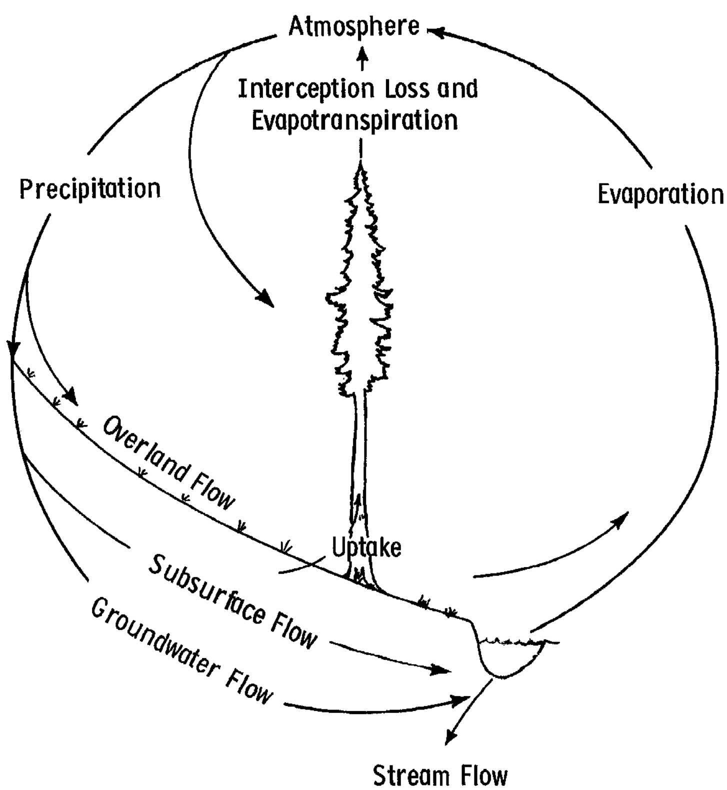
ECONOMIC CONSIDERATIONS OF MUNICIPAL WATERSHED USE:

TO GROW TIMBER OR WATER



Oregon Natural Resources Council

April 1996

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TO GROW TIMBER OR WATER

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PREFACE

This report was prepared for Oregon Natural Resources Council (ONRC) under the direction of Regna Merritt, Water Protection Advocate, ONRC. The report was completed by Dr. Hans Radtke (natural resource economist), Yachats, Oregon in association with Shannon W. Davis (planner), The Research Group, Corvallis, Oregon.

Dr. Radtke is an associate professor on courtesy appointment at Oregon State University and is a recognized leader in input/output analysis and natural resource economics. As a free-lance economist, he has worked on a variety of fish industry related projects: impact analyses of management alternatives for Oregon Department of Fish and Wildlife since 1979; policy analyses of management alternatives for the Pacific Fisheries Management Council since 1985; Economic Assessment Model for the West Coast and Alaska Fisheries since 1984; impact analyses for the Bureau of Land Management on a variety of issues from 1981-1984; policy analyses and research projects for Oregon Coastal Zone Management Association, Inc. since 1986.

Mr. Davis is a systems research specialist with 15 years of experience in the field of planning. His professional interests are in single/multiuse natural resource planning and management with a specialty in resource economic modeling. Mr. Davis served on the Pacific Fisheries Management Council's Scientific and Statistical Committee during which time the Fishery Management Plan for Salmon Management was converted into a framework plan. He has completed many projects involving resource user surveys. He authored, for the Oregon Department of Fish and Wildlife, the Oregon Angler Survey and Economic Study in 1991 and A Study of Fish Resource Related Revenues and Costs: Sources, Uses, and Benefits in 1993. These investigative studies described the economic contributions of natural resources from angling and determined fish management program user fee levels and user benefits.

The report contains methodologies recommended with the understanding that technically sound and defensible approaches would be used. Where judgment became necessary, conservative interpretation was to be employed. Because this philosophy was strictly adhered to in all aspects of the report, the material developed for the ONRC are reasonable estimates of economic tradeoffs of growing timber or water for municipal use in watersheds in Oregon.

This report is prepared to assist in decision making. The authors' interpretations and recommendations should prove valuable for that purpose, but no assurance can be given that decisions based on this plan will fulfill expectations of market demands nor achieve financial projections. Government legislation and policies, market circumstances, and other situations can affect the basic assumptions in unpredictable ways and lead to changes in study conclusions. Neither the study sponsor, nor any person acting on their behalf makes any warranty of representation, expressed or implied, with respect to the accuracy, completeness or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights.

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EXECUTIVE SUMMARY

Most Pacific Northwest municipalities depend on water that flows from streams in public forest land managed for multiple uses. As the population grows and economic activity increases, demand for water quantity and quality goes up, therefore causing a corresponding increase in the value of water. For watershed management, it may be more prudent to "grow water" than to "grow timber."

Early settlers to the Portland area recognized the importance of a future water source in 1892, when they dedicated the Bull Run area as a protected watershed. Since then, we have come to recognize that logging a watershed which provides domestic water creates costs which must be paid in the future. The U.S. Congress recognized the importance of protecting the Bull Run watershed in 1996 legislation. All cutting of trees except to protect water quality and quantity is banned in the Bull Run watershed. In addition, a two-year moratorium on logging in the Little Sandy is imposed while the potential of this watershed to produce water for the Portland metropolitan area is studied.

Many watersheds are managed for multiple use. The philosophy assumes that a variety of management objectives can be attained without appreciable damages to any of the uses. But when one dominant use, such as logging, has impacts on other uses, such as water quality, research suggests it may be beneficial to dedicate some watershed areas for a single use, providing drinking water.

For many municipal watersheds, not logging may provide more "usable" water. In the Pacific Northwest, the summer months of July and August, and sometimes early fall months of September and October, are usually low-water periods. During these months, water may have a higher environmental value for municipal use. A total economic cost accounting of alternative uses of municipal watersheds should include the costs and benefits which go directly to the municipal water utility company, as well as the environmental costs or benefits to the public at large.

An analysis of the harvesting of timber should include the costs of logging, as well as the costs of future growth at realistic future prices. Non-market value methods should be used to estimate alternative values in the watershed when no market values are available for environmental benefits.

The economic analysis of timber production involves two factors that are critically important, but often misunderstood or overlooked. These factors are the "inventory illusion" and the "time factor." The "inventory illusion" is when one is offered a business, a mine, or a stand of timber with the assumption that the inventory may be liquidated without any costs of replacement. The "time factor" is dependent on the use of the interest rate or discount rate. The interest rate is the single most important factor in the analysis of long-term investment decisions. Only with a low discount rate and fairly short rotation periods (less than 40 years) will decisions to manage for timber production be considered economically prudent for the long term.

Short rotation rates affect other critical uses, such as how much water will be available for domestic use, and what the quality will be. At longer rotation periods, of more than 50 years, it is critical that realistic prices and a low discount rate be assumed when managing for timber. When a municipality is deciding if it will "grow timber or grow water," and an interest rate of more than four percent is used, maintaining a watershed exclusively for water is a prudent economic decision. At higher interest rates and longer rotation periods, watershed protection, not timber production, is clearly the prudent economic choice (See Summary Table).

Much of the federal government uses a real rate of interest of between seven and 10 percent. These guidelines are set by the federal Office of Management and Budget. The U.S. Forest Service is allowed to use a four percent real discount rate, which allows them to justify certain timber management practices. For analysis of many other alternative uses of resources, the USFS uses higher interest rates.

The study can be summarized with the following points:

- It is prudent for municipal watersheds to be preserved for water quantity and water quality objectives.
- A case can be made on economic grounds not to harvest timber in municipal watersheds.
- Non-logged watersheds act as a reservoir for water in the crucial annual low-water periods of July to September.
- Unlogged areas act as natural reservoirs, and may avoid the construction of additional reservoirs and treatment capabilities. The avoided cost can be a significant saving.
- Water demand peaks at the time of low water run-off. Water pricing may be a tool that significantly reduces the need to construct new water sources.
- Municipalities that utilize federal lands and watersheds can present economic arguments to reduce or exclude timber management practices in their watershed. Municipalities that do not have federal lands in their watersheds should investigate purchasing land by themselves or by other public agencies for water management objectives.

Summary Table
A Comparison Between Timber Management Objectives and Municipal Water Objectives in Pacific Northwest Municipal Watersheds

	4% 50 Yrs	6% 50 Yrs	7% 50 Yrs	10% 50 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$15,982	$15,982	$15,982	$15,982
Preparatory Costs (compounded)	6,494	16,807	26,945	106,868
Annual Management Costs (compounded)	306	581	812	2,328
Returns to Timber Management Costs	9,182	(1,406)	(11,775)	(93,214)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	2,111	5,371	8,615	34,530
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	6,710	18,250	29,714	467,673
D. RETURNS TO TIMBER & WATER MANAGEMENT	361	(25,027)	(50,104)	(595,417)
E. LOST IN-STREAM BENEFITS	268	508	712	2,037
F. RETURNS TO MULTIPLE USE OF WATERSHED	93	(25,535)	(50,816)	(597,454)

	80 Yrs	80 Yrs	80 Yrs	80 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$30,509	$30,509	$30,509	$30,509
Preparatory Costs (compounded)	21,054	96,635	291,283	1,870,643
Annual Management Costs (compounded)	1,102	3,494	6,378	40,948
Returns to Timber Management Costs	8,353	(69,620)	(267,152)	(1,881,082)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	6,672	31,331	66,567	601,936
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	23,365	12,505	229,361	2,778,320
D. RETURNS TO TIMBER & WATER MANAGEMENT	(21,684)	(113,456)	(563,080)	(5,261,338)
E. LOST IN-STREAM BENEFITS	964	3,057	5,580	35,830
F. RETURNS TO MULTIPLE USE OF WATERSHED	(22,648)	(116,513)	(568,660)	(5,297,168)

Notes:
1. On a per acre basis.
2. At discount rates of 4% and above.
3. 50 and 80 year rotations.
4. ( ) denotes negative benefits.

Source: Study.

CHAPTER I
INTRODUCTION

Most Pacific Northwest municipalities depend on water that flows from streams in public forest land. Some communities' water source is in watersheds managed for municipal water uses. Other communities' water source has little protection, with their watershed managed more for multiple uses, including timber extraction. As the population and economic activity increase, demand for water quantity and quality goes up, therefore causing a corresponding increase in the value of water. A study was needed to determine whether there should be more emphasis on managing watersheds that serve as municipal water sources for multiple uses or protected for a single use. This report provides the economic arguments for watershed management decision making.

The study describes procedures to estimate the economic value of intact watersheds that are being used for water sources. The economic value is compared to costs of alternative uses of the watershed, such as timber growing. Economic methodologies address the additional costs of treatment, storage, etc. necessary for altered watersheds. Three diverse municipal watersheds are selected as case studies to specify and test the procedures. These three were chosen for their unique watershed land ownership and other criteria that can be compared to other municipal watersheds. Documentation is provided so that the procedures can be applied to other examples.

The procedure of the project was to gather information on the economic value of water for municipal use. This was done in several ways. One way of measuring the value of municipal water is to look at the pricing of water in the West. What kind of markets for water transferals exist? How much are municipalities willing to pay for clean water? The second stage was to estimate the cost of clean drinking water under several scenarios: with no disturbance, with heavy alternative use of the watershed and resulting treatment requirements, and several scenarios in between.

The economic costs and benefits of alternative economic use of municipal watersheds (mostly tree growing and harvesting) was evaluated on an annual basis (e.g. annual water benefits versus cutting once in 80 to 100 to 150 years of tree harvesting. The product was to be a descriptive document with a modeling capability to allow other municipalities to evaluate their watersheds.

Specific tasks were as follows:

Task 1: Review existing studies on municipal water pricing in the West. This task is so that guidelines can be established on the market value of municipal water.

Task 2: Describe the economic costs of timber growing in municipal watersheds - trade off between water quality and timber production. Timber growing and harvesting is the main alternative use of most municipal watersheds. Inland streams and rivers provide water used for municipal use as well as habitat for fish and wildlife. Timber harvest in key watersheds can have an adverse impact on the quality of that habitat. That impact can be reduced by curtailment of timber growing for harvest purposes.

The purpose of this task was to evaluate some basic concepts used in evaluation of timber production.

a. Key concepts in evaluating timber production (costs, returns, etc.)
b. The importance of the interest rate. This is especially important in long term versus a steady stream of short term benefits.

Task 3: Estimate the economic cost of sedimentation and benefits of forest cover. This task is to estimate the value of the forest cover in terms of reduction in sediment load (costs of digging out reservoirs periodically) as well as the added economic value of increased water retention (the value of "fog drip").

Task 4: Estimate the added rate payer (domestic and industrial) cost of treatment due to municipal watershed disturbance. Costs include such itemization as: filtration, chemicals, other. Part of this task was to review studies and qualitatively describe the added health problems that may be related to increased chemical intake of users (e.g. effects of chlorinization).

Task 5: Develop spreadsheet and document for its general application to other watersheds. Describe application of procedures to three case examples.

This report outlines the general methodologies of such an analysis. The costs and benefit analysis resulting from resource use in a specific municipal watershed is a different analysis that is not provided in this report. However, the modeling methodology can easily be altered to reflect such differences. It is not anticipated that such differences will change the general conclusion of this report. That is, it is prudent to protect municipal watersheds for quality and quantity domestic water use considerations.

This report provides a background description of key concepts and a literature review on the economic value of watersheds. Chapter III is an overview of timber production investment analysis. Chapter IV compares the alternatives of utilizing a municipal watershed to either "grow timber or water." The final chapter reviews the alternatives facing three municipalities in Oregon, using the study methodological approach.

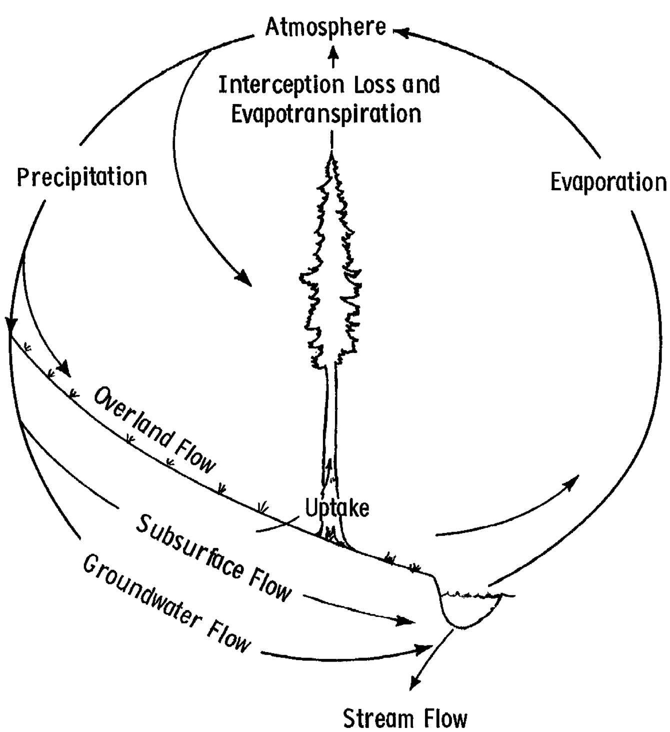
CHAPTER II
BACKGROUND

A. CONCEPTS

1. Water Resources

The hydraulic cycle, shown in Figure 1, depicts the movement of water through a forest ecosystem. The diagram illustrates very clearly that water flow is a key component of the environment, linking together the atmosphere, soil, plant community, and stream components of this system.

