quickly after one to three years. Creep continues unabated while the road disturbance tends to quickly stabilize with vegetation. For this basin, mapped stream miles are approximately 221, an amount that exceeds the number of road miles. Of these, more than half are located in Class IV streams where the bulk of creep movement probably occurs. In addition, our experience indicates that Class IV stream miles will likely increase by over 50% (or more) as more detailed field work is performed.

c. *Comparison of Current and Reference Conditions*

*ii-4. *What are the natural and human causes of changes between historical and current **erosion processes** in the watershed?*

Conditions	Major Causes of Change
Reference- Prior to Forest Management: Large stand replacing fires were the major controlling mechanism of erosion processes. The absence of vegetation after these fires resulted in the transport of large amounts of sediment into the stream. Stream structure such as large logs and boulders caught some of this sediment distributing along the stream channel.	
▼ ▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼ ▼	***Fire Suppression** resulted in the retention vegetation, especially on south aspects.* ***Timber harvest of unstable areas*** ***Road Construction techniques** - Some road building across unstable areas. Some sidecast road construction with fewer controls than today* ***Salvage and stream cleanout** in what is now riparian reserves.*
Reference- Forest Management to 1994: Erosion processes shifted from fire controlled to management controlled. When natural fires did occur, they still affected erosion processes in the same manner. Higher risk of more intense stand replacement fire due to fuel buildup on south slopes that may be hot enough to cause soil damage. Failures resulted from timber harvest and road construction through unstable areas. Less sediment retained in stream channels due to lack of stream structure.	
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	***Timber harvest and road construction-** changes in standards have been implemented.* ***Unstable areas** are avoided.* ***Roads have revegetated.***

Conditions

Current - 1994 to Present:
Management induced erosion has decreased.
Stream channels still lack structure from earlier stream cleanout.
Higher risk of more intense stand replacement fire that may be hot enough to cause soil damage due to fuel buildup on south slopes.

Sediment from timber management activities is not now a significant issue in these watersheds, although it likely once was in some areas. Older units have almost completely revegetated. Duff retention and suspension on more recent units are well within standards. Older roads have revegetated, and newer roads have generally been constructed to higher standards. Some problem sites are present, and require restoration. However, streams channels and riparian areas do not display those features which might indicate problems with excessive off site sediment generation.

Sediment, whether natural or management induced, is not so much the problem as the lack of storage capacity for sediment retention in the channels. This situation is a result of the removal of large woody debris and essential stream structure through harvest and stream cleanout. This can be most clearly observed in French Creek where extensive stream cleanout has resulted in down cutting in several areas.

When the entire area is taken into account, natural rates of slope instability are currently maintained. The slope failure record for the Detroit Tributary Watersheds is a relatively simple one. For the most part, natural slope instability is not a significant factor in sediment productions for most discussion areas, except for Dry, Tom and Log Creeks. Field reviews indicate that management generated road sidecast and sidecast failures have contributed a higher level of sediment to certain drainages, such as French Creek, than might have been anticipated from natural failure mechanisms, except for those times when extreme fire/flood events occur.

In-unit slope failures are not common. Field review after the 1996 flood , to date, have found only a few small landslides related to management activities scattered within the Detroit Tributary Watersheds. Their extension downstream was usually limited and restricted by debris in the draws. The comparison of the 1996 failures with the natural failure rate is difficult, but general observations would indicate that is of the same order of magnitude, and at the lower end of the spectrum.

In conclusion, then there seems little doubt that sidecast road construction, poor road maintenance practices, and harvest of highly failure prone soils can increase the incidence of failures in some systems. On the other hand, natural failures events can transport extensive amounts of sediment to streams, often far in excess of human caused mechanisms. Sediment rich systems often maintain relatively high population levels of aquatic organisms. The concern then is not so much with the amount of sediment as with how it reacts in the system.

Perhaps the major controlling factor is available stream structure, primarily in the form of large woody debris and boulders. The removal of large organic material in critical locations through harvest stream cleanout can increase the severity of failure impacts by (1) overloading natural systems with sediment to the point where existing features function poorly (or not at all), or (2) allowing sediment to be rapidly flushed through the system and thereby robbing the stream of necessary bank building material. Stream cleanout then has more seriously affected stream integrity in this watershed than any increase in sediment that may have resulted from other management activities.

Our goal, with regard to erosion processes, is the elimination of management induced slope failure. Sensitive areas must be avoided, or effects mitigated.

II. PHYSICAL DOMAIN

B. Hydrology **

1. Characterization

*ii-5. *What are the **dominant hydrological** characteristics (e.g. total peak flows, discharge, minimum flows)and other notable hydrological features and processes in the watershed (e.g. cold water seeps, ground water recharge areas)?*

The Detroit Tributaries hydrology is similar to other documented watersheds within the Western Cascades. Peak flows occur during rain-on-snow events in the transient snow zone which is estimated to occur between 450 to 1200 meters (1,500 feet and 4,000 feet) elevation (Christner and Harr, 1982). Due to the orientation of these tributary watersheds to the dominant winter storm patterns the elevation of this zone changes to approximately 365 meters to 1500 meters (1200 to 4900 feet). Detroit Tributary watersheds are within this elevation zone.

Water storage in these watersheds is limited to some deeper upland soils, terraces, flood plains and Detroit and Big Cliff Reservoirs. Glacial soil remnants, terraces, and flood plains act like sponges, retaining water and releasing it slowly during periods of low precipitation. Annual precipitation for the area averages from 79 inches at Detroit Dam to 130 inches on peaks and ridges. Intense precipitation is episodic in nature, and it often generates peak flows which are a major disturbance mechanism for stream channels and associated riparian areas.

Between 1908 to present, maximum discharge occurred on November 22, 1909 discharging 63,200 cubic feet per second, and its minimal flow was on August 21, 1963, discharging 19 cubic feet per second.,This wide range of variability in stream discharge reflects the Mediterranean climate and the corresponding flow regime that changes dramatically with the seasons. In 1953 storage began in Detroit Reservoir. Total capacity of the Dam is 455,100 acre-feet, and usable capacity is 340,100 acre-feet between elevations 1,425 ft, proposed lower limit of operation, and 1,569 ft., top of the spillway gates. Detroit Reservoir is used for flood control, power development, irrigation, improvement of navigation, pollution abatement, and other purposes (U.S. Geological Survey Water Data Report OR-95-1, 1996, pg.229). Since 1953 Detroit Reservoir has been the prominent hydrologic control in this these watersheds.

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 value.

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

The highest priority issue is flow of water, especially peak flow and low flows and the storage of water for downstream beneficial users.

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

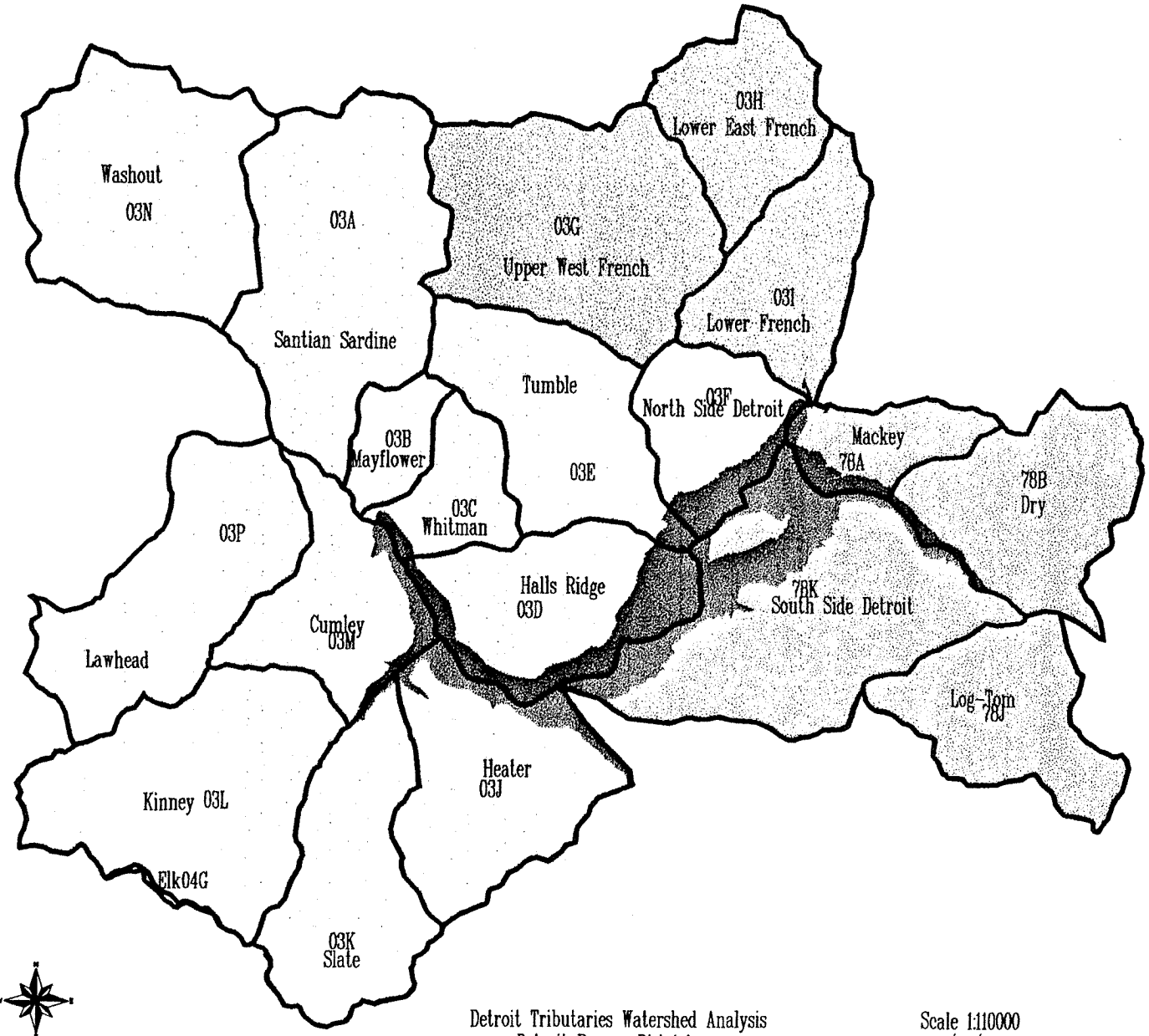
a. Current Conditions

ii-6. **What are the current conditions and trends of the **dominant hydrological characteristics** prevalent in the watershed?*

The watersheds have been divided into planning subdrainage blocks which coincide with sixth field subwatersheds(See ***Map II-2***). ***Map II-3*** shows main streams within these watersheds and ***Map II-4*** shows riparian reserves mapped so far.

Southeastern Planning Subdrainage Block: The sixth field subwatershed in this block is Upper Detroit Reservoir. Due to its orientation in relation to weather patterns, all of the block is susceptible to rain-on-snow events that result in peak flows. Planning subdrainages found within this block are: Southside Detroit (78K), Log-Tom (78J), Dry (78B), and Mackey (78A).

