APPENDIX F, Environmental
Part 2, Wildlife

Additional Water Storage Project, Draft Feasibility Report & EIS

Howard Hanson Dam,
Green River, Washington
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prepared by
Seattle District
US Army Corps of Engineers

Tacoma Public Utilities

US Army Corps of Engineers®

APPENDIX F
ENVIRONMENTAL
PART 2 — WILDLIFE

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SECTION 1 INTRODUCTION

1.1 BACKGROUND

A wildlife mitigation plan was developed to offset the impacts associated with the proposed Howard Hanson Dam (HHD) Additional Water Storage (AWS) Project. During the early project planning stage in the mid 1980s mitigation planning initially focused on impacts to Rocky Mountain elk (*Cervus elaphus*). The mitigation planning efforts were subsequently expanded to evaluate other wildlife species and habitat requirements targeting critical habitat in the basin. Therefore, the current mitigation measures focus on the development of elk winter forage areas and acceleration of late-successional forest characteristics in selected stands in the reservoir area. The level of mitigation that was identified was determined using Habitat Evaluation Procedures (HEP) Analysis (see Section 4). Additional mitigation actions are aimed at replacing emergent marshes and forested wetlands that will be inundated by the higher reservoir.

1.2 PROPOSED PROJECT

Tacoma Public Utilities Water Division (Tacoma), in conjunction with the U.S. Army Corps of Engineers (Corps), proposes to raise the Conservation Pool of the HHD reservoir to elevation 1177 feet mean sea level (MSL) feet in two phases. Phase I will increase the Conservation Pool level from 1147 feet MSL to 1167 feet MSL; an additional 10-foot pool raise would be implemented under Phase II. The purpose of the additional storage capacity is to augment the City of Tacoma's municipal water supply and to provide fish and wildlife restoration opportunities, especially downstream flow augmentation for anadromous fish.

1.3 LAND MANAGEMENT IN THE UPPER GREEN RIVER BASIN

The Howard Hanson Dam and reservoir are located in the upper Green River watershed (Figure 1). The upper watershed covers approximately 233 square miles. Lands within the upper watershed are held by the City of Tacoma, private timber companies, Washington Department of Natural Resources (DNR) and the U.S. Forest Service (Figure 2). Approximately 24% of the upper watershed lies within the Mt. Baker Snoqualmie National Forest, DNR holds 11% and 56% is private commercial forest land. The City of

Tacoma owns approximately 13,630 acres of land in the watershed, representing 9% of upper watershed (Ryan 1996). Of these lands, 10,441 acres are forested.

The Mt. Baker Snoqualmie National Forest lands in the watershed are managed under the Northwest Forest Plan as Late Successional Reserves and Matrix lands or are included in the Snoqualmie Pass Adaptive Management Area. The Matrix lands are located on the south side of the upper Green River valley and are managed for commercial timber production. The remaining lands are managed primarily for wildlife habitat. The state lands and privately held timberlands are managed for commercial timber production.

It is Tacoma's policy to acquire land in the watershed within a half mile of the Green River or its tributaries when it becomes available for purchase or exchange. Therefore, Tacoma's lands are largely confined to the reservoir perimeter and lands adjacent to the mainstream and its major tributaries. Tacoma manages these lands for water quality protection per management policies described in their Green River Watershed Forest Land Management Plan (Ryan 1996). The available forest lands are allocated to one of three management zones: Natural, Conservation and Commercial (Figure 3). Most of the lands surrounding the HHD reservoir are within the Natural and Conservation Zones. The following descriptions are from Tacoma's Forest Management Plan (Ryan 1996).

The Natural Zone is made up of surface waters and lowland forest lands adjacent to the Green River, HHD reservoir, lakes and major tributaries where intensive forest practices would impact water quality. It extends from the average high water mark toward the forested uplands to an effective management boundary such as a road, right-of-way or property boundary.

The Conservation Zone lies between commercial forest lands and the Natural Zone to buffer the Natural Zone from areas of intensive forest management which may impact wildlife habitat or water quality. Management in the Conservation Zone is directed at maintaining or improving vegetative cover for fish and wildlife habitat production. The long-term goal is to accelerate the development of even-age stands into late-successional multi-storied forest stands.

The Commercial Zone has been designated on lands where forest practices will not adversely affect wildlife habitat or water quality. The majority of the Commercial lands are located east of the reservoir.