Figure 1
The Hydrologic Cycle for a Forest

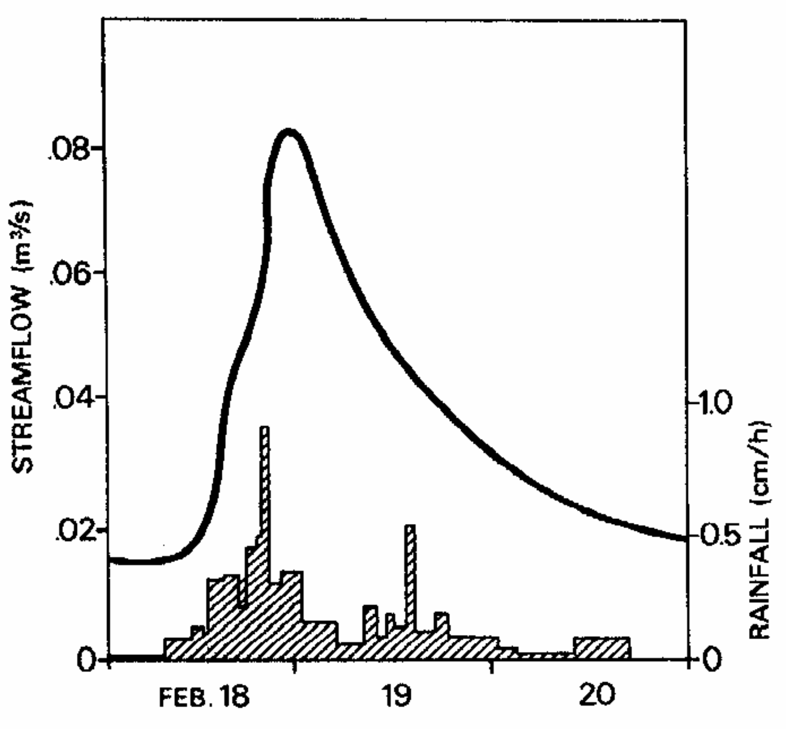


Source: Brown 1991, p. 1.

Runoff and streamflow in small, undisturbed forested watersheds is primarily the result of water flowing through the forest soil, rather than over it. In western Oregon, for example, overland flow as a sheet of water is rarely observed, even under high rainfall events. Infiltration capacities may be several times greater than the maximum rainfall rates. This is particularly true on undisturbed watersheds. Hewlett and Hibbert (1967) have described the runoff process in undisturbed watersheds as a displacement phenomenon, which they call "translatory flow." Rainfall infiltrating the soil mantle moves downward through the soil profile, displacing or bumping water stored in soil pores. Implicit in this description is the hypothesis that not all portions of a watershed will contribute equally to streamflow from a given rainfall event. Those areas near the stream with higher levels of soil moisture will contribute a higher proportion of rainfall than those soils near the ridges which are drier and more distant from the streamcourse. Further, those zones within a watershed which contribute to streamflow will vary, depending upon the amount of stored water they contain. Thus, during dry seasons, only a very small portion of the watershed would contribute to streamflow during a storm. As the watershed became wetted by successive precipitation events, a greater proportion of the watershed would contribute to streamflow. This concept of a zone of contribution to streamflow which shrinks and expands as soil moisture levels change has been termed the "variable source area concept." The concept has major implications for understanding the quality of water in forest streams and how this quality varies during the annual hydrologic cycle.

The concept of translatory flow is also helpful in understanding how forest streams respond so quickly to storm events in the absence of overland flow, or surface runoff. Streamflow may begin to increase almost immediately following the onset of precipitation, primarily as a result of displacement. In western Oregon, for example, peak streamflow follows peak rainfall very closely (Figure 2). Likewise, undisturbed forest soils, with a high proportion of their volume in macropore space, can transmit water very rapidly. Rothacher et al. (1967), note that maximum runoff rates approached 80 percent of the average rainfall rate for the previous 12 to 24 hours.

Figure 2
Precipitation and Streamflow at Watershed 10,
H.J. Andrews Experimental Forest, February 18-20, 1974



Source: Brown 1991, p. 2.

2. Water Use

Streams flowing from undisturbed forests generally have excellent quality (Brown 1991, p. 3). It is this characteristic that makes small streams so valuable for not only fish production but for domestic and industrial use. In the Pacific Northwest, over 300 municipalities obtain domestic water from such streams. Often, this water requires little more than a light chlorination before entering the distribution system. Urban society also seeks recreation sites by forest streams, partly because the streams are aesthetically pleasing and partly because the water is of high quality.

Water quality and quantity is affected by a series of physical and biological components. The levels of water quality and quantity flows can be affected greatly by natural and human actions. For example, the timing of water flow changes and the level of suspended sediment can increase greatly after timber harvesting. Sediment is an important factor determining the quality of water in forest streams because it affects the use to which water can be put, especially for domestic water supply.[1]

The flood of 1996 underscored the dependence of Oregon's municipalities on forest watersheds for its drinking water. "Portland had run out of options: for the first time in 101 years, Bull Run water was unsafe to drink. Officials faced warning nearly 800,000 people to boil their water . . . as the Bull Run ran muddy, they (City officials) started drawing water from two dozen wells unused since 1987 because of the threat of contamination" (Nokes 1996). In Salem ten days after the flood, "We're afraid to brush our teeth or flush the toilet. Many offices bring in bottled drinking water for employees" (Statesman Journal 1996).

Besides an abnormal amount of warm rain that fell in a short period of time, past logging and related road building activities were blamed for some of the damage caused to municipal water systems by the flood of 1996. "A 1975 study by Fred Swanson, a Forest Service resource geologist, looked at timber harvests in a federal forest watershed east of Eugene. Swanson found that the combined effects of logging and road building 'appear to have increased slide activities about five times relative to forested areas over a period of about 20 years.'" (Berton 1995).

The City of Salem's watershed covers more than 500 square miles of land; almost 90 percent of the land in this watershed is public land. Logging activities as well as other human activities in this watershed exacerbated the City of Salem's water problems during the flood. Sedimentation originating in the watershed was held in a man made reservoir for a longer period of time than would have been the case without a major impoundment such as Detroit Reservoir. For a system such as Salem's that utilizes a slow sand filter, persistent high turbidity levels can be a troublesome and expensive problem. The delivery pipeline on the banks of the river was being washed out in sections that had been straightened resulting from construction activities.

1. Much of the previous discussion has been taken from Brown (1991).

Some other municipal water companies reported no special problems resulting from the flood. For example, the City of Yachats drains its water from a small 1,000 acre watershed that is unroaded and unlogged. The approximately 13 inches of water that fell within four days caused no unusual problems.

The perception is that such activities as logging and road building in municipal watersheds cause inconvenience and financial hardship to municipal water utilities, businesses, and households that depend on these watersheds for their water. Some problems may be a direct result of human activities; some problems may have occurred anyway as a result of the extraordinary high levels of rainfall in the first of February 1996.

Each municipal water system and water source has its own specific advantages and problems. The purpose of this study is to discuss a general methodology that may be used to analyze the use of a watershed when competing users vie for a scarce resource. In this instance the scarce resource is high quality water that is safe and deliverable in required amounts throughout the year.

B. LITERATURE REVIEW

Many western Oregon municipalities maintain forested watersheds as a source of municipal water supply. It is not uncommon for these municipalities to periodically log parts of these watersheds and sell timber as a source of municipal revenue. However, logging a watershed used as a source of domestic water supply has certain costs. This document provides a brief overview of economics literature which may prove useful in an effort to assess the economic costs of alternative uses of municipal watersheds. Four general types of studies are reviewed:

1. Studies assessing physical changes in water yield, quality and temperature resulting from logging western Oregon watersheds.

2. Studies describing methodological frameworks for assessing costs and benefits of alternative watershed management plans.

3. Studies describing the cost to municipalities of providing water from alternative sources when logging reduces watershed water yield.

4. Overview of the benefits of water use and water markets.

5. Description of how water markets work.

1. Physical Effects of Logging: Water Yield, Water Quality, and Water Temperature

In many settings clear cutting of forests results in increased annual water yield (Bosch and Hewlett, 1982; Rothacher, 1970). The increase in streamflows has been primarily attributed to reductions in interception, evaporation, and transpiration that occur when forests are removed.

In many parts of western Washington, Oregon and northern California, scientific evidence indicates a different relation between logging and water yield. In Portland's Bull Run watershed, logging has been shown to reduce stream yield during critical low water periods. In this setting forests intercept significant amounts of wind blown fog. Harr (1982) measured 30 percent greater precipitation in forested sections than in the clear cut sections of a patch cut area of the Bull Run watershed. Harr concludes that streamflow reductions of 20mm/year resulted from clear cutting. He states "preliminary analysis based on this study and management still being planned suggests a maximum reduction in annual water yield of 220mm or about nine percent if comparable fog drip occurs over the entire Bull Run watershed." Subsequent studies (Harr and Fredriksen, 1988) estimated that maximum stream temperatures increased 2 to 3 ºC after logging, but temperature increases had mostly disappeared within three years as vegetative growth shaded the streams.

Hicks (1991) analyzes further measurements taken from the same experimental watershed. Their results indicate significant decreases of 25 percent and 14 percent respectively in July and August streamflow as a result of clear cut logging in the Bull Run watershed. Results also indicate increases in stream temperature in July and August with potentially significant salmon mortality consequences. Hicks (1991) predicts, using regression analysis, that water yield after clear cutting in a part of the Bull Run watershed was 20 percent greater than it would have been had the area not been logged. However, in streams of the Pacific Northwest most of the increase in annual water yield following logging occurs from October to March, when water is not in short supply (Harr 1983). The period for which increased summer water yield persisted was short, especially considering the portion of the time that it would represent (eight to 11 percent) during a rotation time of 70 to 100 years under intensive forest management. Following the period of increased water yield immediately following logging, timber harvest may actually reduce July and August streamflows for many years. So far the period of reduced yield has been 19 years, or 19 to 27 percent of the period of a rotation. The actual length of time for which reduced summer flows persist is not known, but they may continue for several decades, until conifers grow large enough to suppress growth of riparian hardwoods.

2. Methodological Frameworks for Assessing Costs and Benefits of Alternative Watershed Management Plans

In case studies, Griffin and McCarl (1989) and Bowes and Krutilla (1989) outline methodologies for comparing the costs and benefits associated with managing Texas brushland and Colorado timberland for water yield. Griffin and McCarl (1989) review the possible benefits of brush control for additional water yields. They caution that even where excess capacity for water storage does exist, the quantity of brush management-produced water may exhaust this capacity and accelerate the construction of new facilities, which is another cost. Simulation results of studies in Arizona demonstrated that brush management produced surface water comes mostly during high flow periods when receivers are nearly full. Additional facilities (and additional costs) may be needed to realize out of stream water benefits. Both studies suggest that municipal watersheds decisions should be based on what environmental economists refer to as a total economic cost accounting. That is to say that cost and benefits which accrue directly to the municipal water utility company as well as environmental benefits or costs which are incurred by the public at large should be considered. An example of such accounting is given in Table 1 (Griffin and McCarl, 1989).

Some of these costs and benefits may be relevant to watershed analysis in the Pacific Northwest. The point should be made that harvesting standing timber may be a short term benefit; however, the costs of replanting on some lands may be greater than the benefits received from such plantings when harvests occur in 50 to 80 or 100 year periods. Bowes and Krutilla (1989) conclude that the net present value of logging in forests in the Central Rockies is not large enough to cover the harvesting costs plus the cost of road access.

The most obvious direct cost of logging in western Oregon watersheds which reduces water yield is the cost of supplying water from an alternative source that costs more. To the extent that changes in water yield as a result of logging persists over long time periods, the relevant cost is the long run cost of marginal water supply. Because demand for municipal water is generally growing over time, long run costs generally involve amortized costs of new water purification capacity, as well as the variable cost associated with purifying water.

3. Cost Studies

Estimates of the long run marginal cost of municipal water generally lie in the range between \$40 to \$400 per acre foot. The marginal value of some alternative uses of water such as agriculture are about \$10 to \$35 per acre foot, for industrial use about \$100 per acre foot, and for hydroelectric use about \$20 per acre foot (this does not include the value of peak demand) (Griffin and McCarl 1989; Renzetti 1992; Mercer and Morgan 1985). Mercer and Morgan summarize the long run cost, on the average, of marginal water for thirty California municipalities. They conclude that conservation through the price system is cheaper than the least cost additional water supply alternatives. The Renzetti study of the Vancouver B.C. municipal water utility gives estimates of the seasonal variation in long run and short run marginal supply costs. The author finds cost to be higher by about 50 percent in the summer season.

These findings are interesting when compared to Pacific Northwest water yield studies of logging watersheds that find that timber harvests may actually reduce July and August streamflows for many years (Hicks, et al. 1991). Some economic costs may accrue due to water shortages (Cabezas and Wurbs 1986). Economic losses due to water shortages consist of losses to consumers and suppliers associated with the implementation of emergency water conservation measures and other damages caused by lack of water. Economic losses come from two sources: losses due to lost production and/or capital investment, and losses due to opportunity costs. The first type of loss is in terms of regional economic losses due to droughts. Opportunity costs are basically inter-regional costs, defined as annual benefits lost by disappointed users, less the costs avoided by the supplier.

Table 1
Economic Values Quantified by Previous Studies

Region Vegetation	Arizona Chaparral /2	Arizona Pinyon-Juniper /3	Arizona Chaparral /4	Western Colorado Forests /5
BENEFITS:				
Water	X	X	X	X
Livestock	X	X	X	?
Game Animals	?	?	?	?
Nongame Animals	?	?	?	?
Game Birds	?	?	?	?
Nongame Birds	?	?	?	?
Freshwater Fish	?	?	?	?
Saltwater Fish	?	?	?	?
Other Recreation	?	?	?	X
Erosion	?	?	?	?
Nonpoint Source Pollution	?	?	?	?
Hydropower	X	X	?	X
Fire Reduction	X	?	X	?
Harvested Timber	?	?	?	X
COSTS;				
Livestock Management	X	X	X	?
Vegetation Treatment	X	X	X	X
Maintenance	X	X	X	X
Treatment-Related Damage to Plant/Animals	?	?	?	?
Seeding	X	X	?	?
Water Development	?	?	?	?
Erosion	?	?	?	?
Non-Point Source Pollution	?	?	?	?
Flooding	?	?	?	?
Environmental Impact Statement	X	?	?	?
Agency Overhead	X	?	?	?

Sources:
1. Griffin and McCarl, 1989
2. Brown et al. 1974.
3. Clary et al. 1974.
4. O'Connell 1972.
5. Krutilla et al. 1983.

It is likely that logging activity in a municipal watershed may lead to some increases in siltation. Holmes (1988) estimates that sediment discharges to surface water supplies induce treatment costs of $17.11 per thousand tons discharged. This includes treatment and cleaning out sediment periodically from a holding reservoir.

4. Competing Use of Watersheds

Everyone is familiar with water as a market commodity, for example as municipal or bottled water. Streamflows provide various market and nonmarket uses. Instream flows are needed for commercial navigation along waterways, and for commercially marketed hydropower. They provide valuable aquatic habitat for economically significant fish species, thus they are an unpaid factor of production for commercial fisheries. However, many of the most valuable uses of instream flows occur in water related non-commercial activities, including sportfishing, swimming and boating. Also, stream water may provide substantial aesthetic benefits (Douglas and Johnson 1993).

Diversionary uses of stream flows obviously compete with instream uses. Streams may be completely dewatered by agricultural diversions for crop irrigation or by municipal diversions.

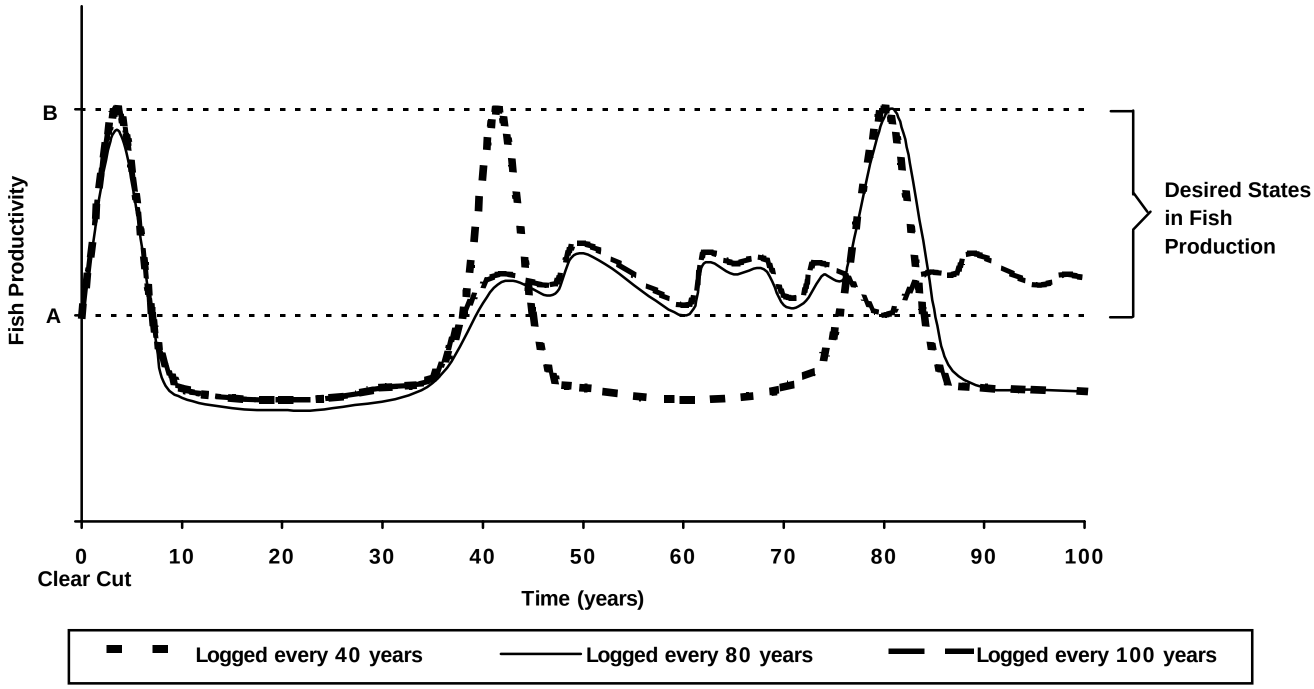
An even more competitive situation is the case of water use in a watershed that is also being managed for timber harvests. Forest management alters the quality and the timing of the flow of water. In the Pacific Northwest clearcutting will change the flow of water to low flows in late summer and early fall, when demand for municipal, recreational, and aquatic use is the most critical.