Subdrainages and Subdrainage Blocks



Legend

- Southeast Subdrainage Block
- Northeast Subdrainage Block
- Western Subdrainage Block

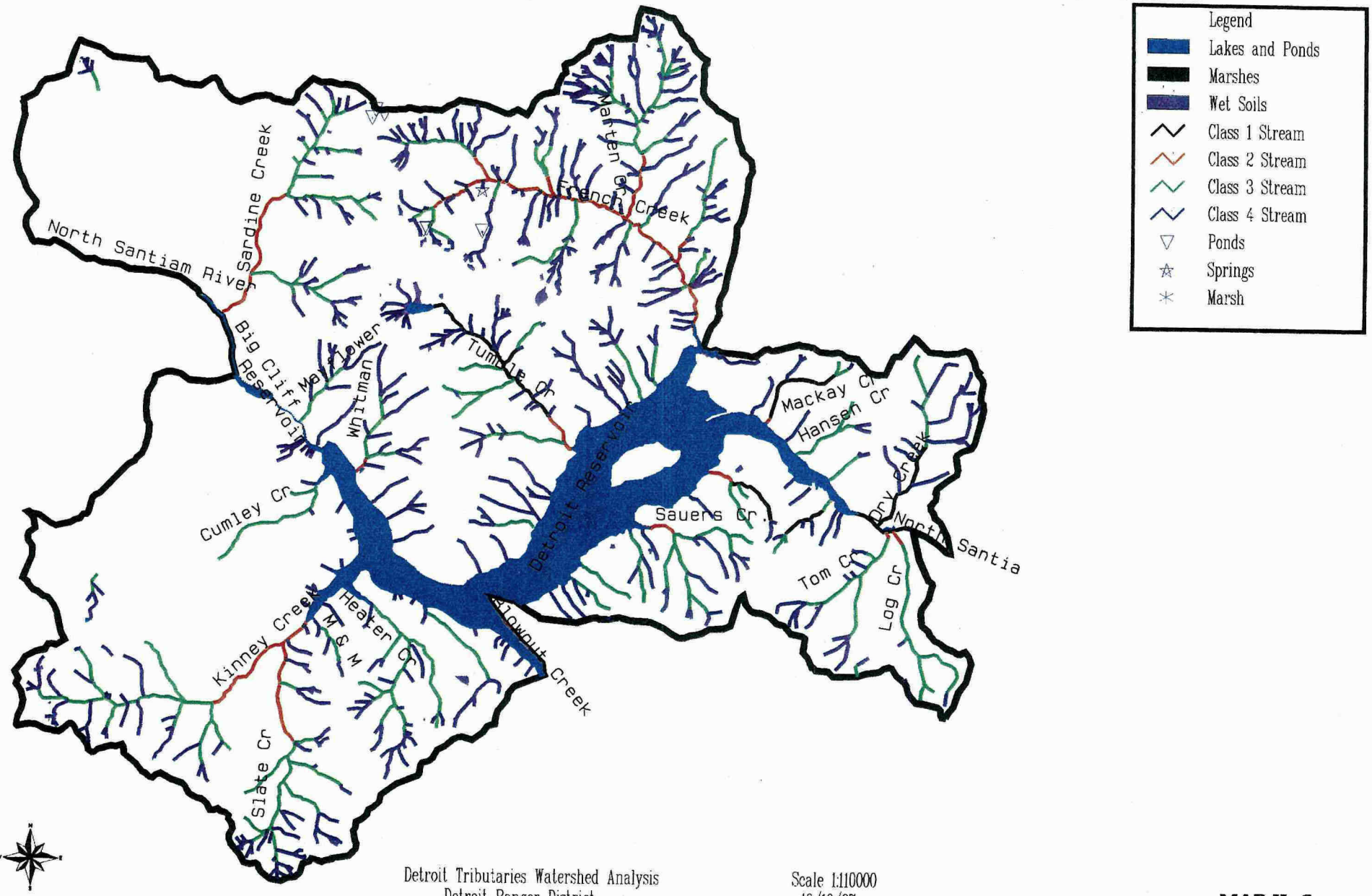
Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
10/05/97

MAP II-2

Request #1489

Streams, Lakes, Ponds and Wet Soils

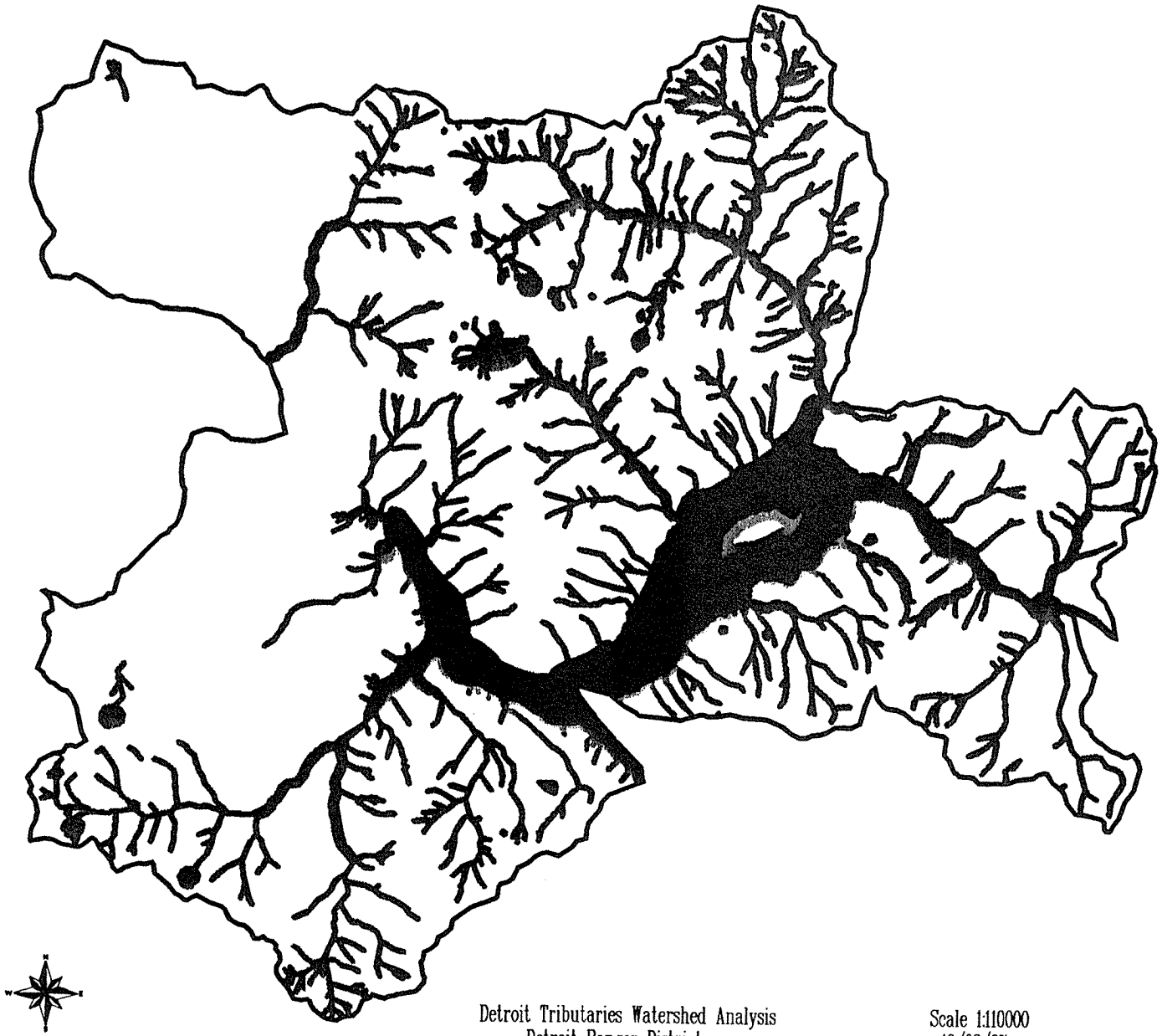


Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
10/10/97

MAP II–3 Request #1594

Riparian Reserves



Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
10/03/97

MAP II–4

Request #1484

Southside of Detroit (78K) has a high water table because of glacial and colluvial dominated terraces occupying toe slope areas within this planning subdrainage. This material provides a water storage potential that allows many streams to have considerable flow into the latter part of the summer months. Above these storage areas are steeper valley walls with shallow soils that are quick to dry out. Wetland in these areas are associated with streams and topographic breaks which are not common in this steep terrain.

Northeastern Planning Subdrainage Block: The sixth field subwatershed in this block is French Creek. Planning subdrainages within this block are Upper West French (03G), Lower East French (03H), and Lower French (03I) planning subdrainages. These planning subdrainages are very susceptible to rain on snow events and subsequent peak flows. The dominant parent material for this area is volcanic in origin, so soils are skeletal and shallow. Water storage in the soils is marginal with the only true storage areas being undulations in the geologic skin underlying these soils.

The shallow soils, which saturate easily, combine with rain-on-snow events to quickly produce peak flow conditions early in the wet portion of the year.

Finally, a remnant glacial terrace exists in the northwestern portion of this area. This remnant has the character of glacial deposits in storing water. The size of the area is small, so it has little effect on groundwater storage.

Western Planning Subdrainage Block The sixth field subwatershed in this block is Lower Detroit Reservoir. This block contains the largest areas within this watershed analysis. Planning Subdrainages found within this block include: Santiam Sardine (03A), Mayflower (03B), Whitman (03C), Halls Ridge (03D), Tumble (03E), North side Detroit (03F), Heater (03J), Slate (03K), Kinney (03L), Cumley (03M), Washout (03N), and Lawhead (03P). This area is very susceptible to rain-on-snow events, so peak flows are a common occurrence in this block.

The shallow soils, which saturate easily, combine with rain-on-snow events, to quickly produce peak flow conditions early in the wet portion of the year. Stream flows recede much earlier in the year due to only small water storage areas existing as forested wetlands, commonly associated with older debris torrent deposits and streams. The dominant parent material for this area is volcanic in origin, so soils are skeletal and shallow. Water storage in the soils is marginal with the only true storage areas being undulations in the geologic skin underlying these soils.

Tumble Lake is the only named natural lake in this block. Origin of this lake is associated with glacial activity and/or colluvial deposits off Elephant Rock to the south of the lake.

b. Reference Conditions

*ii-7. *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 in the past, occurred much as they do now, during rain-on-snow events in the transient snow zone.

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, streams were high energy and scoured steep v shaped valleys. Their floodplains were minimal during these events, wet areas in depressions were scattered throughout the landscape.

Specific data on stream discharge for the reference time period goes back to 1909. The gauging station was on the North Santiam River at Niagara (Station #14181500). Since the Detroit Reservoir was built in 1953 this record only gives a brief glimpse of before reservoir flows. Presumably, the average flows were higher than they are now, since peak flows were higher because of fires and rain-on-snow events, and low flows were likely higher because of reduced transpiration.

c. Comparison of Current and Reference Conditions

*ii-8. *What are the natural and human causes of change between historical and current hydrological conditions?*

Conditions	Major Causes of Change
Reference- Prior to Forest Management: Large stand replacing fires were the major factor controlling hydrological conditions . The absence of vegetation after these fires resulted in less snow intercept and increased peak flows. Peak flows were higher because of fires and rain-on-snow events, and low flows were likely higher because of reduced transpiration. Historically large wood allowed for areas of deposition and water storage.	
▼ ▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼ ▼	***Fire Suppression*** *resulted in the retention of vegetation, especially on south aspects.* ***Timber harvest of unstable areas*** ***Road Construction techniques*** *- Some road building across unstable areas. Some sidecast road construction with fewer controls than today* ***Salvage and stream cleanout*** *in what is now riparian reserves.* Detroit Dam and Reservoir created more water storage areas.
Reference- Forest Management to 1994: It appears that peak flows have decreased over historic conditions, probably as a result of fire suppression allowing vegetation to persist on the landscape. Vegetation changes the rate at which water reaches stream channels and the amount of water available during minimal flow periods. Timber harvest has countered the effects of fire suppression to some extent by removing vegetation, but not to the same degree that fire once did. Management resulted in active removal of wood from channels following early logging and some subsequent fires. This affected both water storage capacity and the number of wetlands, thus allowing the streams to become high energy and reduce the storage potential. Minimum flows are currently higher today than in the past on the mainstem of the North Santiam River due to the increase of water storage areas as a result of the Reservoirs.	

Conditions	Major Causes of Change
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	***Timber harvest and road construction standards*** *Fuel buildup*
Current - 1994 to Present (see Reference- Forest Management to 1994):	
Changes in standards have been implemented (e.g."Best Management Practices" along with the Aquatic conservation strategy)	
Higher risk of more intense stand replacement fire, due to fuel buildup on south slopes, that may remove vegetation, decrease snow intercept	

II. PHYSICAL DOMAIN

C. Stream Channels**

4. Characterization

ii-9. *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)?

Southeastern Block: Deeply incised parallel streams are found within Mackey and Dry planning subdrainages as evidenced by first to third order stream channels. (***Chart II-1***) 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.