1.4 EXISTING WILDLIFE HABITAT CONDITIONS IN THE PROJECT AREA

1.4.1 Deciduous Forest

Four categories of deciduous forest have been identified within the reservoir basin (see Figure 4). Areas supporting mature stands of big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) and having an understory of salmonberry (*Rubus spectabilis*), trailing blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), bracken fern *(Pteridium aquilinum*) and pig-a-back plant (*Tolmeia menziesii)* were classified as mature upland deciduous forest (FD on Figure 4). Young stands of deciduous forest were given a separate classification (FDY). Monotypic stands of mature red alder supporting similar species were mapped separately (FD1),as were monotypic stands of cottonwood (FD2). Deciduous forest habitat types occur along the eastern half of the reservoir upstream of Eagle Gorge, along much of the southern reservoir edge and along the Green River mainstem, North Fork mainstem and most of the larger reservoir tributaries.

1.4.2 Conifer Forest

Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) are the dominant overstory trees in the mature conifer forest habitat. Forests in the Project Area are generally less than 100 years of age. Older second-growth forests that became established under less intensive management are dominated by western hemlock. Some of these stands have canopy openings and support healthy subcanopy and understory layers; others have closed canopies and support little to no subcanopy or understory species and have few to no snags or down woody debris. Sword fern, Oregon Grape (*Mahonia nervosa*) and salmonberry dominate the understory species found in the Project Area conifer forests. The stands are generally healthy and contain few dead trees with diameters greater than 6 inches

More recently established conifer forests are plantations of Douglas-fir where broad leaf shrub and saplings have been controlled with herbicides. These practices have resulted in even-aged stands with few subcanopy trees or understory shrubs. Snags are generally less than 6 inches dbh and little woody debris is found on the forest floor. The uniform canopies typically result in few openings and little understory vegetation.

1.4.3 Mixed Forest

Douglas-fir comprises 40 to 60% of the canopy within this habitat type. Western red cedar, western hemlock, Sitka spruce (*Picea sitchensis*), big-leaf maple and red alder

comprise the remainder of the overstory canopy. Oregon grape, trailing blackberry, salmonberry and sword fern are also dominant understory species in this habitat type.

1.4.4 Forested Wetland

Mature black cottonwood and red alder dominate the overstory in this habitat type. Willows (*Salix spp.*), red osier dogwood (*Cornus stolonifera*), salmonberry, water parsley (*Oenanthe sarmentosa*) and coltsfoot (*Petasites frigidus*) are common understory species. Most of the forested wetland habitat in the project area occurs along the banks and gravel bars of the mainstem Green River and North Fork Green River. Although the river periodically overflows and floods these wetlands, the primary year-round source of water for most of these is from the runoff from adjacent steep slopes.

1.4.5 Scrub-Shrub Wetland

This habitat type includes monotypic stands of willow supporting a sparse, patchy understory of woolgrass (*Scirpus cyperinus*) and bentgrass (*Agrostis spp.*). This habitat type occurs in small patches at the northeast section of the reservoir upstream of Eagle Gorge, the shoreline at the mouth of Cottonwood Creek and along the upper shoreline of the old cedar swamp area in the northwest portion of the reservoir downstream of Eagle Gorge.

1.4.6 Emergent Marsh

Emergent marsh habitat occurs primarily between elevations 1,141 feet MSL and 1,120 feet MSL. Woolgrass (*Scirpus cyperinus*) and soft rush (*Juncus effusus*) are the dominant species at the upper elevations, with common velvetgrass (*Holcus lanatus*), bentgrass (*Agrostis* spp.), quackgrass (*Agropyron repens*), bluegrass (*Poa* spp.), creeping buttercup (*Ranunculus repens*) and sedges (*Carex* spp.) intermixed within the areas of soft rush. Quackgrass and creeping buttercup, as well as patches of aquatic mosses, occur below the elevation of 1,130 feet MSL; but this elevation provides a marginal growing season and marginal water depth for plant survival. Only the "toughest" plants (those adapted to these extremely minimally acceptable growing conditions) survive at this depth.

A Section 1135 Fish and Wildlife Restoration Project to be implemented prior to Phase I of the Additional Storage Project will increase the conservation pool level from 1141 feet MSL to 1147 feet MSL (Phase I baseline condition). The 1135 Project pool raise will likely cause a shift in emergent habitat species below elevation 1141 feet MSL. One of the enhancement measures of the 1135 Project is to plant sedges (*Carex* spp.) over 18.5 acres (1,200 plugs per acre) between 1,141 feet MSL and 1,147 feet MSL and 10 acres of Columbia sedge (*Carex aperta*) (600 plugs per acre) below 1,141 feet MSL.