For municipal use, the requirement for meeting higher water demands in late summer in normal low water flow periods may involve actions to reduce peak demands or increased capital investments in water storage. The benefit of not cutting trees is to allow the undisturbed watershed to act as a natural reservoir for the critical low water years.

Competing uses of the watershed will also directly affect output of other uses, for example salmon production. Forest succession is an important component in salmon survival. The condition of forests along the riparian zone is of great importance to salmon. Moreover, this effect is important enough to lead to changes in fish production during forest succession (the process of development of a forest following clearing). Figure 3 shows that immediately after clearing, there is a short but large increase in salmon production. The increase in production lasts five years or less, after which fish production falls below the long-term range, which is indicated by the lower and upper boundaries. Salmon production remains in this low region during about 40 years of forest succession, after which forest conditions, for salmon, become equivalent to those under older forests, and the potential production is within a middle range, varying from year to year with other factors, but less than the zero-to-five-year peak and greater than the five-to-40-year low.

The model depends on three assumptions: (1) only if the resultant increase in stream temperature due to the disturbance does not exceed the tolerance limit of the fish; (2) only if there is a future of the system. When a system is disturbed such as in a logging operation, it then has a higher probability of failure than it previously did; and (3) only if the increased light available to the stream does not result in rapid growth of filamentous algae which is detrimental to the fish populations. This model suggests that long-term, average potential

Figure 3
Hypothetical Production Level of Salmon Over Time Under Logging Rotations of 40, 80, and 100 Years (Desirable Levels of Fish Production Fall Between A and B)



Source: Botkin et al. 1994.

salmon production will increase with time from clearing and coverage on some asymptotic level after approximately 70 years (Botkin et al. 1994).

The problem of competing uses of a watershed between timber and fish is that long rotations of timber management are not prudent from a strictly investment criteria, while shorter rotations are not beneficial to aquatic life.

5. Water Markets

In some western regions a market for water is developing. Water transfers from agriculture (usually taken at the source of agriculture intake), are increasingly seen as the most appropriate means of meeting growing municipal demands. For example, in 1991 farms in Yolo and Solano counties in California provided the State Drought Water Bank with 196,000 acre feet of water. In exchange, the farmers were required to fallow their land and they received $125 per acre foot of consumptive water use. The overall regional economic impact of this exchange was neutral (Howitt 1993).

The attraction of water transfers from uses such as agriculture to municipal use lies in the generally high amount of water use by agriculture and the apparent willingness of municipal users to pay higher water rates (Conner 1995).

CHAPTER III
ECONOMIC ANALYSIS AND TIMBER PRODUCTION

Economic analysis of timber production involves two factors that are critically important to economic analysis, but that are often misunderstood or overlooked. These are the "inventory illusion" and the "time factor." A discussion of interest rates or discount rates is used to explain the time factor. The discussion of discount rates is offered because it explains the cost of money over time and assumptions about them are critical for investment decision making.

A. INVENTORY ILLUSION

The "inventory illusion" takes place when one is offered a business or a stand of timber (or a mine, herd of buffalo, grocery store, etc.) with the assumption that the inventory may be liquidated without any costs of replacement. Many examples may be offered, such as:

- American Buffalo Herd. The American Buffalo was hunted to extinction because of the presence of a huge inventory of animals. The benefits at the time of hunting clearly were greater than the long-term costs, because no costs were included in a policy to maintain a herd.

- Pacific Northwest Salmon. Over time in the Pacific Northwest, salmon have been harvested at a rate that is not sustainable. When destruction of natural habitat was mitigated, the costs of maintaining a level of salmon harvest close to historic levels is considered by many as too costly.

- Mining. Much of the West was settled based on quick returns from mining metals. Most mining included only the costs of extraction and did not include the costs of replenishing the resource.

- Nuclear Power. Nuclear power seemed to be the cheaper alternative for many nations' energy needs. As factors of risk (Chernobyl) and costs of spent fuel, etc. are included, the true cost of this almost "free" good are being reassessed.

- Old Growth Forests. "Liquidating old growth forests is not forestry; it is simply cutting old growth trees - spending our inheritance" (Maser 1988). The argument in this article is that by following intensive forestry principles without consideration of soil depletion, wood fiber production and other benefits derived from the forest will decline dramatically after the first rotation. Until recently in Oregon's forestry management history, the trees were cut and the land was left to regenerate itself. In this manner, with practically no regeneration costs, a new stand becomes available perhaps in about one hundred years. The new generation is then confronted with the "inventory illusion" and decides to harvest the timber. Today, however, replanting and cultivation costs have to be included in management decisions, making the decision to harvest not as straightforward as it might have been.

- Grocery Store Gift. If one were to receive a grocery store with inventory as a gift, it would be easy to show a profit by selling the inventory without replenishing it. By selling the inventory quickly one may also take the cash return and invest in other more profitable endeavors. To stay in the grocery business is therefore no reflection of the inventory gift, but rather a reflection of the future stream of costs and revenues and overall profits.

B. TIME FACTOR

To grow trees in the Pacific Northwest to maturity takes a long time. Many of our natural stands are over 100 years old. The ones that survived fires may be 200 years and more. Areas that were logged in the early years of settlement are now over 100 years old. The stands logged during World War II are beginning to reach levels where harvesting decisions are being contemplated.

In any kind of business analysis that does not include other costs (beside harvest costs) or future intensive management costs, the total clear cutting option is clearly the best choice. However, when management costs are included as a factor over a long period of time, the cost of money becomes the important factor. The cost of money is usually reflected by the interest rate. At periods over 40 years, the interest rate becomes the most crucial part of any economic analysis.

1. Social Rate of Discount[1]

Because many natural resource allocation decisions made by public bodies involve a long time period, considerations are often given to the inclusion of lower interest rates. These considerations are especially crucial when intergenerational use of unique natural resources is considered, which does not necessarily involve investment type decisions.

The social rate of discount is the rate that should be used to compute the present value of benefits and costs of public investments and public policies if decisions based on benefit cost analysis are to be optimal. The following summary of factors should be included in choosing a social rate of discount.

- *Social Rate of Time Preference* - the rate at which society is willing to exchange consumption now for consumption in the future.

- *Consumption Rate of Interest* - the rate at which individual consumers are willing to exchange consumption now for consumption in the future.

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1. Lind 1982.

- *Marginal Rate of Return on Investment in the Private Sector* - the rate required to satisfy investors after alternative investments have been considered.

- *Opportunity Cost of a Public Investment* - the value of the private consumption and investment foregone as a result of that investment.

- *Risk* - this is related to the degree to which variation in the outcome of a public project will affect variation in the payoff from the nation's total assets.

The inclusion of the social rate of discount may make sense for considerations of unique resources that are to be held for future generations; however, when investments in timber production also include a four percent discount rate, many of the reasons for giving special considerations are no longer justifiable.

A lower interest rate will work against uses such as water quality or fish and wildlife, because most return a near-term and steady stream of annual benefits, while trees return a benefit only far into the future. By taking a four percent discount rate versus a ten percent discount rate, and deriving the present value of timber versus fish and wildlife, it can be shown that the lower interest rate will shift the advantage in favor of timber over wildlife, fish, or other water uses. Therefore, fish, wildlife, and other water uses protection or investments will be disadvantaged in the analysis even if all other methods and assumptions are neutral.

2. Interest Rates Appropriate to the Economic Analysis of Public Lands Management[1]

In most public land management actions, the benefits and costs vary over time. Adding a dollar's worth of benefits today to a dollar's worth of benefits in twenty years implies that people are equally willing to trade a dollar today for a dollar in twenty years. We know that this is incorrect. One might suspect that it is incorrect because of inflation, but although inflation is certainly a problem, the benefits and costs of public management actions are normally measured in real dollars (adjusted for inflation). Therefore the main issue is whether a dollar of a benefit, for example camping, today is equal to an inflation-proofed, or real, dollar of camping benefits in the future. Put another way, would you give a dollar today in exchange for a guarantee to receive a dollar (fully indexed in value for inflation) twenty years from now? The chances are that you would not treat a dollar today and an inflation-indexed dollar twenty years from now as equivalent. There are two reasons for this. First, there is the time preference for consumption. Other things being equal, most people prefer their enjoyment or benefits now rather than later, and they are willing to pay an interest premium to borrow money for this purpose. Second, if a person is to forego consumption benefits today, he or she can invest the money in a productive enterprise that will yield a net return.

1. Much of the discussion on the appropriate interest rates is taken from Loomis (1993).

a. The Discounting Process

The interest rate reflects both the "time preference" for money and the rate of return that could be earned by investing this money. Most people are familiar with the concept of compound interest rates. For benefit/cost (B/C) analysis, where we wish to take a future flow of monetary benefits and calculate the value in the present period, the reverse process is used, called discounting. This takes those future dollar benefits and costs (real or inflation indexed) and computes their present worth. For example, it answers the question: how much benefit does $10 in benefits twenty years from now provide in benefits today?

An example may help to illustrate this process. If the interest rate is 7.125 percent, this implies that $1.00 of benefits ten years from now is worth $0.50 to us today. Thus, at 7.125 percent interest rate, $0.50 today and $1.00 in ten years are equivalent in terms of their present worth or value to me today.

If we know what interest rate people use to be indifferent between present and future consumption, we can convert any future benefit into an equivalent present value. We can do this for the entire stream of benefits and costs over the life of a public project, and determine if the present value of the benefits is worth the present value of the costs. For example, at 10 percent interest rate, the present value at year 0 of $500 per year in benefits and an initial investment cost of $2,000 with annual operation and maintenance costs of $200, would calculate as shown in Table 2.

Figure 4 provides a graph of the distribution of present value of $1.00 received over 50 years at a four percent, seven percent and 10 percent discount rate. Note the rapid drop-off at 10 percent compared to four percent. For example, cutting the discount rate from 10 percent to four percent results in a more than doubling of the present value of a dollar to be received in year 20.

b. Selecting the Interest Rate

The selection of the appropriate discount rate of both philosophical and practical importance. Lind's recent reassessment of determination of the discount rate recommends that the appropriate government discount rate should be the interest rate the government must pay when it borrows (Lind 1990).

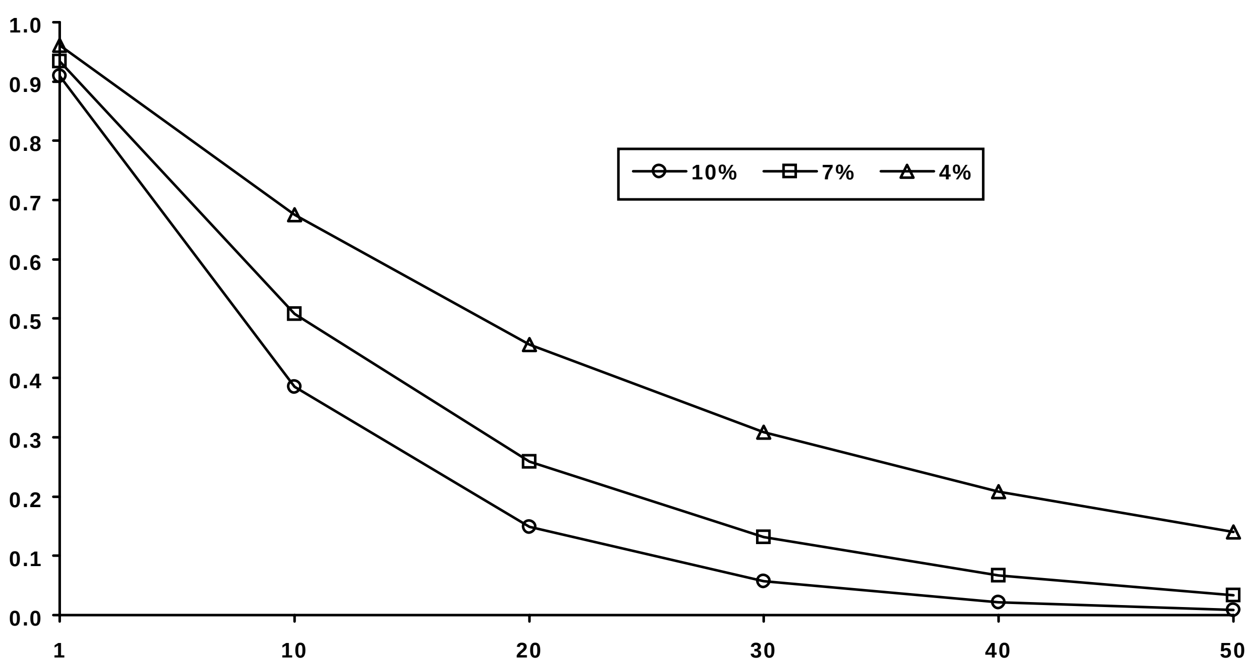
Another group of economists stresses the "social time preference" in determining the discount rate. In particular, they start by viewing the discount rate as a measure of people's preference for present versus future consumption, and then introduce a public goods or beneficial externality argument, which states that individuals care more about future generations than their private savings decisions might indicate.

Table 2
Comparison of Discounted and Undiscounted Benefits and Costs at 10% Interest Rate

	Discount	Benefits		Costs		Net Benefits
Year	Factor	Nominal	Discounted	Nominal	Discounted	Discounted
1	0.9091	$500	454.55	$2,000	1,818.20	-1,363.65
2	0.8264	$500	413.20	$200	165.28	247.92
3	0.7513	$500	375.65	$200	150.26	225.39
4	0.6830	$500	341.50	$200	136.60	204.90
5	0.6209	$500	310.45	$200	124.18	186.27
6	0.5645	$500	282.25	$200	112.90	169.35
7	0.5132	$500	256.60	$200	102.64	153.96
8	0.4665	$500	233.25	$200	93.30	139.95
9	0.4241	$500	212.05	$200	84.82	127.23
10	0.3855	$500	192.75	$200	77.10	115.65
Discounted Sum			$3,072		$2,865	$207
Net Present Value						$207
Benefit/Cost Ratio						1.07

Source: Loomis 1993, p. 140.

Figure 4
Present Value of $1 Over 50 Years Using Various Interest Rates



Source: Study.

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c. Interest Rates Used by Federal Agencies

Federal agencies use different interest rates for their economic analysis. It would seem that it is at least as important to have a consistent discount rate across all public land management agencies as it is to have one that is theoretically correct. Reviewers of management plans need to be aware of how the interest rates affect the justification of one management alternative over another.

Much of the federal government uses a real rate of interest of 10 percent set annually by the federal Office of Management and Budget (OMB). OMB established this rate using the theory that the appropriate discount rate relates to the opportunity cost view, particularly the foregone rate of return in the private sector. OMB permits the Fish and Wildlife and water related federal agencies (U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, Soil Conservation Service, etc.) to use a discount rate set by the U.S. Water Resource Council. This rate has averaged 7.8 percent during the 1980's. It is in accord with Lind's theoretical development that the government borrowing rate is the appropriate discount rate.