Headwater channels have lower sediment storage capacity in pools and backwater areas due to the lack of channel structure such as logs and boulders. Sediment storage capacity decreases as streams transition into the valley wall regions where high energy streams transport sediment through to the North Santiam River and reservoir.

In the western portion of this block, Southside Detroit exhibits a terrace before entering the reservoir. Streams in this area show depositional characteristics of a moderate gradient stream. Small flood plains and large woody material retained within the system create a wide, shallow channel during low flows.

As described in the Geology section, debris torrents have at times played an important role in the development of the first and second order stream channels in this subdrainage block. Material from debris torrents builds terraces in 3rd and 4th order stream channels which are shaped and reshaped by peak flow events.

Northeastern Block: Channel morphology in this subdrainage block reflects old volcanic geology. The parallel drainage network in this area creates high gradient, high energy streams. ***(Chart II-2)***

Western Block: Channel morphology within this subdrainage block is a combination of dynamic erosion and stream energy. Glaciated headwalls have eroded to form steep gradient stream channels. Stream channels are incised into unconsolidated colluvial material in the headwaters and old volcanics in the lower valley reaches. Overall, a dendritic drainage pattern is found on this subdrainage block.

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 and management removed much of the larger vegetation from the landscape, leaving streams without an adequate supply of large woody material to provide structure and store sediments. These areas generated increased peak flows and a landscape 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 channels tend to act like pipes and pump sediments through to higher order stream channels.

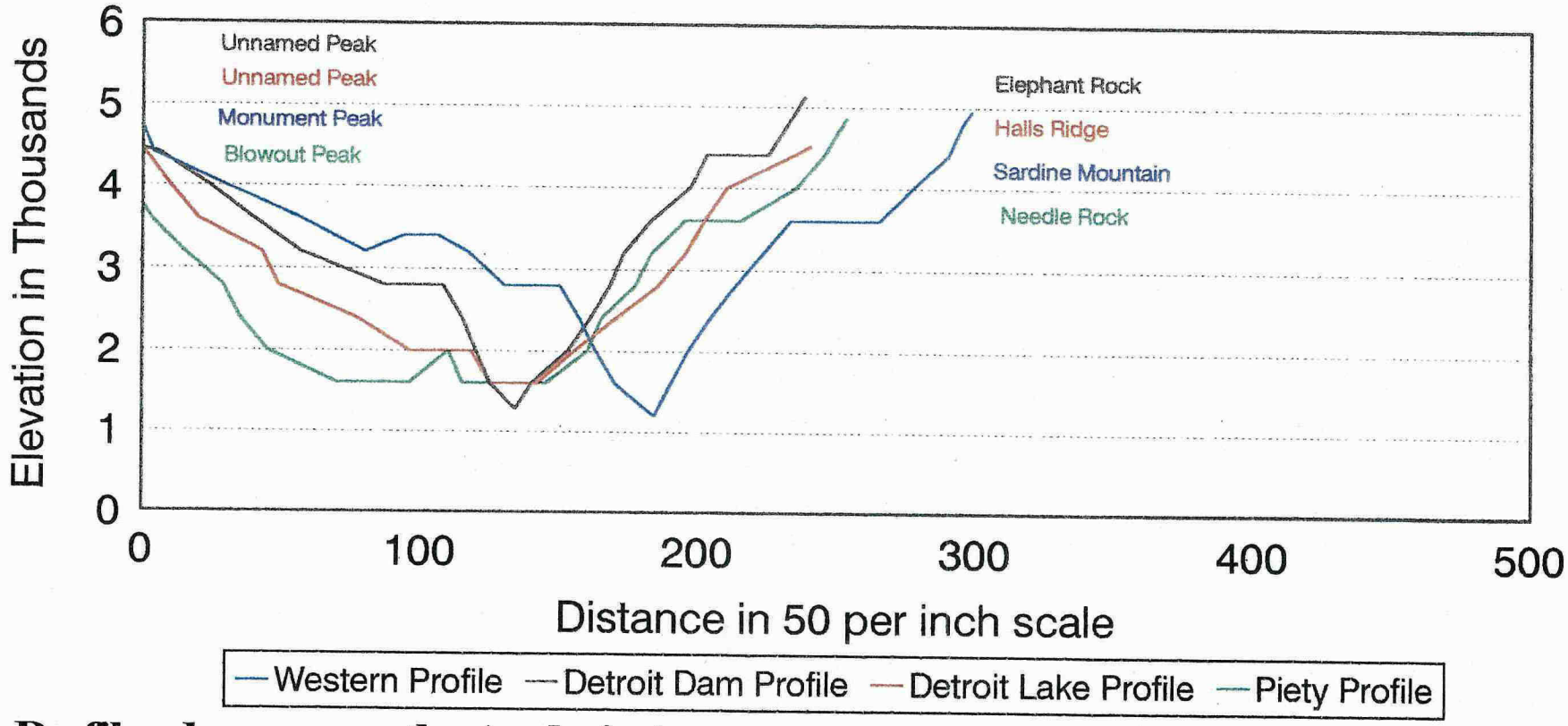
Third and 4th order streams in this subdrainage block are more typical of those of other western Cascades watersheds. Here stream channels transport sediment down narrow valley bottoms that are interrupted or confined by earthflows. Some of the sediment collects behind the large woody material in the channel. At the toes of the earthflows, channel roughness and gradient increase forming a stepped channel as illustrated by longitudinal profiles in ***Chart II-3***.

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

Stream channels and their associated floodplains are a valuable part of the ecosystem.

Profiles Detroit Watershed Analysis

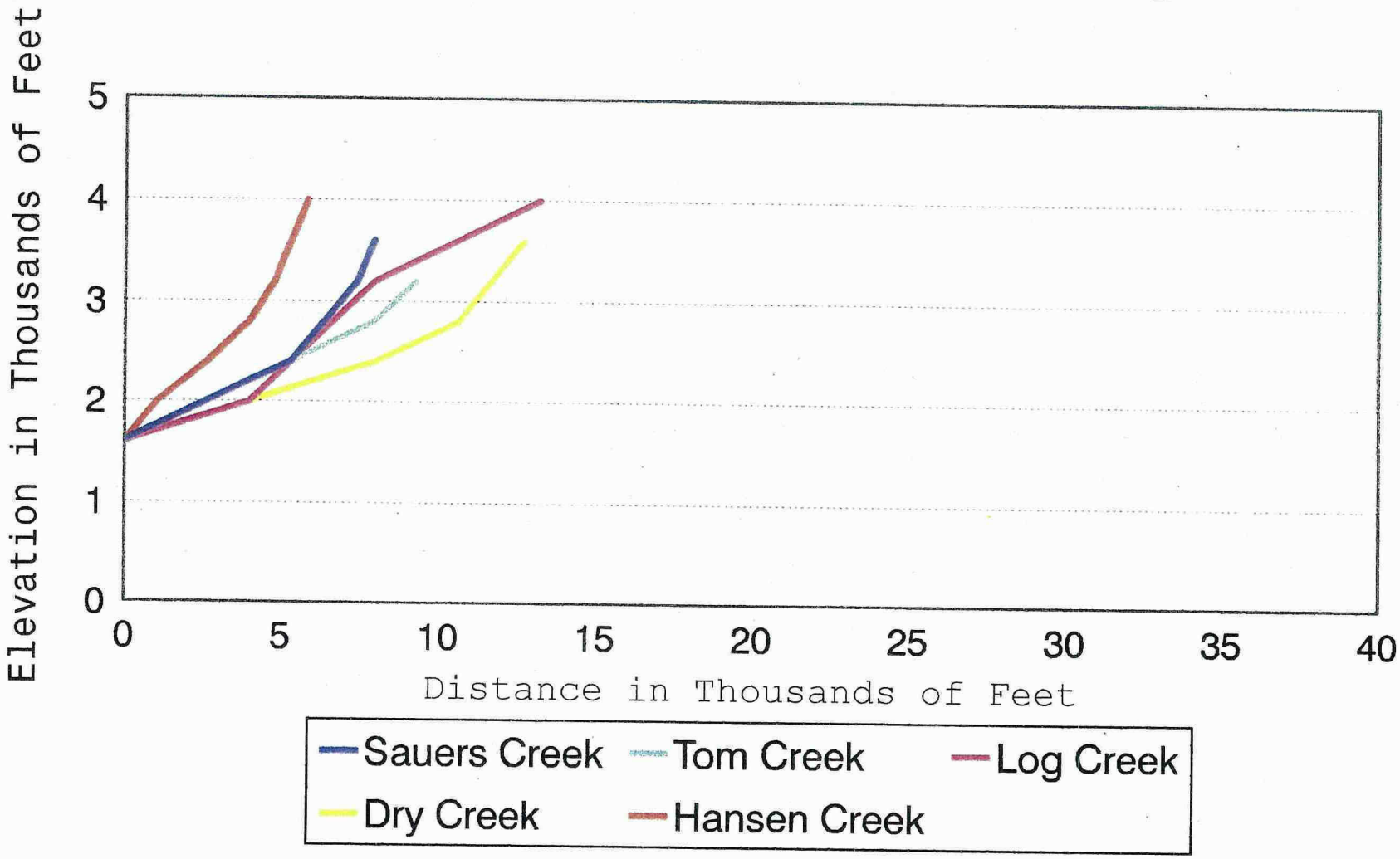
Peak to Peak Profiles



Profiles done across the Analysis Area

Longitudinal Profiles

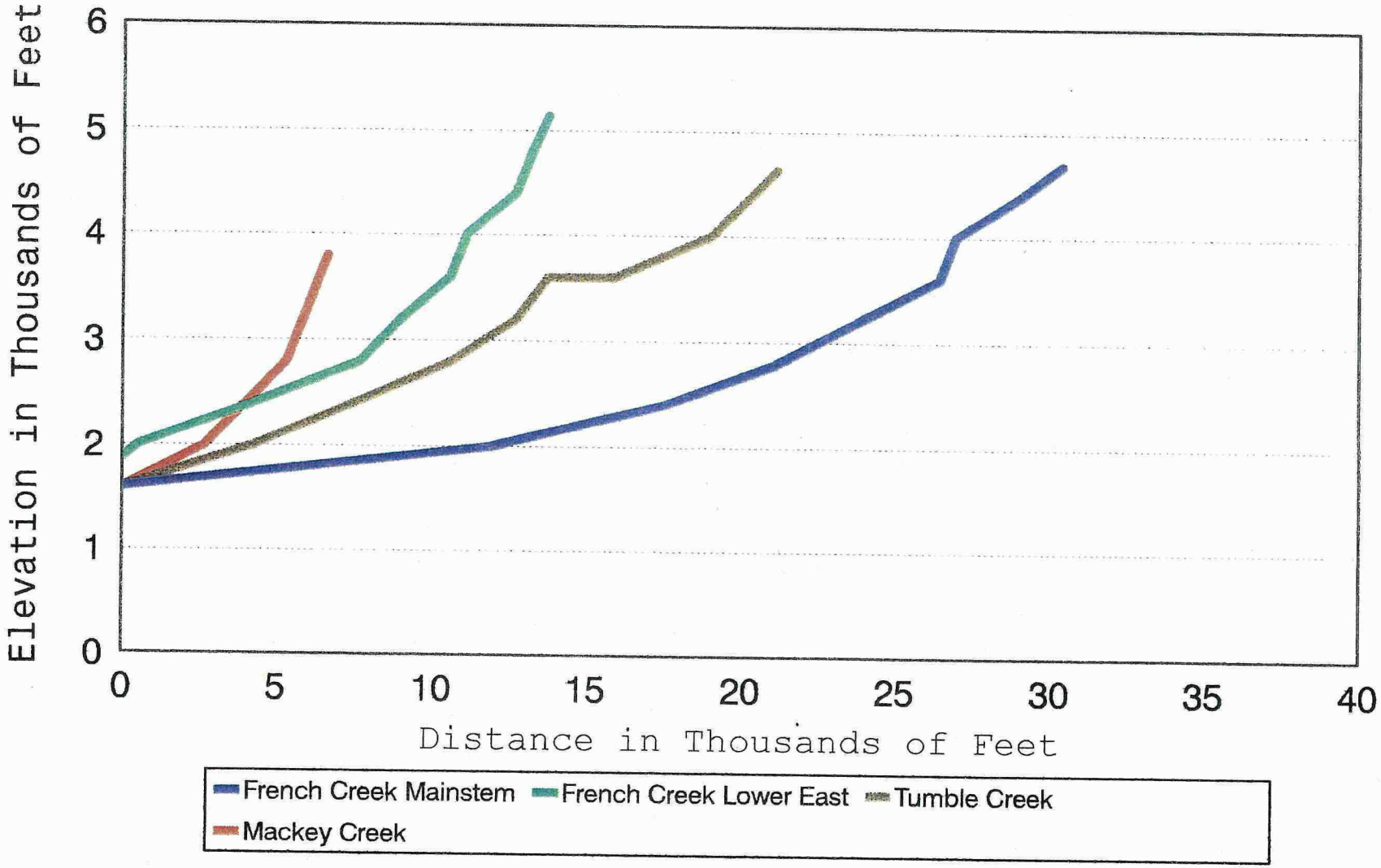
Detroit Tributaries Planning Subdrainages



Southeastern planning subdrainages.