1.4.7 Upland Shrub

Upland shrub habitat in the reservoir area is dominated by young red alder, salmonberry, blackberry and sword fern. Most upland shrub habitat occurs within the powerline rights-of-way which are managed essentially as steady-state shrub, young deciduous and grassland communities.

1.4.8 Grassland

Grassland and weedy forbs dominate the grassland habitat type that occurs along the portions of the old railroad embankment above elevation 1,140 feet MSL and in the upper areas of the old MacDonald farm. Grass species include timothy (*Phleum pratense*), red fescue (*Festuca rubra*), quackgrass and redtop bentgrass (*Agrostis stolonifera*). This area is heavily browsed by elk which prevents this abandoned pasture land from converting to shrub and forest habitat.

1.4.9 Mudflat

Occasional patches of algae are supported on mudflats found along much of the perimeter of the reservoir.

1.4.10 Talus Slope/Rock

Rock slopes supporting little vegetation occur along and adjacent to the face of the dam, as well as upstream from the reservoir along a railroad grade from elevation 1150 feet MSL to 1180 feet MSL.

1.5 EXISTING WILDLIFE RESOURCES

Information concerning wildlife use of the HHD reservoir has primarily been derived from observations made by state wildlife biologists, Tacoma Water Division personnel and Corps operations personnel and biologists. Additional information was obtained during marbled murrelet (*Brachyramphus marmoratus marmoratus*) surveys conducted in 1994 (Beak 1994) and informal surveys conducted by Corps staff.

The most visible mammals in the reservoir area are elk and black-tailed deer (*Odocoileus hemionus*). The large numbers of herbivores in the basin has resulted in a significant

mountain lion population (*Felis concolor*), reported to be one of the highest population densities in the United States (Spencer pers. comm. 1996). Black bears (Ursus americanus) are relatively common, though not often observed. Furbearers in the project area include beaver (*Castor canadensis*), mink (*Mustela vison*), muskrat (*Ondatra zibethica*), weasels (*Mustela* spp.), raccoon (*Procyon lotor*) and snowshoe hare (*Lepus americanus*). Pika (*Ochotona princeps*) have also been observed on the rock slopes along the railroad grade. Small mammals such as Townsend chipmunk (*Eutamius townsendi*), chickaree (*Tamiasciurus douglasi*), red-back voles (*Clethrionomys gapperi*) and deer mice (*Peromyscus maniculatus*) are also common. Several species of amphibians are also known to occur in the basin. The Pacific tree frog (*Pseudacris regilla*) rears in the reservoir. Cascade frogs (*Rana cascadae*) have been found near the reservoir and red-legged frogs (*Rana aurora*) may be the most common amphibian in the project area, based on a survey conducted in March, 1997.Great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), green-winged teal (*Anas crecca*), wood duck (*Aix sponsa*), harlequin duck (*Histrionicus histrionicus*), hooded merganser (*Lophodytes cucullatus*) and common merganser (*Mergus merganser*) may nest near the reservoir. Breeding harlequin ducks have also been observed nesting on the reservoir in the early 1990s. The Washington State Department of Fish and Wildlife (WDFW) has placed common loon nesting platforms on the reservoir since 1993. Common goldeneye (*Bucephala clangula*), ring-necked duck (*Aythya collaris*) and bufflehead (*Bucephala albeola*) utilize the reservoir during the winter. Belted kingfishers (*Ceryle alcyon*) nest along the reservoir.

Raptors occurring in the basin include bald eagle (*Haliaeetus leucocephalus*), red-tailed hawk (*Buteo jamaicensis*), Cooper's Hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*) and several species of owls. Bald eagles are observed on a year-round basis at HHD reservoir, but no nesting activity has been noted. A golden eagle nest has been reported approximately three miles northeast of the reservoir upstream of Eagle Gorge (WDFW 1995). Osprey nesting has not been observed along the perimeter of the reservoir; however, osprey nesting has been documented along the Green River between HHD and the headworks (WDFW 1995).

1.6 ENDANGERED SPECIES COORDINATION

Biological assessments (BA's) for the Additional Water Storage Project have been prepared on three occasions — originally on July 27, 1992, again on September 6, 1996, and finally on October 20, 1997. The U.S. Fish and Wildlife Service (USFWS) did not concur with the conclusions in the first assessment regarding marbled murrelets and spotted owls (which was "no effect" for both of these species). The USFWS requested the Corps to conduct surveys to confirm that these species are not present in the project area. The Corps utilized data from Washington Department of Ecology (WDOE) spotted owl surveys, which confirmed that spotted owls are not present in the Charlie Creek

drainage adjacent to the project area. Through coordination with the Tacoma Water Division forester, the Corps has determined that the forest age and structure in the project area is not suitable for spotted owl nesting. These findings were included in the 1996 BA.