The U.S. Forest Service uses a four percent real discount rate. Although this discount rate is probably closer to the "social time preference" rate and the correct long-term private rate of return, there is a source of error in comparing the economic efficiency of public land projects that are calculated using different discount rates. For example, the BLM might reject a wildlife habitat improvement project that would yield only an eight percent rate of return because this return is below its 10 percent discount rate. The Forest Service might accept a timber stand improvement project that yields a return rate of five percent because it exceeds its four percent discount rate. As a result, the public foregoes a BLM habitat project offering an eight percent return for a Forest Service timber project that offers a five percent return.

d. Allocation Versus Investment

The arguments are compelling for using a lower discount rate in order to assure benefits for the future. So is the argument for receiving the greatest benefits from a set of assets or investments. However, these objectives may not always be reached simultaneously. For example, the argument that a stand of timber is best harvested today and the proceeds invested in alternative projects at greater interest rate returns of 10 percent may make financial sense. However, a new stand of timber may take 100 years to reach the equivalent inventory again. An investment of funds in the management of timber for harvest would not make financial sense, since an investment of $1,000 for 100 years at 10 percent should be worth over $10,000,000.

On the other hand, if we accept a lower interest rate, then the alternative of leaving forests uncut may be viewed as the preferred investment alternative. It would not matter if we cut the timber today, because we are not losing any better alternative investments. Or, putting this into economic jargon, the "opportunity cost" of not cutting the timber would not be very high.

The problem is that the use of a four percent rate by the Forest Service appears to be a calculating factor that justifies the cutting of existing timber stands, while at the same time allowing timber management activities to take place.

e. Investment Rate Versus Social Rate of Discount

The discussion of public resource management involves wise investment decisions and intergenerational protection of unique resources. A discussion of the wisdom to harvest a standing forest will involve the "opportunity cost" of the value of those trees. The trees could be cut, and revenues invested at interest rates of about seven percent to 10 percent. This seems prudent. However, when deciding to harvest the existing stands, intensive management will be the alternative for the next harvest cycle. At the interest rate chosen as the "opportunity cost" of the existing timber stand, an economic analysis over time will show that the rotation rates of 40 years and over will not yield appropriate discounted returns. Conversely, if a lower rate of interest (three or four percent) is used to justify intensive timber management, then the opportunity cost of not cutting the existing timber is economically reduced, especially if other annually recurring benefits are included in the flow of benefits.

If the argument is used to accelerate timber harvests because of high opportunity costs, the returns from alternative investments (such as bank investments) may be higher than the costs of continued timber management. So it would pay to cut existing forests, but not to manage forests intensively. If, on the other hand, we justify intensive timber management at lower interest rates, then the cost of not cutting trees is not very high, and we should not be concerned about cutting forests at an accelerated rate.

C. REAL PRICE PROJECTIONS

Another important consideration in the economic analysis of forest management is price projection. Over the past thirty years the United States has experienced a fairly large increase in stumpage prices. This was especially true between 1986 and 1991 (Table 3).

The projected increase between 1993 and 2040 is at an annual rate of about 0.3 percent. An annual increase depends on the base year chosen. If 1976 is used as a base year, the argument can be made that the annual rate of increase to 2020 is about two percent. The present indications are that these real increases will be zero or only slightly positive over the next 30 years. There are many reasons for these perspectives, for example the second generation of timber production in the southern Unites States, Chile etc., and the use of substitutes.

Based on increasing human population and declining resources for fish, wildlife, and water quality, it would seem to be appropriate that the economic value of enjoying alternative use of forest land resources would at least keep up with the real value of timber. In the past, the Forest Service has not used the same projection of real increases for other competing uses. For example, they show no increase in real prices for recreational based natural resource goods. The Oregon Department of Forestry (ODF) in its analysis chooses to use present prices as an indication of real future prices (Lettman 1995). The basic assumptions that the ODF

Table 3
Stumpage Prices in the Contiguous States, By Region, 1952-1991, With Projections to 2040

								Projections				
Region	1952	1962	1970	1976	1986	1991	1993	2000	2010	2020	2030	2040
Price (2) per thousand board feet (Scribner log rule)												
Softwoods-sawtimber												
North	90	60	54	51	25	49		82	132	160	190	212
South	129	108	120	141	103	121		234	265	285	272	324
North Rocky Mountains	28	23	41	74	31	55		182	164	221	209	216
South Rocky Mountains	25	16	32	59	30	55		92	105	116	127	149
Pacific Northwest (2)												
Douglas Fir Subregion (3)	4	63	105	156	99	254	252	248	283	302	298	291
Ponderosa Pine Subregion (4)	66	39	60	105	93	125		203	198	234	221	228
							373	367	419	447	441	431
Pacific Southwest (5)	54	39	66	114	82	134		208	194	247	244	236
Price (2) per thousand board feet (international 1/4" scale)												
Hardwoods-sawtimber												
North		72	76	77	91	94		121	122	131	145	161
South		31	45	58	42	40		65	77	95	112	131
Price (2) per cubic feet												
Delivered Pulpwood												
Softwood												
North					0.97	0.95		1.06	1.05	1.25	1.38	1.7
South					0.77	0.84		0.7	0.64	0.66	0.82	1.01
West					0.71	1.01		0.94	0.75	0.79	0.93	0.91
Hardwoods												
North					0.75	0.77		0.66	0.74	0.78	0.79	0.86
South					0.67	0.69		0.61	0.71	0.87	1.08	1.34
West					0.77	1.1		1.02	0.81	0.86	1.36	1.32

Notes:
(1) Stumpage prices are measured in constant (1982) dollars and are in net of inflation or deflation. They measure price changes relative to the general price level and most competing materials.
(2) Excludes Alaska.
(3) Western Oregon and western Washington.
(4) Eastern Oregon and eastern Washington.
(5) Excludes Hawaii.

Sources: Data for 1952,1962,1970,1976 and 1986 based on information published by the U.S. Department of Agriculture and summarized by Adams, Jackson and Haynes (1988). Projections from personal communications with Richard Haynes, U.S. Forest Service, Portland, Oregon, 1994.

uses (i.e. that the real price of timber will remain constant) are a basis for the next section discussion.

D. FOREST LANDS INVESTMENT ANALYSIS

This section utilizes information used by ODF to analyze investment opportunities of private lands and possible partnerships with ODF. The investments are analyzed at a four percent interest rate with no real timber price increases. The example uses a timber tract that is equivalent to a medium productive site.[1] The yield and revenue projections are listed in Table 4.

Costs were taken from a background paper developed for ODF (Grainger et al. 1993). The option chosen was grass and recent clearcut, and manual preparation. (See Tables 4a, 4b, and 4c of this section.) The manual preparation option is used under the assumption that high soil disturbing and spray operations would not be used in any area considered a water source for municipalities. A $2.00 per acre per year general management cost over the life of the timber production period was added to the analysis as one of the options. Land costs are not included, which may add another $30 to $50 per acre in annual costs. To simplify the analysis, all costs were assumed to occur in year one (except for the recurring $2.00 per acre management cost), and all revenues were assumed to be received at the end of 50 or 80 years. The analysis is completed at interest rates from one percent to 10 percent (Tables 5a and 5b).

The investment analysis clearly shows the importance that the length of time and interest rate assumptions have on the final outcome. With interest rates of up to four percent, the B/C ratio is positive at 50 years and at 80 years. This drops to a less than one B/C ratio at six percent interest rate. At seven percent over an 80 year time period the B/C ratio declines to 0.12. This example underscores the dilemma facing public agencies attempting to justify timber management for late successional forests.

Other factors should also be examined. For example (Oregon State University Extension Service, 1993), a woodland manager can expect to generate a private return of 13 percent by growing timber with a federal cost-sharing program (Elwood 1993). For the 50 year rotation period the B/C ratios are lower. The critical assumptions in this example are: (1) seven percent interest rate, (2) final harvest at 50 years, (3) federal government 75 percent cost share on all initial costs of planting, preparation etc., (4) a three percent real increase in timber prices over the next 50 years.

An erroneous conclusion may also be made when analysts do not include the costs of silviculture in their timber management calculations. For example, Abubaker and Lord, in their evaluation of timber harvests in the Portland Bull Run watershed, state "we estimate very roughly that the present value of the total net benefits from timber harvesting (discounted at

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1. Such yield projections should be used with caution. They assume that the total acreage is harvestable. For example, in the ODF Elliot Forest, the total forest output is based on a 32,000 BF per acre basis, at an 80 to 120 year growth period. The yields used in this analysis should therefore be viewed as optimistic yields.

Table 4a
Investment Analysis on Timber Production

Assumptions:

1. Age of harvest: 50 years or 80 years
2. Costs of manual preparation, conversion from grass or recent clear cut:

a.	Site preparation	$ 99.00
b.	Plant trees	208.10
c.	Animal protection	144.30
d.	Release-survival	462.00
	Total costs per acre	$913.40

3. Annual management fee $2.00 per acre (no land costs are included).
4. Revenues:
   - a. 50 years: $15,982
   - b. 80 years $30,509

Notes: Information from Tables 4b and 4c.
Source: Study.

Table 4b
Calculation of Forest Trust Timber Values Nonindustrial Plant and Clearcut

Age	MBF	DBH	DEFECT	ABILITY	UNSTOCK-ABLE AREA	UNLOGGABLE FPA ETC	FIRE & PEST	CLUMP-INESS	NET VOLUME
20	0.00	0.00	1.00	0.98	0.99	0.95	0.99	0.96	
25	2.19	7.10	1.00	0.98	0.99	0.95	0.99	0.96	1.92
30	6.08	8.40	1.00	0.98	0.99	0.95	0.99	0.96	5.32
35	10.76	9.50	1.00	0.98	0.99	0.95	0.99	0.96	9.37
40	16.44	10.60	0.99	0.98	0.99	0.95	0.99	0.95	14.09
45	23.97	11.50	0.99	0.98	0.99	0.95	0.99	0.95	20.45
50	30.80	12.30	0.98	0.98	0.99	0.95	0.99	0.94	25.86
55	36.37	13.00	0.98	0.98	0.99	0.95	0.99	0.94	30.38
60	43.91	13.70	0.97	0.98	0.99	0.95	0.99	0.93	36.11
65	50.95	14.40	0.97	0.98	0.99	0.95	0.99	0.93	41.68
70	57.55	15.10	0.96	0.98	0.99	0.95	0.99	0.92	46.33
75	64.11	15.70	0.96	0.98	0.99	0.95	0.98	0.92	50.83
80	69.82	16.30	0.95	0.98	0.99	0.95	0.98	0.91	54.46

Notes: Percent remaining after yield reduction.

	GRADE %			VALUE BY GRADE			POND	LOGGING	STUMPAGE	HARVEST	SEVERANCE	NET
Age	SM+	2 SAW	3 SAW	SM+	2 SAW	3 SAW	VALUE	&HAULING	VALUE	TAX	TAX	VALUE
20	0.00	0.00	0.00	$818.75	$773.75	$683.75	$0	$160	$0	$2.14	6.40%	$0
25	0.00	0.00	1.00	$818.75	$773.75	$683.75	$1,310	$160	$1,004	$2.14	6.40%	$935
30	0.00	0.00	1.00	$818.75	$773.75	$683.75	$3,638	$160	$2,787	$2.14	6.40%	$2,597
35	0.00	0.00	1.00	$818.75	$773.75	$683.75	$6,406	$160	$4,907	$2.14	6.40%	$4,573
40	0.00	0.12	0.88	$818.75	$773.75	$683.75	$9,789	$160	$7,534	$2.14	6.40%	$7,022
45	0.00	0.24	0.76	$818.75	$773.75	$683.75	$14,421	$156	$11,232	$2.14	6.40%	$10,469
50	0.00	0.24	0.76	$818.75	$773.75	$683.75	$18,243	$156	$14,208	$2.14	6.40%	$13,243
55	0.00	0.35	0.65	$818.75	$773.75	$683.75	$21,733	$151	$17,144	$2.14	6.40%	$15,982
60	0.00	0.47	0.53	$818.75	$773.75	$683.75	$26,216	$147	$20,908	$2.14	6.40%	$19,493
65	0.00	0.47	0.53	$818.75	$773.75	$683.75	$30,262	$147	$24,135	$2.14	6.40%	$22,501
70	0.00	0.53	0.47	$818.75	$773.75	$683.75	$33,890	$143	$27,264	$2.14	6.40%	$25,420
75	0.02	0.57	0.41	$818.75	$773.75	$683.75	$37,497	$137	$30,534	$2.14	6.40%	$28,471
80	0.02	0.57	0.41	$818.75	$773.75	$683.75	$40,181	$137	$32,719	$2.14	6.40%	$30,509

Source: Lettman 1995.

Table 4c
Costs Summarized by Management Options and the ODF Costs from the FIP Program Private Non-Industrial Rehabilitation Opportunities

	SITE PREP & PLANT				CONVERSION TO LOW STOCKING	
	GRASS		BRUSH			
ESTABLISHMENT COSTS	ALL TOOL	MANUAL	ALL TOOL	MANUAL	ALL TOOL	MANUAL
Site II Conversion					$71.50	$204.10
Site Prep	$58.82	$99.00	$207.70	$229.74	$201.66	$99.00
Plant/Trees	$198.11	$208.10	$198.11	$208.10	$298.11	$208.10
Animal Protection		$144.30		$144.30		$144.30
Release - Survival	$58.82	$462.00	$58.82	$130.76	$58.82	$130.76
Release - Growth	$29.41		$58.82	$392.28	$58.82	$392.28
Site III Conversion					$71.50	$204.10
Site Prep	$58.82	$99.00	$207.70	$229.77	$201.66	$99.00
Plant/Trees	$198.11	$208.10	$198.11	$208.10	$198.11	$208.10
Animal Protection		$144.30		$144.30		$144.30
Release - Survival	$58.82	$462.00		$130.76		$130.76
Release - Growth	$58.82		$58.82	$261.52	$58.82	$261.52
Site IV Conversion					$71.50	$204.10
Site Prep	$58.82	$99.00	$207.70	$229.74	$201.66	$99.00
Plant/Trees	$198.11	$208.10	$198.11	$208.10	$198.11	$208.10
Animal Protection		$144.30		$144.30		$144.30
Release Survival	$58.82	$462.00		$130.76		$130.76
Release Growth	$58.82		$58.82	$130.76	$58.82	$130.76

Note: Establishment costs quoted in dollars per acre with 10% management fee included in cost of each activity.
Source: Grainger et al. 1994.

Table 5a
Forest Investment Analysis for 50 and 80 Year Cycles With No Management Fee

Interest	Discount Factor		Returns		Benefit/Cost Ratio	
			50 Years	80 Years		
Rate	50 Year	80 Year	Discounted	Discounted	50 Years	80 Years
1%	0.608	0.451	9,749	13,760	10.67	15.1
4%	0.141	0.043	2,253	1,312	2.46	1.44
6%	0.054	0.009	863	275	0.94	0.3
7%	0.034	0.004	543	122	0.59	0.13
10%	0.008	0.0005	127	15	0.14	0.02

Notes:
1. Interest rates range from 1% to 10%.
2. Silviculture costs per acre are $913.40 without a management cost.
3. Net value expected at 50 years is $15,892 and net value expected at 80 years is $30,509.
4. A benefit/cost ratio of 1 generally means that the returns over time are equal to the costs incurred over time, discounted at the appropriate interest rate.

Source: Study.

Table 5b
Forest Investment Analysis for 50 and 80 Year Cycles With Management Fee

			Returns			
Interest			50 Years	80 Years	Benefit/Cost Ratio	
Rate	50 Years	80 Years	Discounted	Discounted	50 Years	80 Years
1%	64	89	9,678	13,719	10.60	15.02
4%	153	496	2,232	1,291	2.44	1.42
6%	290	1,647	847	260	0.93	0.28
7%	407	3,057	530	110	0.58	0.12
10%	1,164	20,486	119	5	0.13	0.005

Notes:
1. Interest rates range from 1% to 10%.
2. Silviculture costs per acre are $913.40 plus a management fee of $2.00 per acre per year is included, compounded yearly, and discounted to the present.
3. Net value expected at 50 years is $15,892 and net value expected at 80 years is $30,509.
4. A benefit/cost ratio of 1 generally means that the returns over time are equal to the costs incurred over time, discounted at the appropriate interest rate.