Longitudinal Profiles

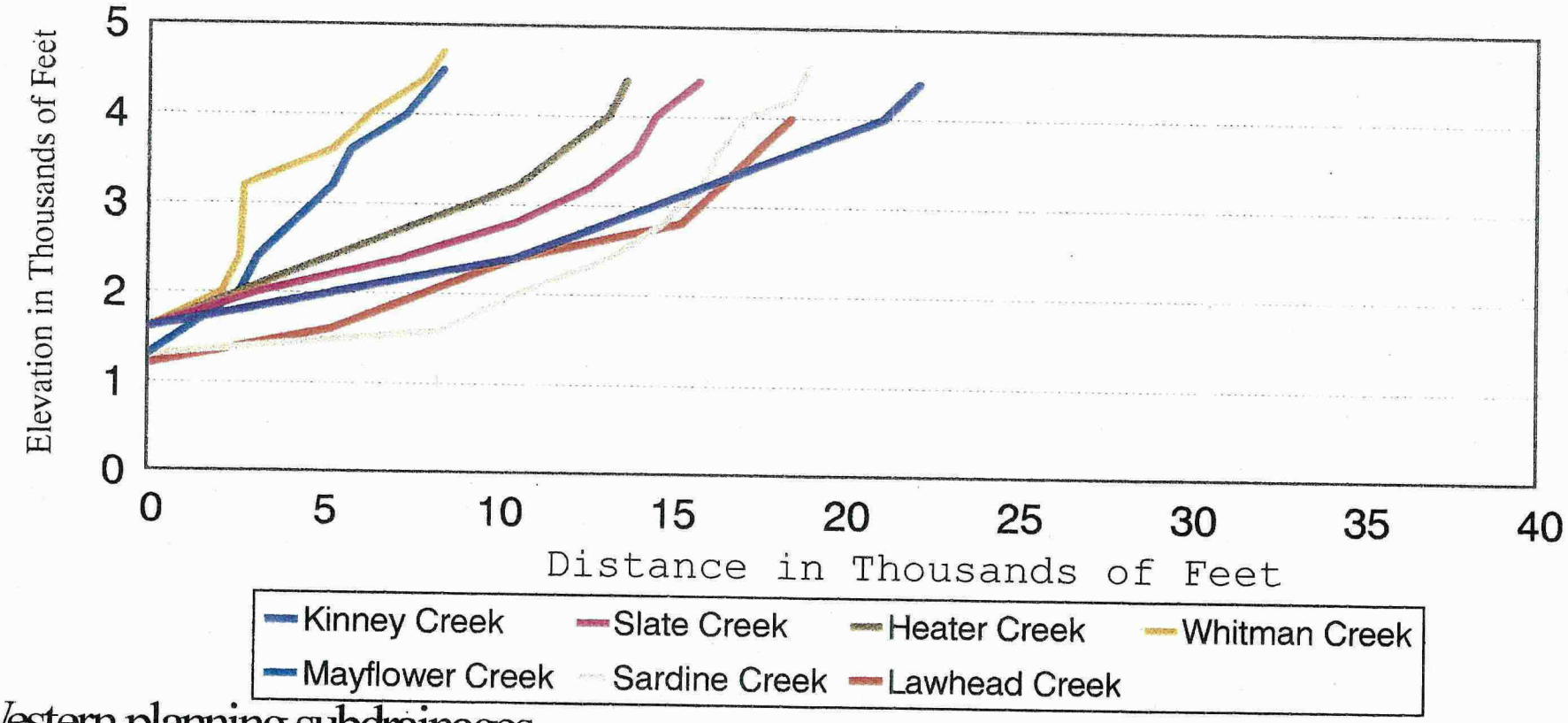
Detroit Tributaries Planning Subdrainages



Northeastern planning subdrainages.

Longitudinal Profiles

Detroit Tributaries Planning Subdrainages



Western planning subdrainages.

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

Channel bank stability and protection of headwall areas are the highest priority issues.

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

a. Current Conditions

ii-10. *What are the current conditions and trends of stream channel types and sediment and deposition processes prevalent in the watershed?

First to third order streams* are Rosgen type Aa+ channels (steep, narrow channels with little sinuosity) or G channels (gully type channels). Most 4th and 5th order stream channels are Rosgen type B channels (moderate gradients, channel width and sinuosity), while a few are A channels (somewhat less steep, narrow and straight than Aa+ channels). ***Chart II-4*** shows the breakdown of the Rosgen stream classification system. The types of sediment and depositional processes prevalent in the watershed are closely associated with channel types.

The ***Southeastern subdrainage block*** is a conglomerate of colluvial, and debris torrent material which becomes sediment that is transported through the Rosgen type Aa+, A, and B channels. Deposition on the terrace above the reservoir occurs .

In the ***Northeastern block***, sediments are transported through the Rosgen type Aa+(steep gradients, narrow channels with little sinuosity), A, and B channels.

* Stream order can be equated to the branches of a tree. First order streams are the "twig", second order streams are the "branch" and third order streams are the "trunk".

Type B channels are present in higher order channels such as French Creek. Channels historically contained a high percentage of exposed bedrock and large boulders. In addition, debris torrent activity in headwaters streams kept French Creek loaded with structure. Most of the fine sediments were, and still are, transported out of the system.

Rosgen type C channels, with their lower gradients, and wider, more sinuous channels are covered by the reservoir. The reservoir stores these sediments some of the finer sediments can be mobilized during storm events.

The main sediment sources in the ***Western subdrainage block*** are related to fire and the resulting surface erosion. At times, debris chutes and soil ravel may occur in steep topography. Nearly all channels types in this subdrainage block are transport reaches.

Rosgen channel types for this subdrainage block are Aa+ (steep gradients, narrow channels with little sinuosity) to B (moderate gradients, channel widths and sinuosity), while portions of headwater channels are G type (very steep gully like features).

In ***all subdrainage blocks*** 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.

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

Management activities have mimicked the effect of fires on sedimentation in Detroit Tributary streams, but on somewhat smaller scale. This management-induced sedimentation is a result of harvest units where no riparian vegetation was left; roads that were sidecast; recreational activity in proximity to stream channels; fuel management activities; and removal of large wood. Many of these activities are no longer practiced, but the effects are still evident.

Rosgen Channel Types

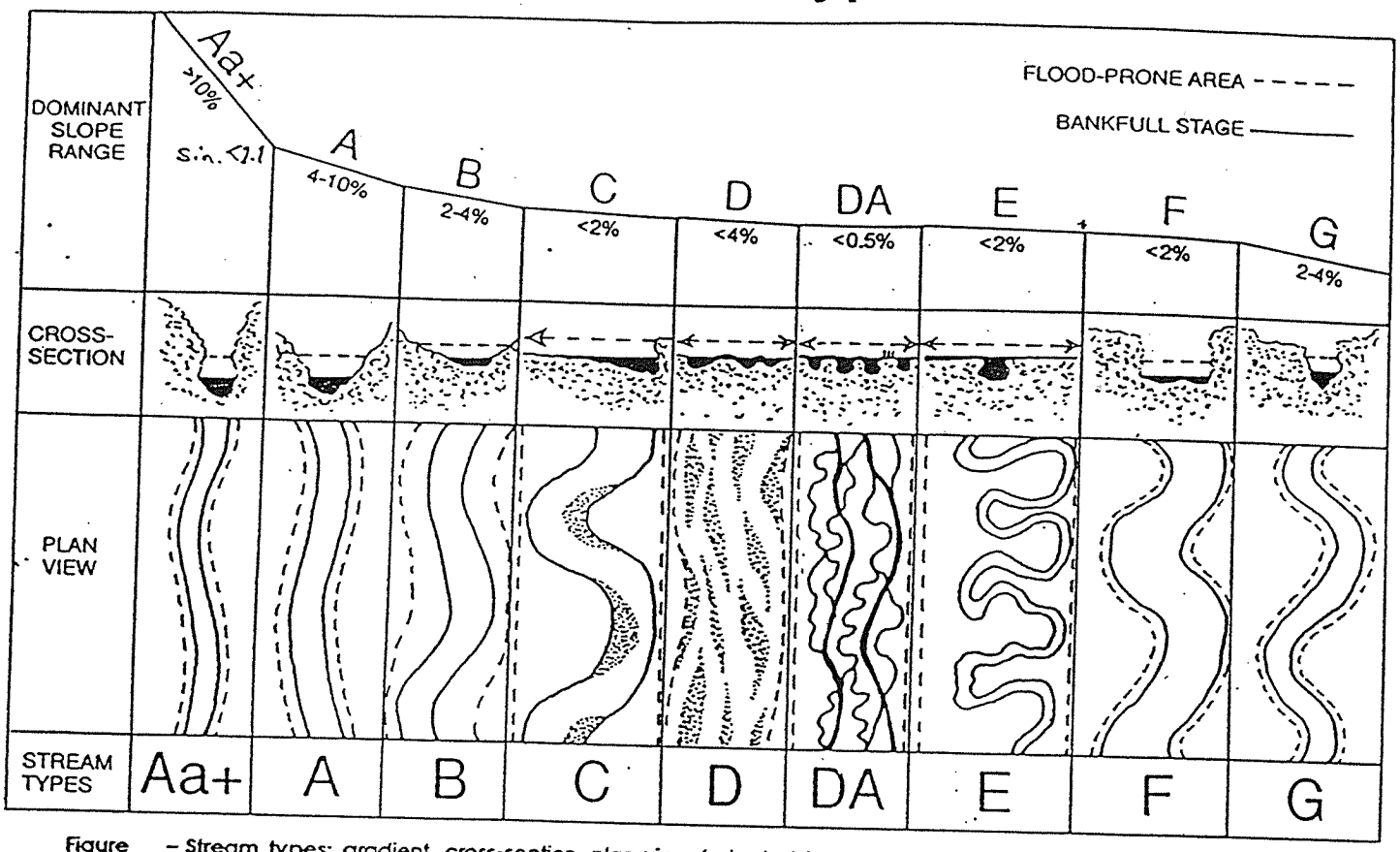
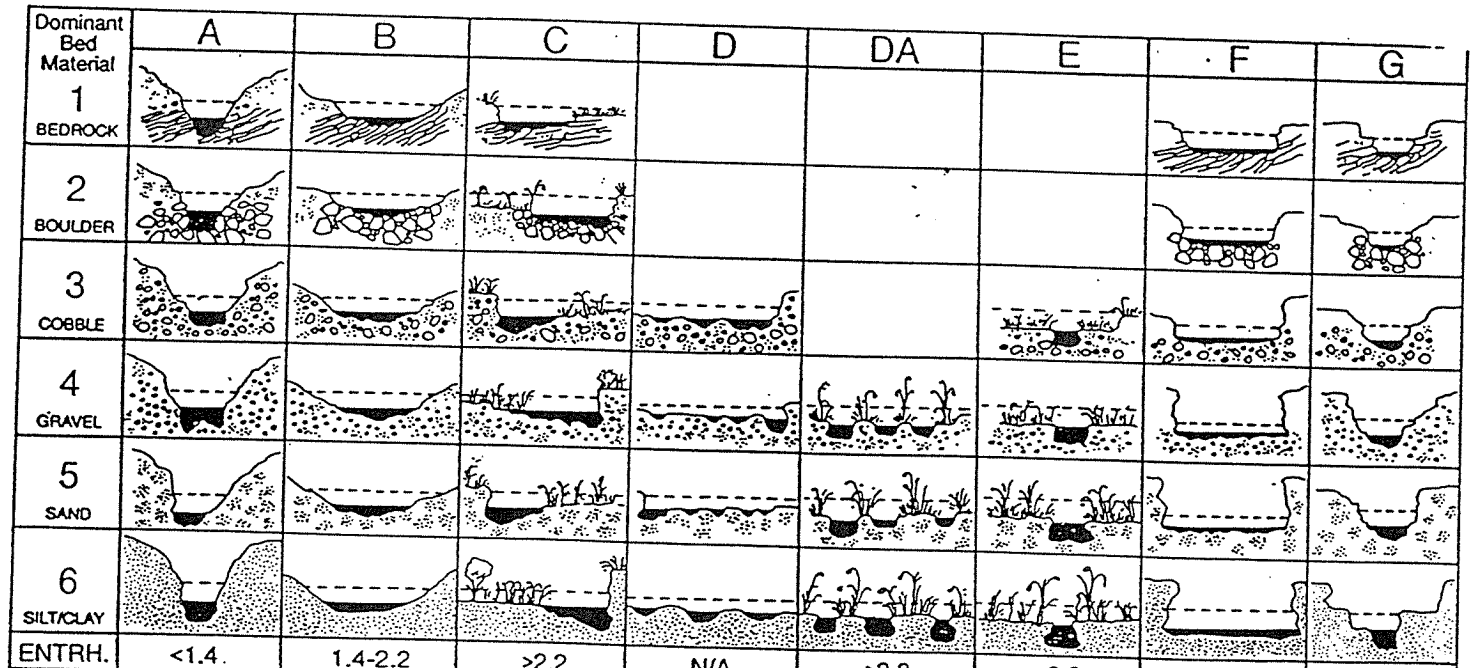


Figure – Stream types: gradient, cross-section, plan view (adapted from Rosgen 1994). Original drawings by Lee Silvey. Courtesy of Catena Verlag.



Dominant Bed Material	A	B	C	D	DA	E	F	G
1 BEDROCK								
2 BOULDER								
3 COBBLE								
4 GRAVEL								
5 SAND								
6 SILT/CLAY								
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

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

c. *Reference Conditions*

*ii-11. *What were the historical morphological characteristics of **stream valleys and general sediment transport and deposition processes in the watershed?***

The historic morphological characteristics of stream valleys in Detroit tributary streams are similar to existing 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.

Historically, sediment transport and deposition processes were a result of peakflows and erosion. After fire 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 peakflows 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 retained less wood than the wider U-shaped valleys. These V-shaped valleys acted as chimneys drawing fire through them and consuming the woody material in the stream channels.

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

Depositional areas are mainly associated with larger order streams and 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.

Soils are a good indicator of historic channel conditions and morphology. ***Map II–5*** shows various soil groupings for the Detroit tributaries watershed. In areas of volcanic soils, very little woody material is available in stream channels.

These soil groupings also relate to historic erosion. ***Table II-1*** shows dominant erosion processes by soil groupings:

Table II-1:

Erosion Process	Soil Grouping
Surface Erosion	All volcanic soils
Stream Erosion	Stream terrace Colluvial deposits
Debris Torrents	Moist unsuited/unstable All volcanics
Weathering/ Freeze Thaw	Moist unsuited rock and cliffs

d. Comparison of Current and Reference Conditions

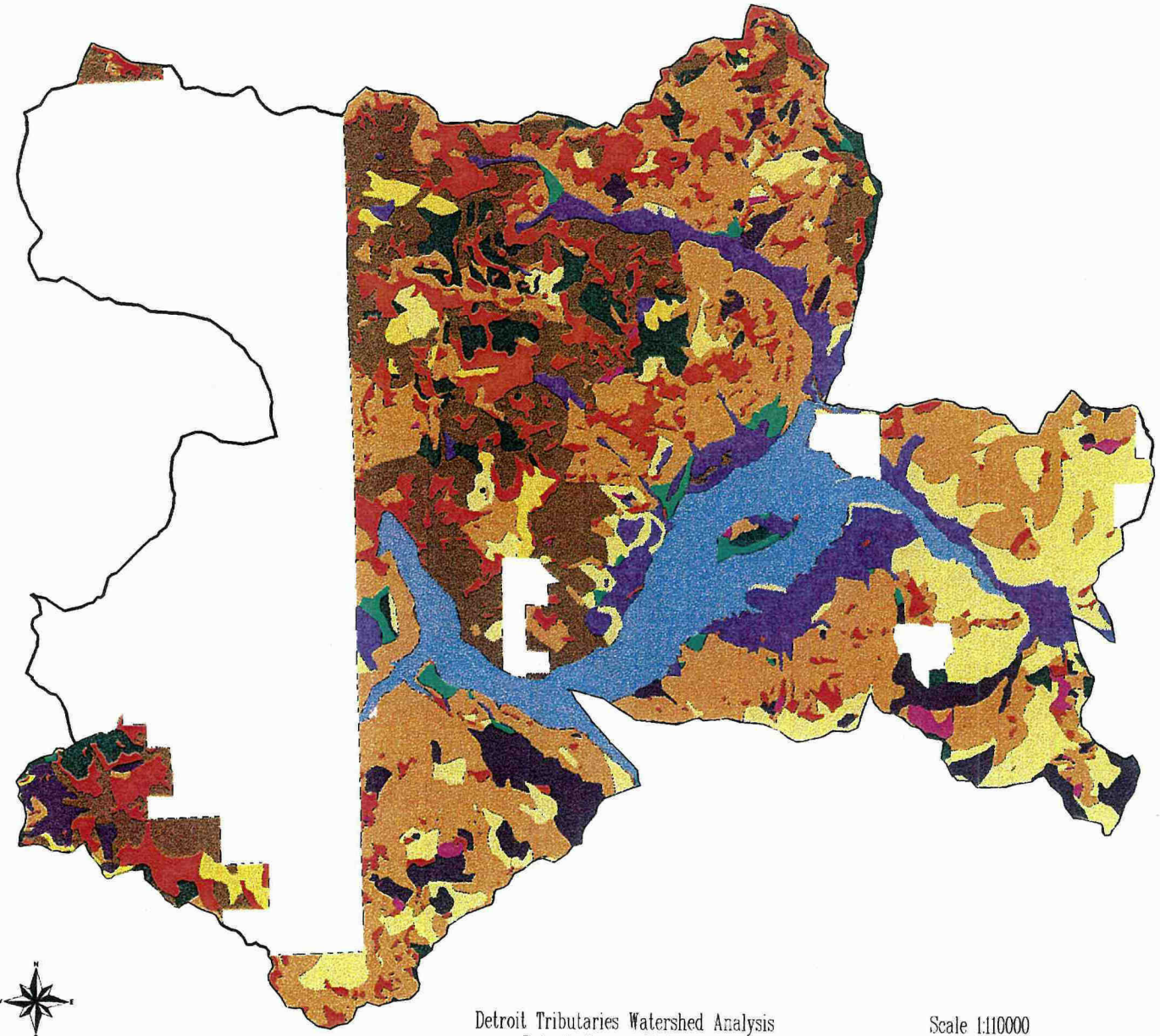
*ii-12. *What are the natural and human causes of change between historical and current **channel conditions?***

The most change between historic and current conditions is evident in forth order and larger stream channels. Smaller order channels have exhibited only minimal changes, for the most part.

Conditions

Reference- Prior to Forest Management:
Historically, sediment transport and deposition processes were a result of peakflows and erosion. After fire 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 peakflows on stream channels were long lasting.

Soil Categories



Legend

- Unsuited
- Old Slumpy Ground
- Mostly Unsuited/Unstable
- Stream Terrace
- Glacial Soils
- Upland Glacial Bench
- Steep Volcanic Basalt
- Tuff Brecca Steep Volcanics
- Mod. Steep to Steep Volcanics Tuff & Breccias
- Mod. Steep to Steep Volcanics Basalts

Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
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MAP II–5

Request #1535

Conditions	Major Causes of Change
Reference- Prior to Forest Management (continued): 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.	
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	***Fire Suppression*** ***Timber harvest*** ***Road Construction*** ***Salvage and stream cleanout*** *in what is now riparian reserves.*
Reference- Forest Management to 1994: One change that is evident, stems largely from fire suppression. In many areas, there is an increase in the buildup of down woody material as well as an increase in channel vegetation, since peak flows occur less frequently than they did when catastrophic fires occurred regularly in the watershed.	
Another change is the reduction in surface erosion upslope from stream channels as a result of fire suppression activities. This reduces the sediment available to stream channels to rebuild floodplains. Both sediment and wood have to be available to the channel for proper channel/floodplain interactions.	
Fourth order and greater streams, historically experienced peak flows that altered their channels. Sediment delivered to these channels would build flood plains in response to the natural wood concentrations in the channel. Currently, that sediment loading has been reduced and the wood component removed by management activities such as stream clean out, etc.	

Conditions	Major Causes of Change
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	***Timber harvest and road construction-*** *changes in standards have been implemented (e.g. "Best Management Practices" along with the Aquatic conservation strategy)*
Current - 1994 to Present: Today, stream channels in this watershed have high energies just as they did historically. The reintroduction of large wood into these systems can help the stream channels to reduce energies, retain more sediment, and function as they once did.	

II. PHYSICAL DOMAIN

D. Water Quality**

1. Characterization

*ii-13. *What aquatic-dependent beneficial uses occur in the watershed?*

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

- Domestic water is obtained from the Mackey Creek, Tumble Creek, and associated tributaries for summer homes, the Detroit Community, Detroit Ranger District facilities and several campgrounds. Water from the tributaries flows into the North Santiam River which serves as a domestic water supply for several downstream municipalities, including Gates, Mill City, Lyons, Mehama, Stayton, Sublimity and Salem.

- Fisheries are found in the main stem of the North Santiam River, other major tributaries, and lakes and reservoirs in the analysis area. This fisheries resource is not extensive in the tributaries because of steep channel gradients. Kokanee, which are a landlocked anadromous fishery, are present in the watershed. Historically, the North Santiam River provided anadromous habitat for winter steelhead and spring Chinook prior to the construction of Detroit and Big Cliff dams.

- 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.

- Historically and currently, water-related recreation use has been extensive. Most recreation facilities in the Detroit Tributaries area are in riparian zones.

- The North Santiam River generates hydroelectric power through hydroelectric operation of Detroit Reservoir.

- Water use for fire suppression and road maintenance are periodic in nature. Use depends upon the amount of activity in the area. Historically, due to the fire frequency and the fire suppression efforts, water sources were developed to aid in the control of fire. These sources would then be utilized during road maintenance.

*ii-14. *Which water quality parameters are critical to these uses?*

Water quality parameters critical to beneficial users are temperature and type and timing of sediment input. Another potential critical parameter is biological contaminants.

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 the Detroit Tributaries is solar radiation.

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

- Reproduction success of certain aquatic species is reduced when fine sediment inputs occur during egg incubation
- transportation systems can be damaged by coarse bedload deposition that plugs culverts
- impellers on hydroelectric facilities can be eroded by fine grained material
- water treatment costs increase as a result of turbidity from suspended colloidal material
- spawning habitat for various aquatic species is created by stream deposition

- beaches for recreation are created from fine grain deposition
- riparian habitat for riparian-dependent species can be created as a result of depositional areas creating flood plains that later become vegetated

As illustrated above, sediment can have both positive and negative impacts on various other 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.