Source: Study.

eight percent) could be in the neighborhood of $100 million (stumpage sales net revenue of about $8 million appears to be sustainable)" (Abubaker 1992). These authors failed to include the silviculture costs incurred. They only include the harvest stumpage as a benefit. This is a problem of the inventory illusion.

CHAPTER IV
GROWING TREES OR GROWING WATER IN MUNICIPAL WATERSHEDS

Because of the region's growth in population and economic activity, water production (in terms of new developments or in terms of conservation) is becoming an important issue for Northwest municipalities. This chapter explains a rough economic analysis of the alternatives for emphasizing municipal water or timber production for management of Pacific Northwest watersheds.

A. ECONOMIC ANALYSIS METHODOLOGY

1. Economic Concepts

The economic valuation of Oregon's natural resources involves both financial (market) and non-financial (non-market) values. Most products of land and water use, such as timber and agricultural products, are priced in the market places of the nation's (or world's) economy. Conflicting demands for these products are resolved in the market, and prices are established when users bid against one another for the available supply. Therefore, it is conceptually easy to estimate the gross values and net economic values associated with timber and crop production, because market prices and production cost information tell us how society values such products.

However, this is usually not true for public produced goods such as drinking water and water associated recreation activities. Non-financial values are involved because recreational uses of wildlife such as fishing, hunting, or viewing are usually "non-market" commodities. That is, wildlife is considered to be property of the state, and hunting or viewing rights are not typically sold through a competitive market. Thus, no market price exists to suggest how society values recreational use of the resources and to signal producers how much of the resources should be supplied. Conceptually, non-financial or non-market values represent people's willingness to pay for the use or availability of resources above and beyond participation costs. (Alternatively, people's willingness to accept compensation for a reduction or loss in resource use can be posed as a different conceptual measure of non-market value.)

The measure of net economic value which represents benefits or "user values" to resource users of public goods is often called "consumer surplus" by economists. Consumer surplus is difficult to understand as a real economic benefit because it represents money that has not been collected by anyone (such as the government) as payment for the benefit received (such as recreational hunting or wildlife viewing). The fact that no-one actually charges "consumers" the full amount they would be willing to pay does not make the consumer surplus any less real. In concept, the uncollected monies that could have been extracted can be thought of as income that remains to be used by the consumer for other purposes.

Another kind of non-market value, generally referred to as preservation value, includes option value, existence value, and bequest value. Option value represents an amount people would pay to ensure the availability of an opportunity for themselves in the future. Existence value is the benefit from knowing a resource exists. Bequest value represents a willingness to pay for maintaining a resource for future generations.

2. Examples of Economic Values

The natural resources of watersheds contribute to the economic welfare of society. The analysis of policy decisions which would affect the quantity or quality of natural resource use requires detailed information on the economic values generated from the different uses. Some of these may be competing uses, others complementary.

An example of a competing use could be that of anadromous fish and timber production. Inland streams and rivers provide spawning and rearing habitat for anadromous fish. Timber harvest can have an adverse impact on the quality of that habitat. Clearcut timber harvest often involves the removal of the protective vegetative cover along streamsides which lie within timber sales boundaries. Some of the characteristics of the streams that are affected are stream temperature, sediment loading, level of dissolved oxygen, stream flow, and the accumulation of woody debris. Removal of forest canopy which shades streams results in higher average temperatures. This can be beneficial to smolt survival in cooler climates. However, loss of shade also results in wider temperature variations and increases the risk of lethal temperatures of either extreme. Disturbance of the vegetative soil cover causes increased runoff and erosion leading to sedimentation loading in streams. Sediment fills spaces in spawning gravel, smothering emerging fish and eliminating some spawning beds altogether. Suspended sediment clogs the gills of smolts, increasing oxygen demand, while lowering levels of dissolved oxygen in the water. The production of small invertebrates upon which salmonids feed is reduced. Stream flow is affected when vegetation is removed. Peak storm flows increase, causing increased bank erosion and streambed scouring. Dry period flows decrease. On the other hand, stable deposits of downed large woody material block stream flow, beneficially creating rearing pools for the young smolts. Logging can add large debris to stream systems and can be beneficial. However, if the new accumulation of large debris is instable and peak storm flows are high, the risk of debris flow that causes scouring of the streambed increases. Downstream debris jams can completely block fish access to upper stream reaches.

In most areas, maintaining intact vegetation offers protection from the effects of logging by stabilizing streambanks, blocking sedimentation, reducing variation in stream flow, trapping logging debris, and by providing shade.

In-stream flow benefits for streams and rivers have been investigated by a number of resource economists. These valuation efforts differ in scope, method and quantitative results. The following is a short review of some of these studies, with the intent to show that there are some economic values of in-stream benefits. They may be utilized as a general indication of what value society places on such benefits, however it may be impossible in all cases to quantitatively use these values to compare with other uses.

Contemporary research deals with a broad range of water resource valuation issues. Loomis, in a review of inflow methodology and analysis, brackets the range of estimates conferred from in-stream flows at $15 to $74 per acre foot of water (Loomis, Journal of Environmental Management 1987). Values for water may change as supply and conditions change, for example in periods of drought municipalities may buy water at prices in excess of $500 per acre foot (Smith 1990).

An illustrative study of the benefits if in-stream flows is provided by Loomis (Institute of Ecology 1987). He used a contingent value method study to estimate benefits provided by streamflows that feed California's Mono Lake. The City of Los Angeles began to exercise water rights that it had acquired in the 1940's on four of the five streams that feed the lake. Water levels at Mono Lake dropped sharply. Chemical concentrations in the water changed. Shoreline recreational opportunities were adversely affected by diminished lake water levels. Off-site benefits of restoring surface water levels of Mono Lake per California household were $42 per year, and represented 90 percent of the total aggregate value.

Most of these studies are for recreational user days (Table 6a) or contingent valuation estimates of a household's "willingness to pay" for water quality or quantity (Table 6b). These values may not be directly convertible to water quantities produced by watersheds. Based on the Loomis review, for the analysis of growing timber or growing water, a value of $50 per acre foot will be used as a representative of in-stream values.

B. TIMBER MANAGEMENT OBJECTIVES

Most municipal watersheds are in public ownership. In many cases the stands are comprised predominantly of 40 to 50 year old trees in areas that were cut and replanted in the mid 1950's. In addition, many stands are comprised of naturally regenerated trees (alder, western hemlock, western red cedar etc.). Scattered stands of mature timber and isolated old growth may also be present within major draws. The Portland Bull Run watershed has experienced logging of 20.6 percent of its area (Wilson 1992). Other people argue that this estimate is too low, that it could be as high as 30 percent, once all logging and roads are included.

The present timber of a municipal watershed may average about 25,000 board feet per acre or 500 board feet average growth per year (50 year growth). A harvest program that involves (after harvest) site preparation, planting, brush control without herbicides, etc., would cost about $913 per acre. After 50 years the program could expect to harvest 25,000 board feet from each acre harvested. At about $635 per thousand board feet (camp run) the program could expect to receive $15,982 per acre from a harvest program. Alternatively, the $913 invested or deposited in a bank would in 50 years be worth from $6,500 to $107,000, depending on the interest rate chosen. In 80 years, the $913 may be worth $21,000 to $1,900,000 (Table 7).

This has to be considered an opportunity cost when comparing these costs to future harvests.

Table 6a
Summary of Some Studies on the Economic Value of In-Stream Use: Recreational Per Day Value

Author	Type of Value	Value Per User Day
Loomis and Sorg (1990)	Anadromous Fishing	$52
	Waterfowl Hunting	$48
	Boating	$10

Table 6b
Summary of Some Studies on the Economic Value of In-Stream Use: Contingent Valuation Per Household Willingness to Pay

Author	Type of Value	Value Per Household
Duffield et al (1993)	buy water to increase summer flows in selected Montana rivers, to improve habitat and recreation	$9.97 per household per year
Loomis (Institute of Ecology 1987)	certain improvement in water level in Mono Lake with associated water quality and habitat improvements	$42 offsite benefits per household per year
Mitchell and Carson (1981)	improving water quality in all U.S. rivers and lakes	$111 existence value per household per year

Table 7
Compounded Investment of $913 at 50 and 80 Years

Interest Rate	50 Years	80 Years
4%	$6,494	$21,054
6%	$16,807	$96,638
7%	$26,945	$291,283
10%	$106,868	$1,870,643

Source: Study

At a four percent interest rate the timber management program revenues from harvests would appear to return benefits greater than the timber management cost program ($15,982 revenues versus $6,494 costs at 50 years, and $30,509 revenues versus $21,054 costs at 80 years). At an interest rate of about 5.75 percent the program breaks even over a 50 year rotation period. Any interest rates higher than that would provide a negative return to the timber management program. This is without any other considerations that may involve costs to the municipal water supply.

C. MUNICIPAL WATER SUPPLY OBJECTIVES

1. Timber Management Effect on Municipal Water Supply

Timber management activities directly affect production, quantity and timing of water supply.

a. Sediment Production

Road construction, as part of timber management, has contributed to major increases in sediment production (Harr and Fredriksen 1988; Miner 1968; Beschta 1978; Fredriksen 1965 and 1970; Harr et al. 1975). The combined effects of logging and road building in some areas of the Coast Range appear to have increased slide activities about five times relative to forested areas over a period of about 20 years (Berton 1995). For the Bull Run watershed, the combination of increased road construction, logging activities, and the 1964 flood resulted in developed narrow channels that created higher discharge volumes and damaging drainage routes.

Most watersheds in the Coast Range have been heavily logged over the years. The Coast Range may differ from areas such as Bull Run in rainfall, geology, topography, and logging practices, and the sediment yields in the Coast Range are on the average three times larger than in the Bull Run watershed (Hamilton, 1994, p. 149). The methodology employed in this report should therefore be viewed as a conservative estimate of the cost of sediment treatment. Increased filtration and disinfection costs may result from management activities that increase the probabilities of sediment load. Average typical costs (using a design basis of 80 million gallons per day (MGD) associated with sediment removal are about $114/MG. Incremental annual disinfection costs for chloramination are about $2.15/MG. Sediment discharges to surface water supplies induce treatment costs of $17.11 per thousand tons discharged (Holmes 1988, p. 361).

b. Water Yield

Water is most highly valued during summer months when demand is high and supply is low.

Economic investigations in some geographic areas show the potential desirability of brush and timber management in watersheds, but also show benefits to be critically dependent on added water yield value and cost sharing policy. Wildlife, water rights, and environmental issues are also important considerations (Griffin and McCarl, 1989).

Brush management and timber harvests produced surface water comes mostly during high flow periods when reservoirs are full; additional facilities (and additional costs) may be needed to realize out of stream water benefits induced by intensive brush or timber management.

The studies cited in the Literature Review section of this report concluded the following:

- Water yield resulting from logging and loss of "fog drip" may reduce water yield in clear cuts by nine percent.
- The maximum temperature in a clear cut area may increase by two to three percent after logging, but this difference will dissipate after three years.
- Water yield after clear cutting in part of the Bull Run watershed was 20 percent greater than it would have been had it not been logged. In streams of the Pacific Northwest most of the increase in annual water yield following logging occurs from October to March, when water is not in short supply.
- The period for which increased summer yield persisted was short, especially considering the proportion of the time that it would represent (eight to 11 percent) during a rotation time of 70 to 100 years under intensive forest management. Following the period of increased water yield that occurs immediately after logging, timber harvest may actually reduce July and August streamflows. The percent of reduced yield may be about 25 percent of the period of rotation. This may be until conifers grow large enough to suppress growth of riparian hardwoods.
- Water yield reduction due to logging activities in the Pacific Northwest is about 25 percent in July and 15 percent in August.
- Timber management programs may result in having to build a new reservoir to hold water for low water periods. This could have been accomplished by retaining a natural watershed. The choice may be to build a concrete reservoir or to maintain the natural state of the watershed.

2. Municipal Water Supply Costs Due to Timber Management

Many publicly owned timber lands are managed under timber harvest guidelines in which timber harvest acreage is 15 percent or less of the total watershed area per decade.[1] Some of the costs that may result from a timber management program are decreased water flows and increased treatment requirements.

a. Decreased Low Late Summer/Early Fall Water Flow

The preceding sections discuss water flow and timber management. A 50 year timber management program reduces the flow available to the municipal water system in late summer and fall. Section II A discusses the most likely reduction in water yield. The discussion leads

1. Since 1990 new criteria for managing U.S. Forest Service lands have been established. As a result of concern for endangered species the timber management objectives may no longer be valid. This analysis, however, will proceed as if the old objectives are current.

to an inference that 25 percent of a period of timber cut rotation will result in reduced flow of 25 percent in July and 14 percent in August. For the critical period in July, a timber management program may reduce water availability to about six percent (.25 x .25 = .0625). The alternative is to build larger reservoirs or develop new water sources. Such development costs are very expensive and are "lumpy," that is to say these systems may only be built in certain sizes. An alternative way to calculate the cost of a water reservoir (or no water) is to use the cost of a representative water reservoir that a municipality may have to build. Such a reservoir may be for 1,000 acre feet at a cost of $3,500,000 (or $3,500 per acre foot).

Taking the Bull Run watershed and its water use as a guide, several general analytical relationships may be made. The Bull Run watershed drains about 107 square miles (68,480 acres). "Average annual runoff at the mouth of the Bull Run River is 600,000 acre feet, which is equivalent to a water depth of 105 inches spread uniformly over the watershed area. For the past several years 42 percent of this flow has been diverted to the City of Portland system. The runoff is distinctly seasonal, with the low flows in the summer and peaks in both winter and spring." (Aumen et al. 1989).

A typical Northwest watershed may not receive 105 inches of rain per year. For this analysis we assume a smaller average rainfall of 50 inches per year and one third municipal water use. This is equivalent to about 1.4 acre feet of municipal water use per acre per year.[1]

A timber management program in a Northwest watershed may reduce the water flow in July and August. With a timber management objective, a 0.06 reduction in water availability can be expected in July. Reservoirs have to be built for peak demand and low flow periods. A low flow period will require construction of additional reservoir capacity.

A watershed program that would avoid a 0.06 reduction in water availability (and therefore avoid additional storage) may be counted as a benefit. Reservoir storage may cost about $3,500 per acre foot. The amortized 50 to 80 year annual cost of such a capital project is $165 to $350 per year, depending on the interest rate chosen (from four to 10 percent).

Each acre may produce 1.4 acre feet of municipal water use per year. A six percent reduction in August is equivalent to having to build storage facilities that would cost from $14 to $29 per year in amortized payments (e.g. $165 x 1.4 acre feet x .06 = $14).

Over a period of 50 to 80 years these avoided costs may be valued at $2,111 to $601,936, depending on the interest rate chosen (e.g. $14 compounded per year by a 152 factor for a 50 year period is equal to a present saving of $2,128). This example again demonstrates the power of discount rates when contemplating long term decisions (Table 8).

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1. These are conservative estimates. The Bull Run use is 3.7 acre feet per acre. The following calculations of avoided reservoir construction may be adjusted to specific total water use.

Table 8
Value of Avoided Capital Cost Per Acre Due to a 6% Summer Water Loss in a Typical Northwest Municipal Watershed (Compounded Annually)

Interest Rate	50 Years	80 Years
4%	$2,111	$6,642
6%	$5,371	$31,331
7%	$8,615	$66,567
10%	$34,530	$601,936

Source: Study

b. Increased Water Treatment Costs

The additional treatment due to sedimentation and disinfection resulting from management activities may result in an increase in costs. "Water quality remediation, through the construction and operating of a water treatment plant, might be necessary if unanticipated water quality degradation were to follow timber harvesting, although the probability appears low, perhaps 0.1 or less, that such degradation would occur. The treatment plant would be required eventually by EPA regulation, but its construction might be advanced by ten years if degradation of water quality were found (for Portland Bull Run System). The cost of the plant would be around $50 million and annual operating costs of about $2 million are anticipated. In order to cope with lower quality runoff, an $80 million plant, with annual operating costs, would be required." (Abubaker and Lord 1992, p. 849). The part of the system that would provide for water treatment would cost $30 million. This is an estimate of a reservoir and treatment cost for the existing situation - with increased sedimentation due to logging activities. There are discussions taking place regarding construction of regional treatment plants in the Portland area that would draw water from the Willamette River. The cost of such an expanded system is estimated to be between $300 million and $500 million (Nokes 1995). The costs for a filtration plant are based on Abubaker and Lord's estimates. These may be conservative. Other estimates are that "an expensive water filtration plan . . . would cost the City of Portland $150 million to $200 million and . . . probably never would be necessary but for the logging activities." (Larson 1987).