Biological contaminants: The third potentially critical parameter for water quality is biological contaminants. Contaminants, such as water borne diseases, can impact both domestic and aquatic users. In the Detroit Tributaries area there is potential contamination from human waste because of the amount of recreation use the area receives, and from stocking non-native fish species such as hatchery rainbow trout. At this time, the degree to which this is a concern is unknown. In addition to the recreational areas, community sanitation systems pose a risk to water quality. Currently leach fields within the area are being reviewed and a community septic system is being proposed.

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

Water and water quality have life-sustaining and economic (e.g. domestic and industrial water supplies), aesthetic, and recreational value.

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

The highest priority issues are temperature, type and timing of turbidity, and other potential contamination (e.g. colloidal sediments, sanitation, fuel).

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

a. Current Conditions

*ii-15. *What are the current conditions and trends of beneficial uses and associated water quality parameters? What are the current conditions with regard to water quality parameters ?*

Current conditions and trends of beneficial users are similar to historic conditions and trends.

Water quality for domestic water use is generally high in the Detroit Tributaries area. Episodic storms temporarily reduce water quality, as sediment increases along with rising waters. This sediment is flushed out of the watershed and 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 this condition changed. A February storm event delivered increased sediment loads into the reservoir and flushed existing reservoir sediments downstream. In light of the tighter requirements adopted by the State of Oregon that reduced the acceptable level for turbidity in finished drinking water (the condition of water after being treated), downstream communities, especially Salem, were concerned when turbid waters flowed past their water intake systems and they had to rely on alternate water sources for domestic use. Their main concern was that they wanted to determine where sediment sources originated that ended up in the Detroit and Big Cliff reservoirs. The character of sediment they were most concerned with was ultra fine clays or colloidal materials. In the Detroit Tributaries area, sources of these clays are failure zones of earthflows, weathering and geologic erosion of weak volcanic ash deposits.

The Willamette National Forest has entered into a memorandum of Understanding with the City of Salem is working closely with the City to address water quality concerns.

ii-16. What and where are the "303d" water quality limited water bodies within the watershed?

There are currently no "303d" water quality limited water bodies within these watersheds.

ii-17. What effects do proposed improvements in the local infrastructure (e.g. proposed sewer project) have on water quality?

Proposed improvements within the area fall under all permitting requirements as specified by the State and county agencies. Water quality protection is considered under these permitting requirements. Change in current water quality is not anticipated.

b. Reference Conditions

*ii-18. *What were the historical **water quality** characteristics of the watershed?*

Historic water quality characteristics are difficult to determine quantitatively due to the lack of 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.

Water Temperatures: Fires controlled the amount of vegetation on south and west aspects. The amount of vegetation shading the streams determined the temperatures in those streams.

Turbidity: Historically sediment characteristics can only be classed in relation to historic disturbance. Sediment pulses more than likely came through the system during episodic events that created short term impacts. This sediment was transported into the North Santiam River and through to the Willamette River. Sediment particle size depended upon the source and location. First through fourth order streams contained boulder to clay size particles that were mobilized and fifth and greater order streams would move cobble to clay size particles. The difference between the two, related to the amount of woody material present to increase channel roughness and reduce energy.

Biological contaminants were likely lower in historic times, because less people used the area and there was no fish stocking program.

c. *Comparison of Current and Reference Conditions*

*ii-19. *What are the natural and human causes of change between historical and current* ***water quality*** *characteristics of the watershed?*

Conditions	Major Causes of Change
Reference- Prior to Forest Management: Historically, due to the fire regime, first to fourth order streams were burned. This burning reduced the vegetation next to the streams and allowed solar radiation to reach the water.	
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼ ▼	*The causes of change from historic to current relates more to the areas of* ***solar radiation*** *rather than if solar radiation was/is a problem.* ***Fire Suppression*** *resulted in the retention vegetation, especially on south aspects.* ***Timber harvest and Road Construction*** ***Salvage and stream cleanout*** *in what is now riparian reserves.* *Introduction of Hatchery fish*
Reference- Forest Management to 1994:	
Water Temperature: (see Current - 1994 to Present)	

Conditions	Major Causes of Change
Reference- Forest Management to 1994:	
Turbidity: Historic sediment production characteristics have been impacted primarily by fire suppression/prevention activities and large scale wood removal during stream clean out. A reduction in sediment available to the system, as a result of fire management and a lack of wood to hold sediments, led to a change in sediment type. Failures following fires used to load channels with fine and coarse sediments, that would be retained by the large wood and would be slowly metered through the system.	
Biological Contaminants (see Current - 1994 to Present)	
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	***Timber harvest and road construction-*** *changes in standards have been implemented (e.g. "Best Management Practices" along with the Aquatic conservation strategy)*
Current - 1994 to Present:	
Water Temperature: Currently first to fourth order streams are vegetated, for the most part, and solar radiation does not have an opportunity to increase water temperature (some effect will occur due to changes in microclimate but in looking at the watershed as a whole this becomes minor).	
Turbidity: Currently, sediment production is mainly due to in-channel recruiting and episodic pulses, during large storm events, which cause road failures and natural debris torrents. During storm events, these pulses of sediment pass through the system. Stream energies are so high, at this time, that sediment of all sizes, are moved.	
It seems likely that **biological contaminants** are greater now than in the past, because of increased human use over time, as well as, the introduction of hatchery fish to the system.	

II. PHYSICAL DOMAIN

E. Fire

1. Characterization

ii-20. What factors contribute to fire occurrence and where do they occur?

Fuels, topography, weather (hazards) , and ignition (risk) are the factors contributing to fire occurrence.

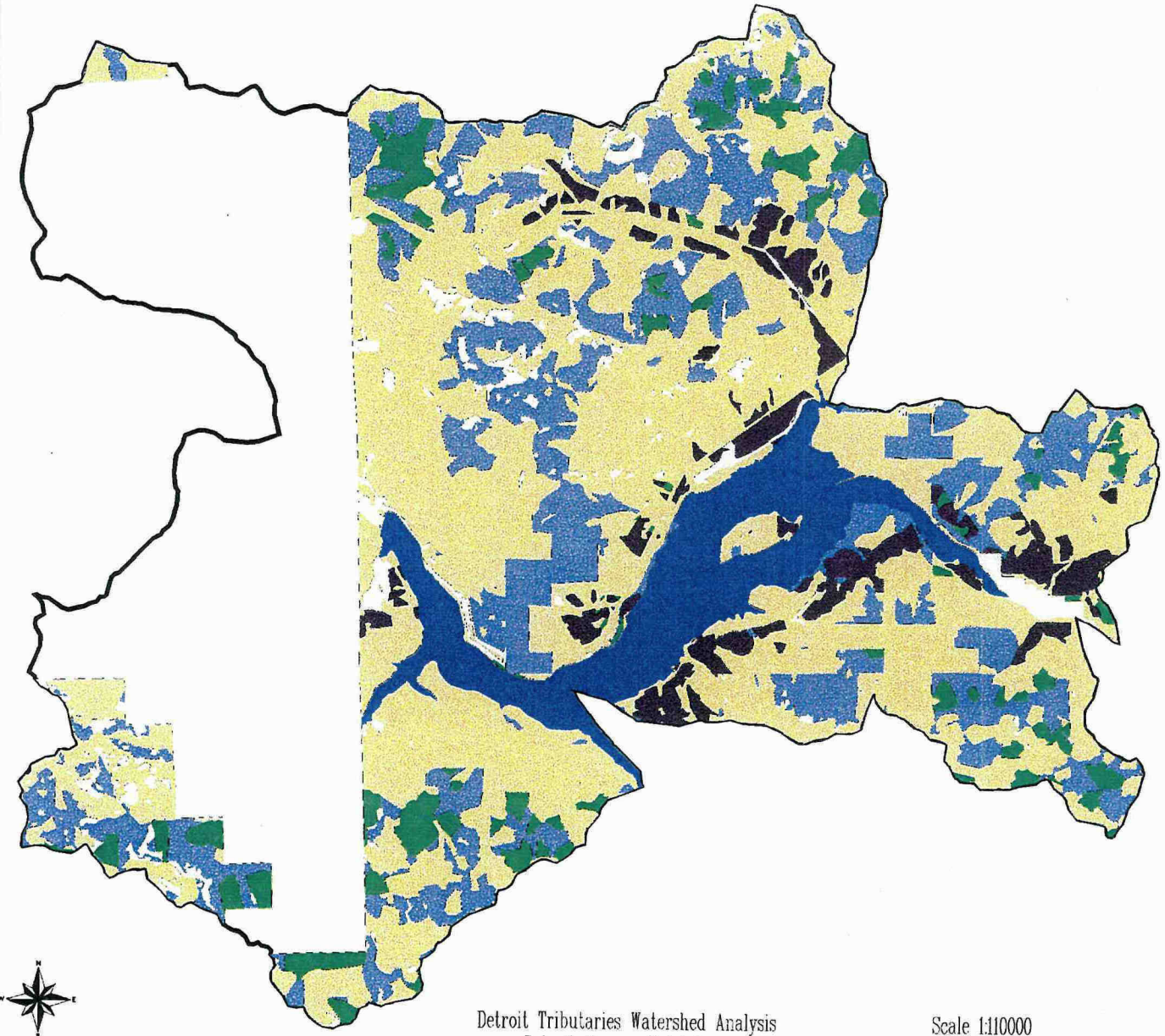
Fuels: Fuels are grasses, brush, timber and slash. Fuel model properties are descriptive of vegetation, quantities (fuel loadings), depth of loadings, and the arrangement of fuels on the landscape. The National Fire Danger Rating System and the Aids to Determining Fuel Models for Estimating Fire Behavior describes and assigns fuel models for providing a quantative basis for rating fire danger and predicting fire behavior. The classified fuels in these watersheds are mostly comprised of National Fire Danger Rating Fuel models G, H, K, L. (See ***Map II-6***). Vegetative data gathered via satellite imagery (PMR data) , on a large general over viewing, modeled the majority of the waterhsed as a fire behavior fuel model 10 (Anderson 19xx) (see ***Table II-2***) Some of the areas in a fuel model ten may exceed maximum allowable fuel loading identified in the Forest Wide- Standards and Guides for non-wilderness.

Fire behavior for a fuel model ten given eight percent dead fuel moisture, 100% live fuel moisture, effective wind speed at midflame height at five miles per hour, fire intensities would suggest a spread rate of approximately 8 chains per hour and a flame length of 5 feet . Fires with these present values are at the upper limit of control by direct attack. More wind or drier conditions could lead to an escaped fire. This model assumes a continuous topography , wind , and fuel conditions.