Water systems cannot be built on a continuous scale as there are certain size requirements. However, taking the above as an indication of water treatment costs associated with logging on a per acre foot basis, a general analysis of the long run costs of logging for water quality may be derived. The Bull Run system utilizes about 252,000 acre feet per year. Therefore:

- $50 million general water EPA required plant or $198 per acre ft ($730 acre)
- $30 million water quality treatment plant or $119 per acre ft ($438 acre)
- $2 million operating costs for lower quality or $8 per acre ft ($29 acre)

A system that is designed to alleviate water quality problems due to logging activities may cost $325 per used acre foot or $1,197 per watershed acre.

The savings of not building a plant for the next ten years is substantial because of not having to pay the capital and interest costs ($730 per acre). There is also an annual savings of $438 per acre on the quality component of the treatment plant. These savings may be realized during the 50 or 80 year period of not cutting trees. In addition, there is a $29 per acre savings in annual treatment costs that may be attributable to logging activities. These could also be avoided for ten years. The costs may be higher if the additional costs are only attributable to lower quality water. The $29 per acre savings in such a case would be compounded yearly throughout the 50 or 80 year period.

With the above assumptions, the opportunity costs of having to build a reservoir and treatment center resulting from timber management may be calculated. For example, a payment plan on $730 at four percent over a 50 year period (730 x .047 = $34) would require a $34 per year payment. A $34 saving compounded yearly at four percent is equal to $408 in ten years. After the ten years this $408 may receive simple interest for the next 40 years for a total value of $1,958 (Table 9).

The present values per acre of watershed of these costs are substantial, ranging from $6,710 (calculated over a 50 year period at four percent) to $2,778,320. These calculations again point out the power of the discount rate over longer terms.

Table 9
Estimates of Opportunity Costs of Building a Reservoir and Treatment Center Resulting from Logging Activities

	4%		6%		7%		10%	
	50 yrs	80 yrs	50 yrs	80 yrs	50 yrs	80 yrs	50 yrs	80 yrs
EPA Requirement	1,958	6,365	6,254	35,813	10,879	82,650	52,232	916,953
Water Quality Construction	3,082	11,571	8,053	48,916	12,835	101,088	51,172	900,855
Avoided Treatment for 10 Yrs	1,670	5,429	3,943	40,458	6,000	45,623	364,269	960,512
Total Value of Avoided Treatment Plant	6,710	23,365	18,250	125,187	29,714	229,361	467,673	2,778,320

Source: Study.

D. COMPARISON OF TIMBER MANAGEMENT ALTERNATIVES VERSUS WATER MANAGEMENT OBJECTIVES

A comparison of timber management and water management in municipal watersheds shows that "growing" water is a prudent objective at interest rates above four percent (Table 10). This conclusion may be reached without including other "instream benefits" that may result from undisturbed watersheds. The next section discusses some of the potential benefits, and includes some of these instream benefits.

Table 10
A Comparison Between Timber Management Objectives and Municipal Water Objectives in Pacific Northwest Municipal Watersheds Not Including In-Stream Benefits

	4% 50 Yrs	6% 50 Yrs	7% 50 Yrs	10% 50 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$15,982	$15,982	$15,982	$15,982
Preparatory Costs (compounded)	6,494	16,807	26,945	106,868
Annual Management Costs (compounded)	306	581	812	2,328
Returns to Timber Management Costs	9,182	(1,406)	(11,775)	(93,214)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	2,111	5,371	8,615	34,530
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	6,710	18,250	29,714	467,673
D. RETURNS TO TIMBER & WATER MANAGEMENT	361	(25,027)	(50,104)	(595,417)
E. RETURNS TO MULTIPLE USE OF WATERSHED	361	(25,027)	(50,104)	(595,417)
	80 Yrs	80 Yrs	80 Yrs	80 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$30,509	$30,509	$30,509	$30,509
Preparatory Costs (compounded)	21,054	96,635	291,283	1,870,643
Annual Management Costs (compounded)	1,102	3,494	6,378	40,948
Returns to Timber Management Costs	8,353	(69,620)	(267,152)	(1,881,082)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	6,672	31,331	66,567	601,936
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	23,365	12,505	229,361	2,778,320
D. RETURNS TO TIMBER & WATER MANAGEMENT	(21,684)	(113,456)	(563,080)	(5,261,338)
E. RETURNS TO MULTIPLE USE OF WATERSHED	(21,684)	(113,456)	(563,080)	(5,261,338)

Notes:
1. On a per acre basis.
2. At discount rates of 4% and above.
3. ( ) denotes negative benefits.

Source: Study.

E. IN STREAM AND OTHER BENEFITS OF WATER QUALITY

The management of watershed in headwater areas affects aquatic and riparian resources and human communities far downstream. The maintenance of riparian habitat has several primary and secondary effects for the beneficial use of water for domestic consumption. Riparian zones act as a silt fence for immediate uplands adjacent to the stream and thus reduce suspended clay particles. The reduction of silt transport reduces water treatment needs. The shading effects the temperature of the water which in turn affects the dissolved oxygen content. Increased algae growth prompted by elevated temperatures causes undesirable taste and odors. The self-cleansing ability for algae growth, bacteria and nutrients of a stream is directly related to the amount of dissolved oxygen and temperatures in a stream. Vegetation along streams also draws a lot of water through evapotranspiration through the leaf and canopy, however its presence also promotes recharge of groundwater supplies.

Economic studies have identified benefits to in-stream water use. Some studies have also identified higher benefits to late summer flow water. Using a $50 benefit per acre foot as a guide to benefits received from in-stream water use may allow some estimates to be made of total use of a watershed.

Using a watershed of 68,480 acres with annual runoff of 600,000 acre feet and 42 percent diverted use, or about 3.5 acre feet per acre of water use per watershed acre, as an example, an overall instream value per used municipal water may be derived. Such an annual use may be valued from $26,775 to $3,582,950, depending on the interest rate and the time period used (Table 11).

Table 11
Estimated Total Economic Value of In-Stream Water Use of an Acre of Watershed for the Pacific Northwest (Water Acre Foot Valued at $50, an Acre Water Production Valued at $175, Compounded Annually)

Interest Rate	50 Years	80 Years
4%	$26,775	$96,425
6%	$50,750	$305,725
7%	$71,225	$558,075
10%	$203,700	$3,582,950

Not all of the water or water use may be at risk when other uses such as timber management are included in the calculations. However, timber management of a 15 percent decadal cut would reduce the late summer and fall flow by about one percent or about 0.034 acre feet per acre per year. Over a 50 to 80 year period these losses amount to $268 to $35,830 per year (Table 12).

Table 12
Estimated Economic Loss Per Acre as a Result of Timber Management in a Municipal Watershed

Interest Rate	50 Years	80 Years
4%	$268	$964
6%	$508	$3,057
7%	$712	$5,580
10%	$2,037	$35,830

These negative values at interest rates higher than four percent may be greater if actions take place in timber management that threaten the supply of constant water flow, or water flow in critical periods such as late summer or early fall, or conversely in peak flows with high turbidity levels in winter months.

When estimates of in-stream economic values are included in the comparison between timber and water management objectives, the return for managing for water management increases (Table 13). Timber management may be prudent at low interest rates and at fairly short rotation periods. At longer rotation periods with assumptions of market interest rates, timber management in municipal watersheds may return higher costs than benefits. Multiple use concepts that include competitive uses such as timber growing may result in higher costs to water users of municipal watersheds.

F. WATER PRICING AS A MANAGEMENT TOOL

Marginal costs of municipal water production tend to rise in the peak summer period. Marginal costs are usually inversely related to the stock of water held in the reservoirs as the stock of water in storage declines during the peak summer quarter, system pressures also decline, increasing pumping costs.

The current accounting and pricing practices of water utilities promote inefficient levels of consumption. Furthermore, the value of water itself is frequently not reflected in current prices (Renzetti 1992).

The results from Renzetti's work suggests that there is potential economic improvement from reforming water prices.

Renzetti's study does acknowledge that adopting alternative pricing rules would lead to significant price changes between user groups. Such changes might meet with opposition from the consumer groups that are adversely affected. Thus, the changes may have to be phased in over a number of years or made part of a larger, well-articulated, water conservation strategy in order to ensure that they are politically acceptable.

Renzetti does caution that while reforming water prices does provide for the possibility of an improvement in economic efficiency, carrying out these changes will not necessarily lead to decreases in aggregate water use.

If a water utility is currently employing some form of price discrimination (as most municipalities do), then efficient pricing may imply price increases for some user groups and decreases for others. As a result, it is difficult to predict the direction of change for water use for every municipal water system. Specific circumstances would have to be addressed.

For areas, such as the Portland metropolitan area, that are experiencing rapid growth rates both in population and in industrial use, a closer investigation of water demand and price elasticity of demand, as well as an investigation of marginal costs, may allow the use of water

Table 13
Comparison of Timber Management Objectives and Municipal Water Objectives in Pacific Northwest Municipal Watersheds Including In-Stream Water Benefits

	4% 50 Yrs	6% 50 Yrs	7% 50 Yrs	10% 50 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$15,982	$15,982	$15,982	$15,982
Preparatory Costs (compounded)	6,494	16,807	26,945	106,868
Annual Management Costs (compounded)	306	581	812	2,328
Returns to Timber Management Costs	9,182	(1,406)	(11,775)	(93,214)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	2,111	5,371	8,615	34,530
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	6,710	18,250	29,714	467,673
D. RETURNS TO TIMBER & WATER MANAGEMENT	361	(25,027)	(50,104)	(595,417)
E. LOST IN-STREAM BENEFITS	268	508	712	2,037
F. RETURNS TO MULTIPLE USE OF WATERSHED	93	(25,535)	(50,816)	(597,454)
	80 Yrs	80 Yrs	80 Yrs	80 Yrs
A. TIMBER MANAGEMENT				
Future Harvest	$30,509	$30,509	$30,509	$30,509
Preparatory Costs (compounded)	21,054	96,635	291,283	1,870,643
Annual Management Costs (compounded)	1,102	3,494	6,378	40,948
Returns to Timber Management Costs	8,353	(69,620)	(267,152)	(1,881,082)
B. WATER FLOW REDUCTIONS				
Capital Cost Avoidance (compounded)	6,672	31,331	66,567	601,936
C. WATER TREATMENT COSTS				
Avoided Costs (compounded)	23,365	12,505	229,361	2,778,320
D. RETURNS TO TIMBER & WATER MANAGEMENT	(21,684)	(113,456)	(563,080)	(5,261,338)
E. LOST IN-STREAM BENEFITS	964	3,057	5,580	35,830
F. RETURNS TO MULTIPLE USE OF WATERSHED	(22,648)	(116,513)	(568,660)	(5,297,168)

Notes: 1. On a per acre basis.
2. ( ) denotes negative benefits.

Source: Study.

pricing to increase efficient use of water and also delay the construction of expensive new water sources and reservoirs.

The important concept is the recognition that water is a scarce resource. Because growth in population and economic activity will increase water scarcity, the value of water grows over time (Griffin and McCarl, 1989).

Mercer and Morgan concluded that, on the average, conservation through the price system is cheaper than the least cost additional water supply alternative. "The analysis of this study demonstrates clearly that water conservation through reliance on the price system provides the cheapest source of additional water supply in California" (Mercer and Morgan, 1985, p. 932).

CHAPTER V
THREE OREGON MUNICIPAL WATERSHEDS AND THEIR ALTERNATIVES

The previous sections describe a process of economic analysis that may be undertaken in order to compare resource management alternatives of growing timber or growing water. These alternatives are not mutually exclusive; however, there are costs involved in choosing one alternative over another. It is difficult to compare alternatives where one of them incurs most costs early and returns most benefits many years later, while the other receives constant benefits. For this reason, economists use the discount rate to compare costs and benefits in equal time periods.

This section briefly describes three watersheds in Oregon and analyzes their situation with the information developed in the previous sections. The three municipal watersheds are those that supply water for Yachats, Cottage Grove, and Portland.

A. CITY OF YACHATS WATER SUPPLY

The two existing sources of water for the City of Yachats are Reedy Creek and Salmon Creek (part of the Blodgett Tract). These two creeks and the potential Yachats River are all classified as surface water sources. The watersheds for Reedy Creek have been well protected in the past (the last 50 years). If water is taken from the Yachats River in the future, it is expected to be more turbid, especially in the winter months. In total, this watershed contains about 1,000 acres, of which 250 are privately owned. The U.S. Forest Service is currently negotiating to trade land elsewhere for these privately held acres. When these trades are completed, the Yachats watershed will be almost totally federally owned. The U.S. Forest Service has declared this area to be a key watershed, and no logging is planned or expected in the municipal watershed, once the private lands have been purchased by the U.S. Forest Service.

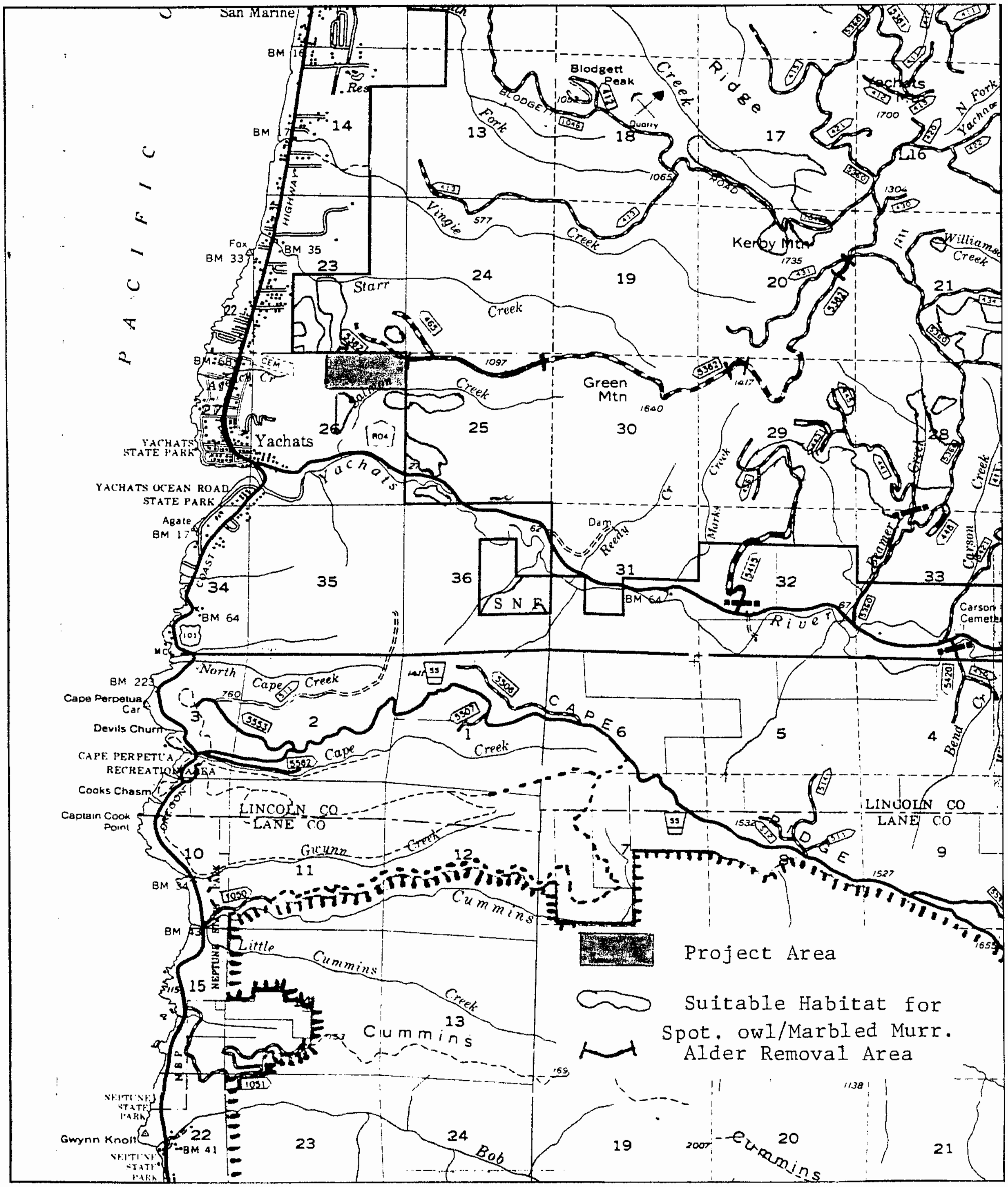
1. Yachats Municipal Water Source

Two surface water sources provide municipal water to the City of Yachats (Figure 5) (USDA 1992):

- Reedy Creek is located at Mile 2.5 of Yachats River Road. The intake is presently operated under a special use permit with the Forest Service. The watershed is approximately 260 acres. The City of Yachats holds a two cubic feet per second (CFS) (1.3 MM gal /day) Water Right on this stream.

- Salmon Creek is located at Mile 1.0 on the Yachats River Road. The Salmon Creek intake is on private land approximately 250 feet from the Yachats River at its confluence with Salmon Creek. This watershed is roughly 460 acres, one third of which is privately owned. The remainder is National Forest. The City of Yachats holds a 2 CFS Water Right on this stream.

Figure 5
North Project Area and Vicinity
Map Shows Segments of Road 5362 Requiring Alder Removal



Note: The project of alder removal may no longer be valid.
Source: USDA 1992.

The City of Yachats also currently holds a 2 CFS Water Right on Marks Creek. At this time, the City has no plans to incorporate Marks Creek into their system.

The Yachats Municipal Water System utilizes about 200 acre feet per year from a natural watershed that covers approximately 1,000 acres. Over a five year period, low summer streamflows averaged 180,000 gallons per day in Reedey Creek and 277,000 gallons per day in Salmon Creek. Based on the area's present population, the average required water supply is 150,000 gallons per day. The maximum daily demand is estimated to be 230,000 gallons. By the year 2013, roughly 250,000 gallons per day may be required, and the daily maximum demand may be increased to 500,000. Water is filtered through a sand filter and pumped to a holding reservoir. The system is able to filter a half million gallons per day.

2. History of the Blodgett Tract[1]

In May of 1917 John Blodgett, owner of Blodgett Timber Company, purchased a 10,000 acre parcel of forest land for $540,000. Sitka spruce, so abundant along the central Oregon coast, was then being used to build airplanes to support the war effort. Mr. Blodgett was a successful speculator. He sold his property, known today as the Blodgett Tract, in November of that year to the U.S. Army's Spruce Production Division. Soon a main access railroad route was completed and about two million board feet of spruce trees were felled and bucked into logs. Preliminary construction had begun on railroad spur roads when the war ended.

In 1920 the Army sold its holdings to CD Johnson, owner of the Pacific Spruce Corporation. Intensive railroad logging continued intermittently until the mid-1930's, by which time the Blodgett Tract timber supply was nearly exhausted. Because of the area's rugged terrain, construction of an extensive system of railroad trestles had been necessary. During peak harvest about 400 to 500 MBF was being removed from the area each day. Logging debris in the form of slash and unmerchantable logs littered the ground and choked the streams, and there was little incentive to replant harvest sites. The standard practice of timber industry operations in those days was to move the rails to other sites as soon as a railroad spur had been "cut out." In 1933 and 1934, available construction rock was more valuable than the remaining timber.

In 1936, the Big Creek Fire burned almost all of the Blodgett Tract. The logging debris provided excellent fuel, and made fireline construction and extinguishing "hot spots" practically impossible. Trestles, ties and other remnants of the Blodgett Tract's unique history were burned beyond recognition. The Forest Service purchased the entire area in July of 1941 for just under $100,000. The Blodgett Tract thus became consolidated into the Siuslaw National Forest's Waldport Ranger District, under whose jurisdiction it has remained ever since. Civilian Conservation Corps workers and Conscientious Objectors planted almost 9,000 acres between 1942 and 1944. Conifer seed was gathered from throughout Oregon, Washington and California in this two year effort to reforest Blodgett Tract.

1. Yachats watershed is part of this tract.

Active management of the Blodgett area in the 1950's and 1960's included salvage harvest and vegetation management operations. Tractors and small scale cable systems were used to access and remove standing dead and fallen western red cedar which had been killed in the 1936 fire. In the 1950's the first large scale fixed wing spraying of herbicides ever performed in the Pacific Northwest was done over this area. Less extensive helicopter applications of herbicides were performed during the 1960's.

3. Water Quality Concerns Expressed by Citizens Involving the Quality of Yachats Water Source[1]

- Private and public water system users depend on a stable and constant supply of high quality water.

- There is a risk of water quality degradation and diminished available volume associated with any management activity.

- There is no reliable alternative to surface water in this area. Special water treatment measures are expensive and funding possibilities are limited. Excessive dissolved organics and increased sedimentation could require special water treatment measures.

- Misuse of chemicals in municipal watersheds could pose a health hazard and could lead to risks not yet identified.

- Failure to meet water quality objectives could result in increased treatment cost.

- Water quality should be the driving issue for all management activities within the municipal watersheds.

4. Current Watershed Timber Management Objectives

Under the "Blodgett Tract Area Analysis" timber harvest acreage should be 15 percent or less of the total watershed area per decade (USDA 1992). The acreage in the Yachats municipal watershed is 260 acres in Reedy Creek and 460 acres in Salmon Creek.[2] According to the 15 percent harvest per decade objective, this watershed could theoretically sustain about a ten acre harvest schedule per year (100 acres per decade). Since 1993, as a result of President Clinton's Forest Plan, new criteria for managing USFS lands have been established. As a result of concern for endangered species, the timber management objectives may no longer be valid.

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1. USDA 1992.
2. About one third of the Salmon Creek watershed is in private lands. The USFS is negotiating a trade for these private lands.

A timber management program in the Yachats watershed would have reduced flow in August through October. This is a period of high demand for water. Any avoidance of building additional reservoirs and treatment facilities will produce benefits that may be compared to the costs of timber management programs. Since the U.S. Forest Service is committed to a wildlife and aesthetic program for the Yachats watershed, the City of Yachats may consider this as a program that will provide direct benefits to water users in Yachats.

5. Future Considerations

The City of Yachats is fortunate in that the federal government is the major owner of the Yachats Municipal Watershed. Even though timber management objectives were, until 1990, a preferred alternative, under President Clinton's Forest Plan this watershed will not be considered for timber management. In addition, the U.S Forest Service is negotiating to purchase or trade the remaining private property in the watershed for its wildlife and aesthetic values. The federal government is managing the City of Yachats watershed for its objectives, to meet ESA requirements, that will at the same time meet the City's objective in supplying a quality water supply to its citizens at minimal costs. Because the private lands are a key component to meet the watershed objectives, the Yachats community should consider the purchase of the private timberlands in the event that the U.S. Forest Service is unable to follow through with its plan.

B. CITY OF COTTAGE GROVE WATER SUPPLY[1]

The City of Cottage Grove water supply is obtained from two diversions on Laying and Prather Creeks in the Laying Creek Watershed, approximately 20 miles east of Cottage Grove (Figure 6).

1. City of Cottage Grove Water Source

The City has Water Rights from the State of Oregon to divert up to 10.00 cubic feet (CFS) or about 6.5 million gallons per day (MGD) (19.90 acre feet) from these sources. Water quality of these streams varies throughout the year.

2. Water Quality Concerns

Turbidity levels and occasional bacterial presence in the finished water from Laying Creek have exceeded the standards of the federal and State drinking water regulations. Emphasis has been made by both the City and the U.S. Environmental Protection Agency (EPA) for the development of a suitable long-term water supply. This has resulted in an expansion of the Laying Creek water source that has resulted in increased water flow capacity, but also increased treatment costs.

1. CH2M Hill 1983.

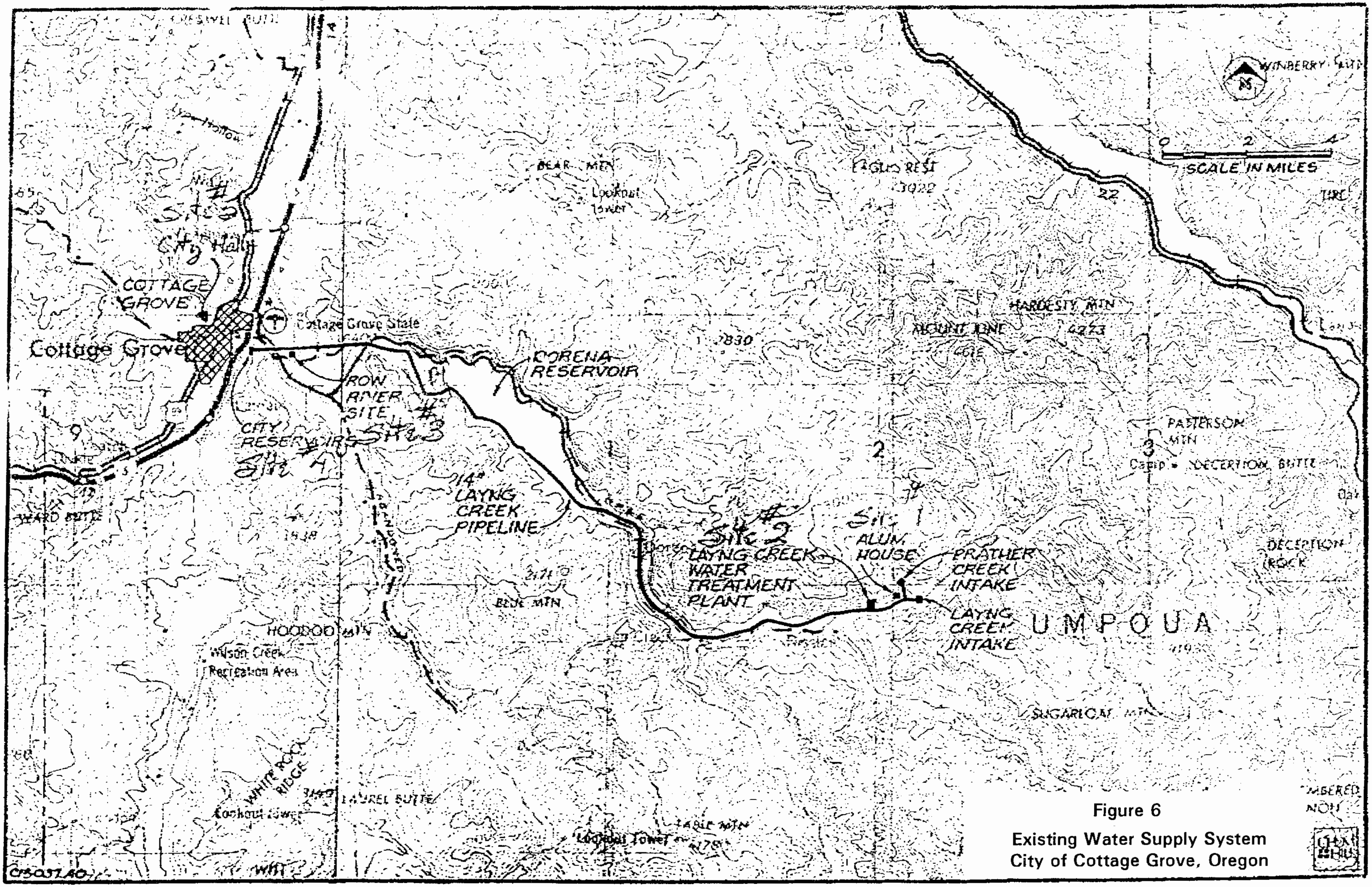

Figure 6

Existing Water Supply System
City of Cottage Grove, Oregon

The quality of water from the Laying Creek watershed now meets all the organic and inorganic chemical standards as established by EPA and the State of Oregon drinking water regulations, except for turbidity, which has often been high during rainy weather and which interferes with the effectiveness of chlorination to meet the standards of microbiological quality.

Upgrading to correct the deficiencies and expansion of the existing Laying Creek treatment facilities has been a major undertaking. It involved increasing the hydraulic capacity and increasing impoundments at the intake to provide the necessary raw water supply during dry weather to meet future water demand. Also, the necessary modifications of the filter facilities to accommodate high flow rates were extensive.

3. Future Considerations

During the deliberations of the City of Cottage Grove concerning new water sources, consideration was given to the use of a new diversion in a different watershed in the area. However, it was decided that in these watersheds that have lower wintertime turbidity, it would be too expensive to develop the delivery system.

No consideration was given to purchase a watershed and develop it as a natural source and reservoir. This report methodologies are especially applicable to municipalities, such as Cottage Grove, that rely on other entrepreneurs or agencies for management of their watersheds.

C. PORTLAND WATER SUPPLY[1]

The Bull Run watershed serves as the source of water for most of the Portland, Oregon area, supplying about a third of the State's population. It lies 35 miles east of the City in the Mt. Hood National Forest. It drains about 107 square miles (68,400 acres) of volcanic-derived landscape at elevations of 750 to 4,150 feet above sea level. The water supply system has 64,000 acre-feet of storage in two major reservoirs and a managed natural lake (Bull Run Lake). The two mainstem reservoirs store about a month's average flow of the river. The watershed is mainly in old growth forest cover, though past logging, recent blowdowns, and salvage logging have left conspicuous breaks in the continuity. (See Figure 7.)

1. Portland's Municipal Water Source

The Bull Run River is a very intense and generous water source area. Average annual rainfall in the watershed is 135 inches, compared to 45 inches in the Portland area. Average annual runoff at the mouth is about 600,000 acre feet. Over the past several years, about 42 percent of this flow has been diverted to the City system. The runoff is distinctly seasonal, with low flows in the summer and peaks in the winter and spring. Fog drip also makes a contribution to the water budget of the Bull Run watershed.

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1. Aumen 1989.

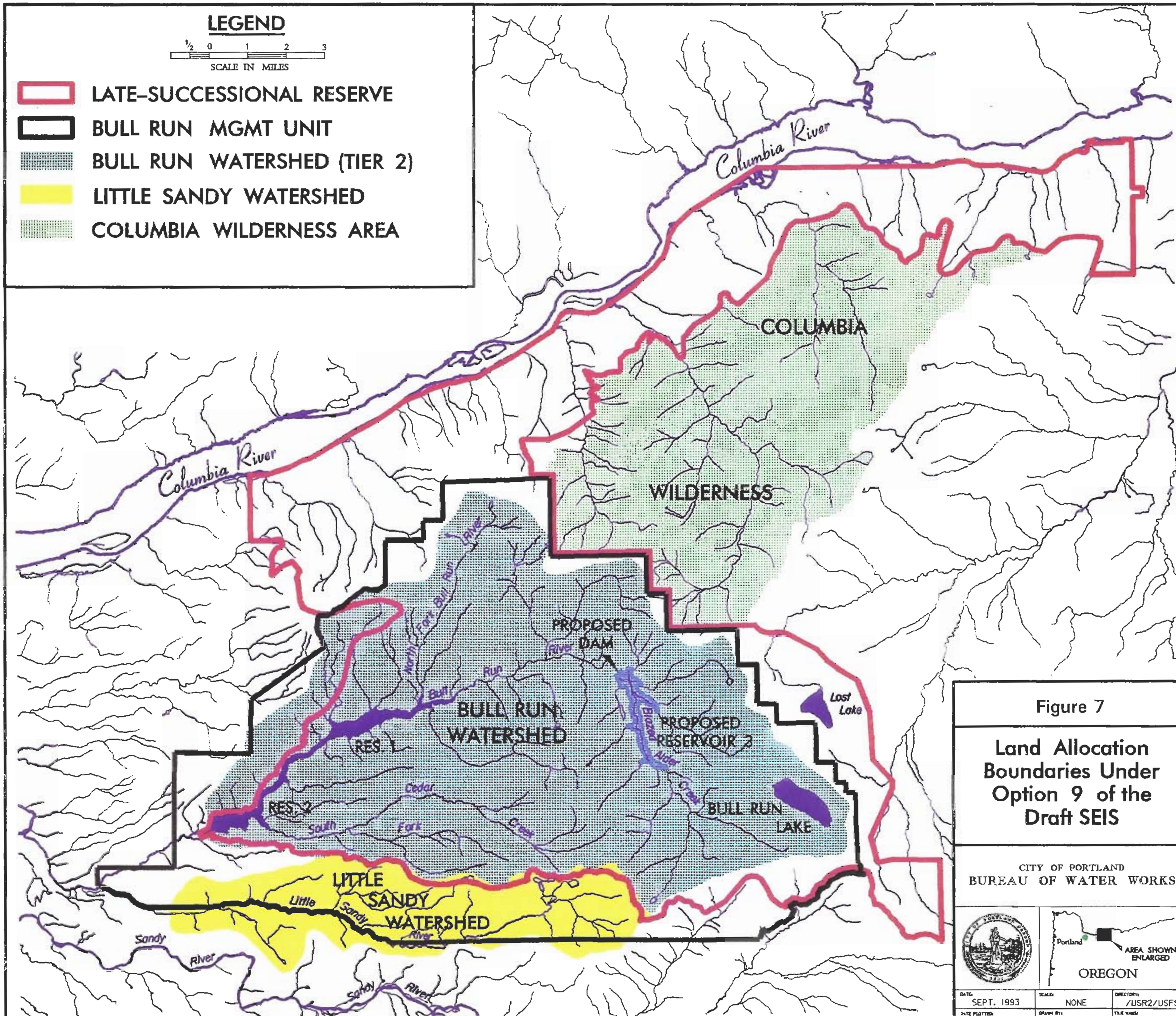

Figure 7

Land Allocation Boundaries Under Option 9 of the Draft SEIS

CITY OF PORTLAND
BUREAU OF WATER WORKS

DATE	SCALE	DIRECTORY
SEPT. 1993	NONE	/USR2/USFS
DATE PLOTTED 02-NOV-1993	DRAWN BY J.P.B.	FILE NAME SEISDRAFT.OWL

Unusually pure, Bull Run water gives Portlanders bragging rights as one of the few cities with a water supply that hasn't required treatment (Nokes 1995). The Portland water receives no treatment other than chloramination.