Table II-2:

Fuel Models		Type of Vegetation	Stand conditions	Total Fuel Load of < 3" dead and live (tons per acre)	Duff and Litter Depth (feet)	Down woody material size
NFDRS Fuel Model	Fuel Model for Estimating Fire Behavior (Anderson)					
G	10	Dense Conifer Stands with heavy accumulation of litter and down woody material.	Overmature, may suffer from insects, disease, wind or ice damage (natural events that create a heavy buildup of dead material on the forest floor). The undergrowth is variable, but shrubs are usually restricted to openings.	12	1.0	>3" diameter
H	8	Conifer	Healthy stand with sparse undergrowth and a thin layer of ground fuels.	5	0.2	Occasional "jackpot" of heavy fuel concentrations < 6" in diameter
K	11	Slash fuels from light thinning and partial cuts in conifer stands	Typically the slash is scattered about under an open overstory.	11.5	1.0	Fuels greater that 3" in diameter are limited to no more than 10 pieces greater than 4" in diameter along a 50 ft. transect
L	1	Western grasslands vegetated by perennial grasses.	Shrubs and trees occupy less than one third of the area.	.74	1.0	

Fuel Models



Legend
- Fuel Model G
- Fuel Model J
- Fuel Model K
- Fuel Model H
- Fuel Model L

Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
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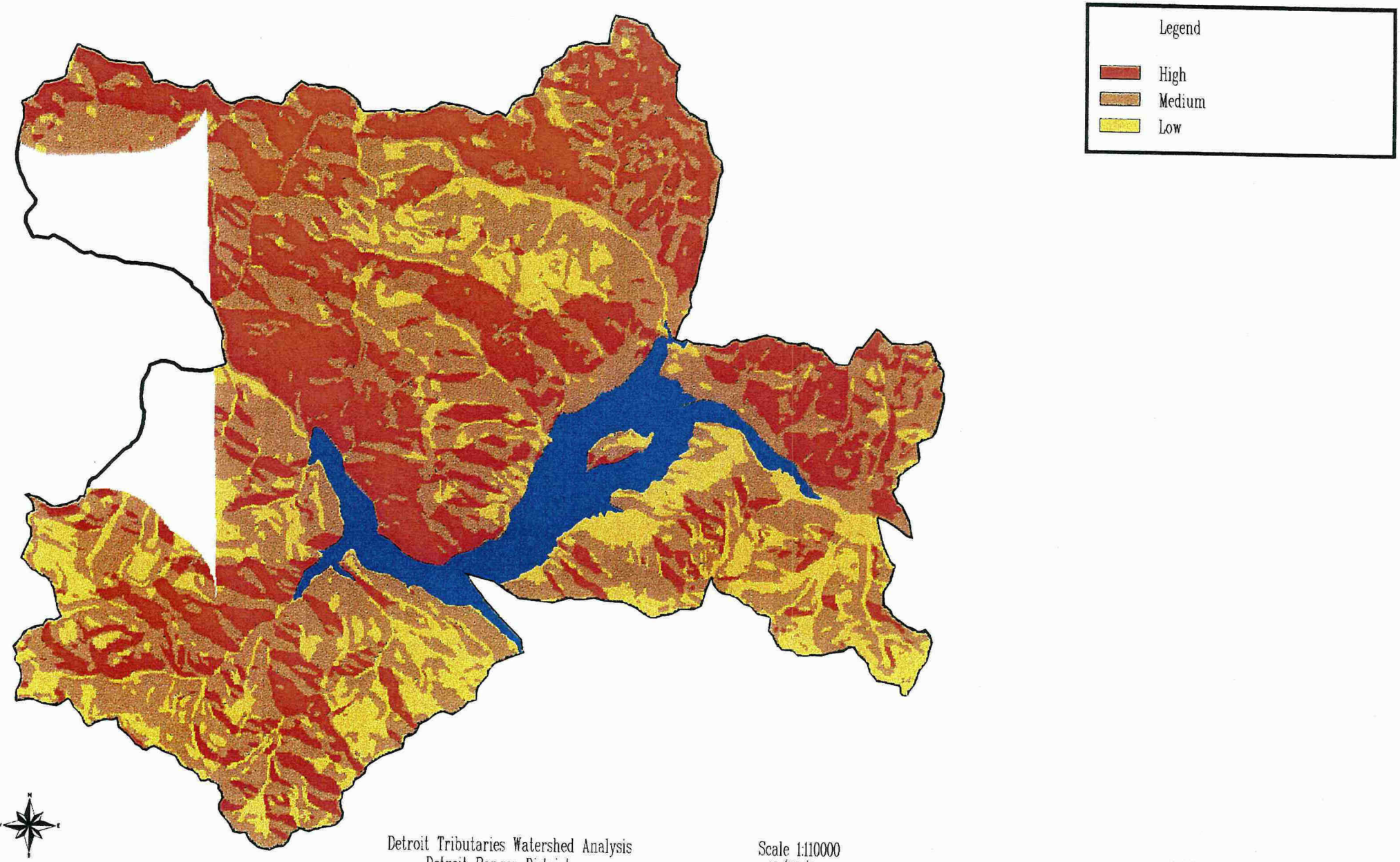
MAP II–6

Request #1480

Fire Hazard Matrix



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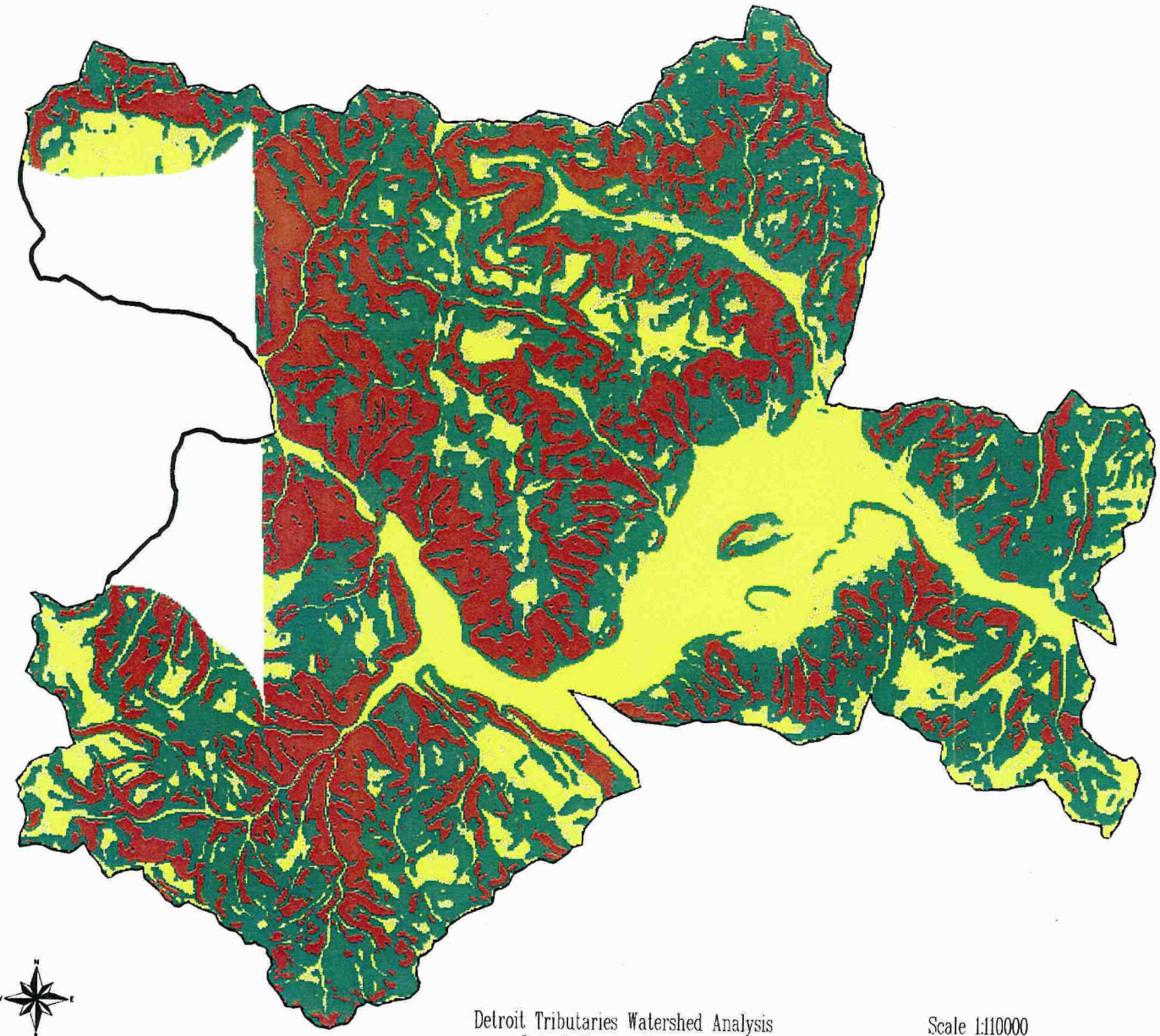
MAP II–7

Request #1478

Slopes



Legend

- Slopes 0 to 20%
- Slopes 21% to 30%
- Slopes 31% to 60%
- Slopes 61% and greater

Detroit Tributaries Watershed Analysis
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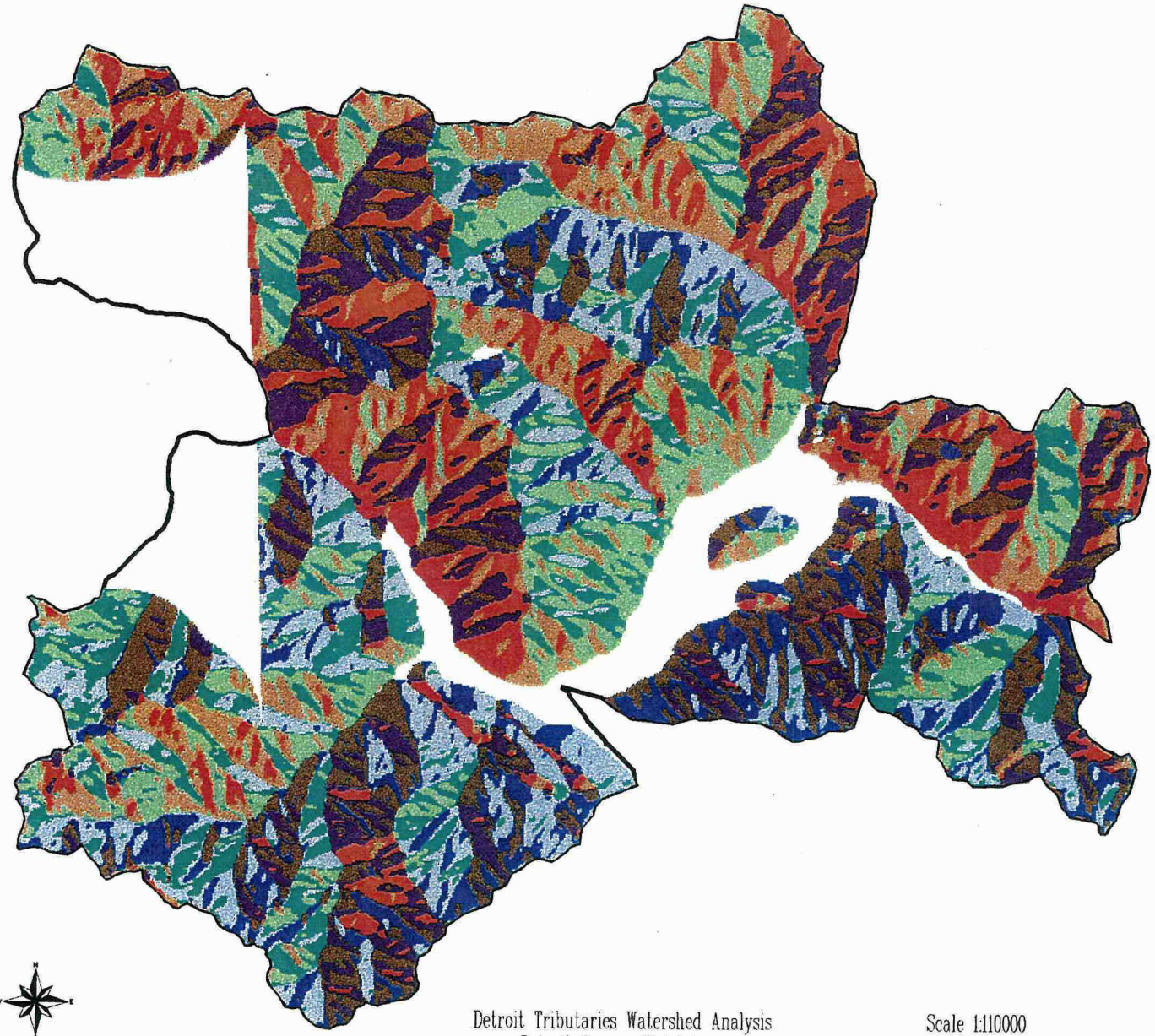
MAP II-8

Request #1486

Aspects



Legend
- North
- Northeast
- East
- Southeast
- South
- Southwest
- West
- Northwest

Detroit Tributaries Watershed Analysis
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MAP II-9

Request #1462

Topography: Topography in the watershed has been assigned High, Medium, and low hazard by the following characteristics:(See ***Table II-3 and Map II-7, Map II-8, and Map II-9***)

Table II-3:

Fire Hazard	Slope	Aspect(s)
High	over 40%	South, Southwest, Southeast, and West aspects
Medium	over 40%	North, Northeast, Northwest, and East aspects
	under 40%	South, Southwest, Southeast, and West aspects.
Low	under 40%	North, Northeast, Northwest, and East aspects.