2. History of the Bull Run Watershed

The Bull Run watershed is part of the Bull Run watershed Management Unit of the Mt. Hood National Forest. A larger Bull Run Reserve was set aside by Congressional legislation in 1904 to serve as a protected watershed, in which all other uses were to be subordinate to maintenance of water quality. Public entry was specifically prohibited.

The U.S. Forest Service initiated large-scale timber harvesting in the 1950's in Bull Run, declaring that by removing old growth timber they were decreasing the possibility of disastrous fires.

In March, 1976, the Federal District Court declared logging there to be illegal. One year after the lawsuit, the U.S. Congress repealed the Trespass Act and reopened the Bull Run to logging (P.L. 95-200). A windstorm in the Columbia River Gorge in 1983 downed 5,770 acres of timber in the Bull Run watershed (Wilson 1992). Salvaging this timber reignited the conflict among the City of Portland, environmentalists, the U.S. Forest Service, and the timber industry regarding Bull Run management.

The blowdown in 1983 renewed the conflict in a watershed owned by the federal government, but serving as a vital municipal resource. As of 1990, 20.6 percent of the watershed (14,018 acres) have been harvested in Bull Run.[1]

3. Water Quality Concerns

The Bull Run River serves as a culinary water source for about a third of Oregon's population. It has a unique focus of public attention in the Portland area, arising from a long heritage of a copious pure surface water supply from a local source, delivered largely untreated. This abundant supply, along with its high quality and natural source, is an item of community pride, perceived to promote good health and well-being, and to act as an economic attractant. In the interests of maintaining the water's natural purity, land use on the Bull Run watershed has been severely controlled (Hawkins 1995).

By any objective standard, the water quality of the streams of the Bull Run watershed can only be described as extraordinary. The Bull Run Reserve was established by Presidential Proclamation in 1892 to protect the water supply. In 1904, Congress enacted the Bull Run Trespass Act, which prohibited entry into the Reserve except for those persons acting in an official capacity. The Reserve remained closed to all but official entry until 1959, when an administrative order issued by the Regional Forester for the U.S. Forest Service (USFS)

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1. Official estimates of the total acres logged are contested by advocacy groups.

opened 42,500 acres of the Bull Run Reserve to public use. In addition, the Regional Forester implemented an active timber management program within the Reserve.

In 1960, Congress passed the Multiple-Use Sustainable-Yield Act, which further substantiated the USFS philosophy of using the diverse resources of national forests. In 1973, resistance by private concerns to any increase in timber activity within the watershed led to a private lawsuit against the USFS's management practices within the Reserve.

In 1976, the USFS ceased issuing contracts for timber harvesting and recreational usage of the previously open 42,500 acres of the Reserve was discontinued. Because the administration of the Reserve had been caught between two conflicting congressional directives (the limitations imposed by the 1904 Trespass Act and those of the 1960 Multiple-Use Sustainable-Yield Act), Congress passed PL (Public Law) 95-200 to resolve boundary and management issues. The primary management objective of PL 95-200 was the continued production of pure, clear, raw, potable water for the Portland metropolitan area. A secondary management objective was the protection, management, and use of the renewable resources within the reserve, as long as management of these resources did not significantly affect water quality. The new law provides for the Secretary of Agriculture, through the USFS, to administer the Bull Run watershed in accordance with USFS policy, except for policy that the Secretary determines would have an adverse effect on water quality. The law specifically required adaption of water quality standards which would provide the means necessary to determine significant effects of management practices on water quality. Once the water quality standards were developed, any management practice found to have a significant adverse effect on water quality, based on standards, would be modified (U.S. Geological Survey 87-4128).

As the result of a 1983 wind storm, the USFS increased logging activity under "salvage logging" objectives. The City of Portland has expressed concern about the effect of human activity, especially logging, in the Bull Run. Numerous studies have been funded and completed to study water quality and the sediment yield of the Bull Run system. Some of these studies are:

- U.S. Geological Survey. "Water Quality Variations in the Bull Run watershed, Oregon, Under 1978 to 1983 Management Conditions." Water Resources Investigations Report 87-4128.
- U.S. Geological Survey. "Variations in Turbidity in Streams of the Bull Run Watershed, Oregon, Water Years 1989-90." Water Resources Investigations Report 93-4045.
- Aumen, Nicholas G., Thomas J. Grizzard, Richard H. Hawkins. "Water Quality Monitoring in the Bull Run Watershed." Task Force Final Report, City of Portland Bureau of Water Works. 1989. pp. 3.
- Hamilton, Doann M. "Sediment Yield Analysis of Reservoir #1, Bull Run Watershed, West Cascade Mountains, Oregon." Masters thesis, Portland State University. 1994.

- Peterson, Curt D., Doann M. Hamilton, Scott F. Burns. "Sediment Deposition in Reservoir No. 1, Bull Run Watershed, Oregon." Department of Geology, Portland State University. 1995.
- Hawkins, Richard H. "Hydrologic Analysis of Water Yield and Low Flows, Bull Run Watershed." Consultant's Report, Contract 29022. City of Portland, Bureau of Water Works. November 1995.

The conclusions of these studies are that the rate of sediment yield in the Bull Run is relatively low compared to other drainages in the Pacific Northwest. This is because of the geographical conditions and terrain of the watershed.

Argument over whether logging is harmful to Bull Run water continues. Unfortunately, sufficient scientific data to reliably demonstrate cause-effect relationships between logging and water quality are still unavailable. Curiously, the burden-of-proof for responsible watershed management practices seems to rest with Portland, environmental scientists, and the public rather than with the U.S. Forest Service (Larson 1987).

The Water Bureau estimates that it will cost $1.5 million to bring its monitoring program up to the level recommended by the Wyden Task Force. Also, the agency is spending $2.2 million on a new Bull Run water quality laboratory (Larson 1990). Some of this monitoring would not be required if logging had not occurred within the watershed.

Land management practices (logging) have contributed to sediment yield. Ongoing research has shown reductions in summer flows following logging and that logging activities in the Bull Run basin have reduced the overall supply of water (Hawkins 1995).

4. Current Watershed Timber Management

The designation of the spotted owl as a threatened species may achieve what 14 years of environmental activism have failed to do: stop the logging. The spotted owl habitat conservation areas recommended in the initial U.S. Fish and Wildlife Service plan incorporates about 95 percent of the Bull Run management unit watershed, including the entire physical drainage. If this plan is adopted, management activity will shift from concentration on timber harvest to monitoring water quality and increasing water supply. A federal circuit court decision in May 1991 blocked any blowdown salvage sales in the Bull Run watershed until the Forest Service develops a conservation plan and environmental impact statement for the spotted owl (Wilson 1992, p. 88). (See Figure 7.)

Whether any future logging activity takes place in the Bull Run Reserve will depend on what type of logging is allowed in late successional reserve (LSR). Management for LSR currently allows logging of stands younger than 80 years.

5. Future Considerations

The Bull Run watershed is a classic example of short run gains versus long run benefits. A standing forest will always entice the "money in the bank" view to endorse cutting the timber. However, forest management in an environmentally sensitive area is expensive. When these expenses are compared to an annual flow of benefits of avoided storage cost construction, additional treatment costs, and other benefits, managing the Bull Run watershed for growing water is economically prudent.

The decision making process may have reached the same conclusion in 1996. The U.S. Congress passed legislation signed by President Clinton that protects the Bull Run watershed by declaring its management to be for water quality and water quantity purposes. Cutting of trees may be allowed only for protection or enhancement of water quality or quantity and for construction of municipal water supply facilities (Appendix A). In addition, a two-year moratorium on logging will be imposed on the Little Sandy watershed to study the water quantity and quality of this watershed on the on the Portland metropolitan area.

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APPENDIX A

FEDERAL LEGISLATION PROTECTING THE BULL RUN WATERSHED

Hatfield Substitute to S.1662

AS INCLUDED IN OMNIBUS APPROPRIATIONS CONFERENCE -- 9-30-96

104th CONGRESS
2d Session

To: Regna M.
Fm: Dave R.
As signed by Pres.
thanks!

IN THE SENATE OF THE UNITED STATES

A BILL

To establish areas of wilderness and recreation in the State of Oregon, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Oregon Resource Conservation Act of 1996".

TITLE I--OPAL CREEK WILDERNESS AND SCENIC RECREATION AREA

SEC. 101. SHORT TITLE.

This title may be cited as the "Opal Creek Wilderness and Opal Creek Scenic Recreation Area Act of 1996".

SEC. 102. DEFINITIONS.

In this title:

(1) Bull of the Woods Wilderness.--The term "Bull of the Woods Wilderness" means the land designated as wilderness by section 3(4) of the Oregon Wilderness Act of 1984 (Public Law 98-328; 16 U.S.C. 1132 note).

(2) Opal Creek Wilderness.--The term "Opal Creek Wilderness" means certain land in the Willamette National Forest in the State of Oregon comprising approximately 12,800 acres, as generally depicted on the map entitled "Proposed Opal Creek Wilderness and Scenic Recreation Area", dated July 1996.

(3) Scenic Recreation Area.--The term "Scenic Recreation Area" means the

activities on the Coquille Forest lands, the Tribe may exercise such jurisdiction as is agreed upon.

(12) In the event of a conflict between Federal and State law under this subsection, Federal law shall control."

TITLE VI--BULL RUN WATERSHED PROTECTION

SEC. 601. The first sentence of Section 2(a) of Public Law 95-200 is amended after "referred to in this subsection (a)" by striking "2(b)" and inserting in lieu thereof "2(c)".

SEC. 602. The first sentence of Section 2(b) of PL 95-200 is amended after "the policy set forth in subsection (a)" by inserting "and (b)".

SEC. 603. Section 2(b) of PL 95-200 is redesignated as "2(c)".

SEC. 604

(a) Public Law 95-200 is amended by adding a new subsection 2(b) immediately after subsection 2(a), as follows:

"(b) TIMBER CUTTING.--

(1) IN GENERAL.-- Subject to paragraph (2), the Secretary of Agriculture shall prohibit the cutting of trees in that part of the unit consisting of the hydrographic boundary of the Bull Run River Drainage, including certain lands within the unit and located below the headworks of the city of Portland, Oregon's water storage and delivery project, and as depicted in a map dated July 22, 1996 and entitled "Bull Run River Drainage".

(2) PERMITTED CUTTING.--

(A) IN GENERAL.-- Subject to subparagraph (B), the Secretary of Agriculture shall prohibit the cutting of trees in the area described in paragraph (1).

(B) PERMITTED CUTTING.-- Subject to subparagraph (C), the Secretary may only allow the cutting of trees in the area described in paragraph (1)--

(i) for the protection or enhancement of water quality in the area described in paragraph (1); or

(ii) for the protection, enhancement, or maintenance of water quantity available from the area described in paragraph (1); or

(iii) for the construction, expansion, protection or maintenance of municipal water supply facilities; or

(iv) for the construction, expansion, protection or maintenance of facilities for the transmission of energy through and over the unit or previously authorized hydroelectric facilities or hydroelectric projects associated with municipal water supply facilities.

(C) SALVAGE SALES.-- The Secretary of Agriculture may not authorize a salvage sale in the area described in paragraph (1)."

(b) Redesignate subsequent subsections of PL 95-200 accordingly.

SEC. 605. Report to Congress.

(a) The Secretary of Agriculture shall, in consultation with the city of Portland and other affected parties, undertake a study of that part of the Little Sandy Watershed that is within the unit (hereinafter referred to as the "study area"), as depicted on the map described in Section 604 of this title.

(b) The study referred to in (a) shall determine --

(1) the impact of management activities within the study area on the quality of drinking water provided to the Portland Metropolitan area;

(2) the identity and location of certain ecological features within the study area, including late successional forest characteristics, aquatic and terrestrial wildlife habitat, significant hydrological values, or other outstanding natural features; and

(3) the location and extent of any significant cultural or other values within the study area.

(c) The study referred to in subsection (a) shall include both legislative and regulatory recommendations to Congress on the future management of the study area. In formulating such recommendations, the Secretary shall consult with the city of Portland and other affected parties.

(d) To the greatest extent possible, the Secretary shall use existing data and processes to carry out this study and report.

(e) The study referred to in subsection (a) shall be submitted to the Senate Committees on Energy and Natural Resources and Agriculture and the House Committees on Resources and Agriculture not later than one year from the date of enactment of this section.

(f) The Secretary is prohibited from advertising, offering or awarding any timber sale within the study area for a period of two years after the date of enactment of this section.

(g) Nothing in this section shall in any way affect any State or Federal law governing appropriation, use of or Federal right to water on or flowing through National Forest System lands. Nothing in this section is intended to influence the relative strength of competing claims to the waters of the Little Sandy River. Nothing in this section shall be construed to expand or diminish Federal, State, or local jurisdiction, responsibility, interests, or rights in water resources development or control, including rights in and current uses of water resources in the unit.

SEC. 606. Lands within the Bull Run Management Unit, as defined in PL 95-200, but not contained within the Bull Run River Drainage, as defined by this title and as depicted on the map dated July 1996 described in Section 604 of this title, shall continue to be managed in accordance with PL 95-200.

TITLE VII--OREGON ISLANDS WILDERNESS, ADDITIONS

SEC. 701. OREGON ISLANDS WILDERNESS, ADDITIONS.

(a) In furtherance of the purposes of the Wilderness Act of 1964, certain lands within the boundaries of the Oregon Islands National Wildlife Refuge, Oregon, comprising approximately ninety-five acres and as generally depicted on a map entitled "Oregon Island Wilderness Additions -- Proposed" dated August 1996, are hereby designated as wilderness. The map shall be on file and available for public inspection in the offices of the Fish and Wildlife Service, Department of Interior.

(b) All other Federally-owned named, unnamed, surveyed and unsurveyed rocks, reefs, islets and islands lying within three geographic miles off the coast of Oregon and above mean high tide, not currently designated as wilderness and also within the Oregon Islands National Wildlife Refuge boundaries under the administration of the U.S. Fish and Wildlife Service, Department of Interior, as designated by Executive Order 7035, Proclamation 2416, Public Land Orders 4395, 4475 and 6287, and Pubic Laws 91-504 and 95-450, are hereby designated as wilderness.

(c) All Federally-owned named, unnamed, surveyed and unsurveyed rocks, reefs, islets and islands lying within three geographic miles off the coast of Oregon and above mean high tide, and presently under the jurisdiction of the Bureau of Land Management, except Chiefs Island, are hereby designated as wilderness, shall become part of the Oregon Islands National Wildlife Refuge and the Oregon Islands Wilderness and shall be under the jurisdiction of the U.S. Fish and Wildlife Service, Department of the Interior.

(d) As soon as practicable after this title takes effect, a map of the wilderness area and a description of its boundaries shall be filed with the Senate Committee on