Weather: Weather of the Detroit Tributary watersheds falls in the North Pacific fire climatic region. Rainfall in this coastal-mountainous slopes averages 80-100 inches of rainfall. Rainfall is concentrated in the winter months; summer rainfall is light. Combinations of high rainfall and moderate temperatures results in a buildup of extremely heavy fuel volumes.

The maritime influence, usually holds the fire danger to moderate levels during most seasons. However, some summers are very dry, and warm with high fire danger. During these periods, fires are characterized by high intensities, firewhirls, and long-distance spotting. The fire season usually runs from June through September. Lightning fires increase in number and severity closer to the mountains. High Fire Danger from strong, dry north to east winds in the late summer and early fall create the potential for stand replacing fires. This occurs when a cold front is followed by a Pacific High extending inland over the coast or when higher pressure develops east of the cascades at the time a trough lies along the coast intensifies the risk.

Fire Risk

Ignition sources within these watersheds are caused by lightning, human caused fires, sparks from machinery, and there is potential from downed power and telephone lines.

2. What value are associated with **fire control and management**?

- Preserving ecosystems that evolved with fire.
- Protecting values or resources at risk from stand replacing fires.

3. What are the highest priority issues or resource concerns associated with **fire control and management**?

Fire Hazard - physical features such as topography; the amount of fuel and how it lays on the landscape; and influences on the buildup of fuels such as winds, floods, insects, and diseases

- Recent wind storms and floods have resulted in an increase of downed timber throughout the watershed. This often results in increased bark beetle populations that eventually kill adjacent live trees. Furthermore, accumulations of downed and dead trees increase risk of stand replacing wildfire. The issue is whether management should actively respond to these events and reduce the fuel loadings by prescribed fire and/or mechanical removal of fuels or let nature run its course, taking the risk of a stand replacing fire occuring, given the effective weathers parameters, fuels present, and ignition takes place.

- Some of the high fire hazard areas are located in owl dispersal routes between Late Successional Reserves that occur to the north and to the south of the Detroit Tributary Watersheds. These areas also contain old growth. Although old growth conditions moderate the hazard, once a fire gets started in these areas, the probability of a large scale stand replacement fire is high. Of special concern are isolated patches of old growth surrounded by plantations.

Fire Risk - natural ignition source such as lightning; human ignition sources such as cigarettes, campfires, sparks from machinery.

- The Detroit Fire occurrence map shows that public use areas are prone to human caused fires. With increases in recreation use, there may be an increase in human caused fires.

- Fires beginning on private land from natural or human causes could spread onto public land , as well as fires starting on public lands spreading to private lands .

- The Cities of Detroit and portions of Idanha are surrounded by National Forest lands and are faced with urban-interface fire issues. Should a fire start on Forest Service land that surrounds Detroit City's municipal watershed, it has the potential to spread and significantly affect the quality and source of the city of Detroit's drinking water.

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

a. Current Conditions

ii-21. What is the current risk and hazard and the trends for fire within these watersheds? Where does it occur?

Table II-4: Fire Hazard in Detroit Tributary Watersheds (see ***Map II-10***)

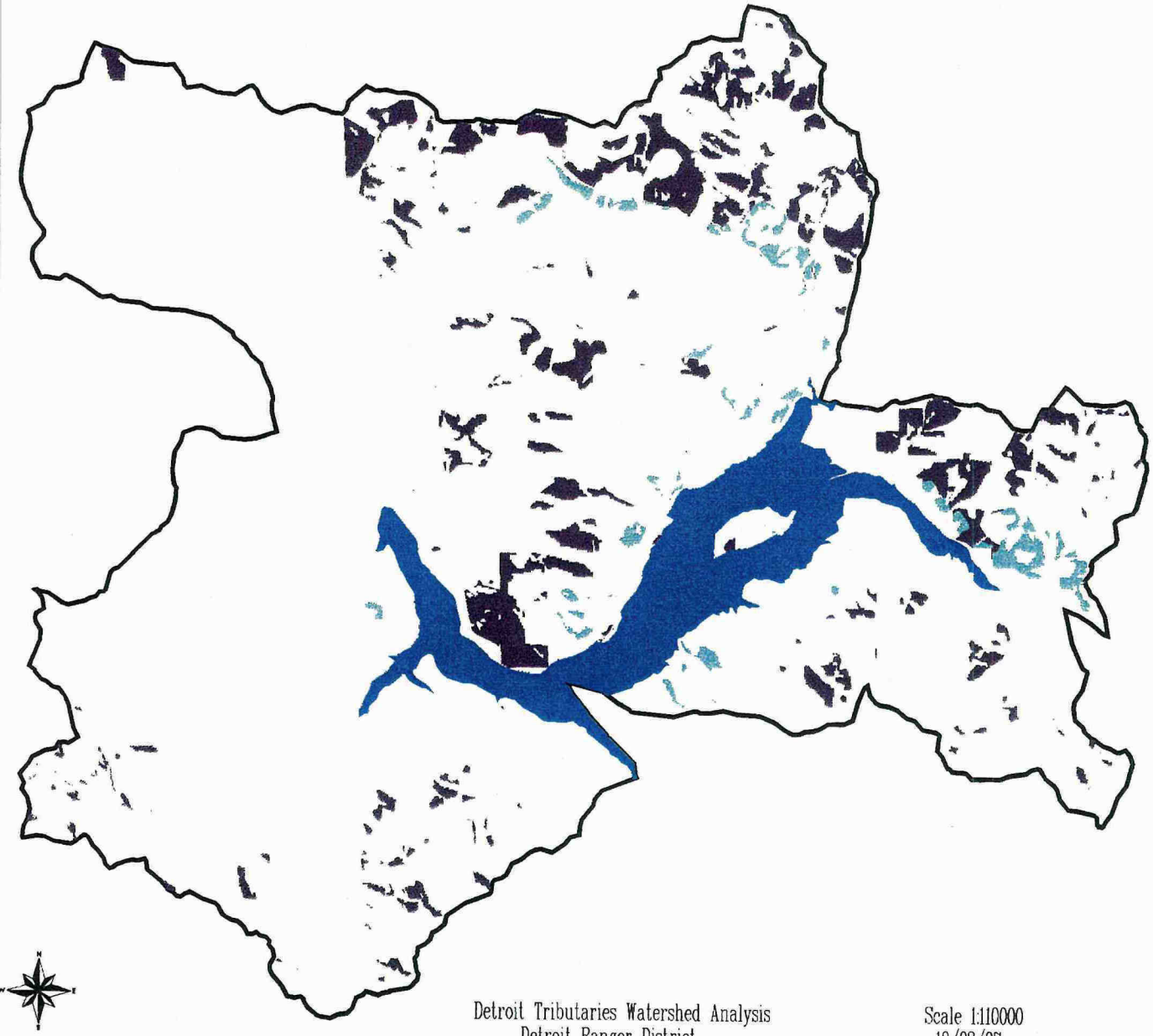
Fire Hazard*	Percentage of Watersheds	NFRDS fuel models	Topography (***Table II-3***)	Comments
High	13%	G , J, and K	High	Some of these High hazard areas have been identified as spotted owl habitat. Fuel loadings in as result of implementing Forest plan down woody requirements, run the risk of contributing to a stand replacing fire event, conflicting with the intent of Forest plan direction with regard developing and maintaining late successional structures in Late Successional reserves, Riparian reserves, green tree retention areas, and wildlife tree clumps.
Medium	63%	G , J, and K	Medium	
Low	24%	H, L	Low	

* This analysis does not include data for the private and state portion of the watershed existing outside of the forest service boundaries. Fire history maps suggest most of the private and state portions of the watershed last burned in the Sardine fire of 1951.

FIRE BEHAVIOR

Given what we know from PMR data (satellite imagery) that a large overview of the watershed is a Fire behavior fuel model 10, ***Aids to Determining Fuel Models for Estimating Fire Behavior*** (Hale E. Anderson , 1982) estimates that the fire behavior has the potential to be uncontrollable by direct attack by on the ground fire fighters. This is without factoring in steep slopes and the hotter s, sw, se, and west aspects that occur in this watershed. The possibility of an escaped stand replacing fire becomes high should a fire start and go undetected or initial attack is delayed. Decreased access into the watershed would delay initial attack.

Fuel Model and Fire Hazard Matrix



Legend

Fire Hazard High and Fuel Model G

Fire Hazard High and Fuel Model K

Detroit Tributaries Watershed Analysis
Detroit Ranger District

Scale 1:110000
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MAP II–10

Request #1479

c. *Reference conditions*

ii-22. What was the historical hazard and risk of fires within these watersheds? Where did fires occur?

Historically hazard (in respect to slope and aspect) was much the same as today, taken that the physical properties of slope and aspect remain the same as today, **13% high hazard, 63% medium hazard** and **24% low hazard.**

Fire history records (1800's) reveal a return interval of 10-30 years, indicating a low to moderate severity fire regime. The longer the interval, the higher the severity due to fuel buildup.

- **Moderate severity fire regime :** Fires are infrequent (25-100 yrs), they are partial stand replacement fires.
- **Low severity regimes:** Fires are frequent (1-25 years), they are low intensity fires with few overstory effects. (see Dave's fire history report for what historically the cause of fire was, ; i.e. risk)

d. *Comparison of Current and Reference Conditions*

*ii-23. What are the natural and human causes of change between historical and current **fire hazard and risk?***

Conditions

Reference- Prior to Forest Management:
Early fires in the area reveal a return interval of 10 - 30 yrs, , indicating a low to medium severity fire regime.
Larger patches of smaller structural stages (early successional) across the landscape from **low frequency stand replacing fires**, especially on south, and west aspects. **Fires prevented fuels buildup on south and west slopes.** Larger patches of larger structural stages in portions of watershed sheltered from fire regime (north, east, aspects, draws)

Conditions	Major Causes of Change
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	*Fuel buildup from* ***Fire Suppression*** *and natural events such as winds, and floods* ***Increase in Human Caused Fires***
Reference- Forest Management to 1994:	
Fire history records suggests a change in fire regime in the Detroit Tributary watersheds. Infrequent stand replacement fires since early 1900's suggest a **change to a high severity fire regimes**. High severity fire regimes are usually high intensity stand replacement fires. This fire regime is typically moist and cool; fires occur under unusual conditions, such as drought with dry hot winds (Pickford et al. 1980). Fires are of short duration (days to weeks) but of high intensity and severity. A cause for this change may be due to the success of fire suppression which has contributed to the build up of fuels.	
The **build up of fuels caused by fire suppression and by natural events** such as winds, floods contributes to the current hazards contributing to the risk of wild fire in the Detroit Tributary Watersheds.	
▼ ▼ ⇦ ⇦ ⇦ ⇦ ▼	*Fuel buildup from* ***Fire Suppression*** *and natural events such as winds, and floods* ***Increase in Human Caused Fires*** *from recreation, arson, and other human uses.*

Conditions

Current - 1994 to Present (see Reference- Forest Management to 1994)
Fire history and fire occurrence data show fire suppression to have been effective in the control of wild fire, although, it has contributed to the build up of fuels and the interruption of a needed disturbance in the balance of a functional ecosystem. This data presents **a low probability of fire in the watershed, although, the fuels present, combined with the topography, given the right supporting weather parameters, hazard does exist for a stand replacing fire in the watershed .** Should a fire start go undetected or there is a elapsed time of attack due to inaccessibility in this rough terrain or unavailability of resources, there is potential for a wildfire that is uncontrollable.
Fire occurrence records indicate a **increase in human caused fires.** This would be most probable due to the creation of the lake, rivers, and the access to recreational opportunities that the area provides. Human fires exist predominately around recreation sites, and of late, there has been an increase in premeditated set arson fires in high hazard areas in the Detroit area.