The Corps invited one of Washington Department of Fish and Wildlife's experts on marbled murrelets to visit the project area in 1993. He indicated the project area contained only three very small stands of trees that had the potential for nesting by marbled murrelets; and, additionally, that the stands were too isolated from one another, and too far removed from viable habitat, to support nesting murrelets. He recommended, however, that we conduct a single year of murrelet surveys following the protocol developed by the Pacific Seabird Group (normally this requires two years of survey) to confirm that murrelets were not present. Following this advice, the Corps conducted a survey in the summer of 1994, which resulted in no detections of marbled murrelets in the project area. This information was then included in the 1996 BA.

The USFWS expressed informal concurrence of the spotted owl and marbled murrelet effect conclusions ("not likely to adversely effect"), but indicated a lack of confidence with the information provided for bald eagles in the 1996 BA. The lack of confidence was a result of "new" downstream flow criteria that agencies had recently recommended and which the Corps and City of Tacoma were deciding how to incorporate into the project. The effect of different flows downstream from HHD on bald eagle food supply and foraging behavior was not at that time addressed, because of the recently proposed change in criteria. The USFWS felt that information on the effect on steelhead and salmon (and therefore the effect on bald eagle prey supply) would not be available until the project criteria were well established. The Corps elected to withdraw the 1996 BA, agreeing that appropriate information was still lacking. The third BA was prepared once downstream flow criteria had been established and impacts to in-stream resources could be predicted with greater confidence. The USFWS has not yet prepared a biological opinion in response to this BA. The final BA is included in Appendix I.

In addition, at least two species of fish — bull trout and the Puget Sound evolutionary significant unit of chinook salmon — may be listed in the next two or three years. In the meantime, data will be gathered that will help us assess the potential effects of the project on these species, should they be listed.

2.1 IMPACT AREA

Phase I will result in a 20-foot pool raise above elevation 1147 feet, affecting 280.51 acres of terrestrial habitat. The Phase II, 10-foot pool raise will inundate an additional 161.46 acres (Table 2.1). The area to be inundated will be cleared prior to each pool raise. However, 20% of conifers and cottonwoods of at least 20 inches dbh will be allowed to remain.

TABLE 2.1 ACRES OF HABITAT INUNDATED BY PHASE I AND PHASE II PROJECTS

	1147'-1170' ** (Phase I)	1170'-1180' ** (Phase II)
FC (mature conifer)	**14.29**	**5.98**
FCY (young conifer)	**0.77**	**13.64**
FD (mature deciduous)*	**147.94**	**85.65**
FDY (young deciduous)	**10.93**	**4.71**
FM (mixed forest)	**48.49**	**28.13**
FO (forested swamp)	**6.68**	**4.92**
SS (shrub swamp)	**2.14**	**0.87**
EM (emergent marsh)	**10.28**	**0**
S (upland shrub)	**1.52**	**0.79**
G (upland grassland)	**11.54**	**2.16**
OW (open water)	**14.69**	**8.3**
T (talus/rock)	**1.78**	**1.32**
MF (mudflat)	**2.45**	**0.09**
ML (mossland)	**0.1**	**0**
R (railroads/roads)	**1.68**	**1.56**
RB (riverbed)	**5.23**	**3.34**
Total Habitat	**280.51**	**161.46**

*FD includes FD1 (alder) and FD2 (cottonwood) (Shapiro, 1985)
**Bolded numbers are acreages inundated by Phase I and Phase II projects (i.e., 1147-1170, and 1170-1180)

Reservoir operation will result in higher pool levels during the active growing season, as is the case under current operating conditions. The ability of plants to survive in the upper reservoir pool area is dependent on the number of days the area is exposed during the growing season. For example, the minimum time required to support selected sedge

species is approximately 40 to 45 days of exposure after inundation. Impacts to emergent wetlands were determined from these inundation schedules. The feasibility of planting other wetland species at various pool elevations for Phase I and Phase II operations was also determined from the proposed inundation schedules and is discussed in Paragraph 3.4.

SECTION 3 CONCEPTUAL WILDLIFE MITIGATION PLAN

3.1 MITIGATION OBJECTIVES

The proposed mitigation considers the management of critical or limited habitat at a landscape level for selected target species. Impacted habitat features will be replaced on the basis of providing average annual habitat units at least equal to those lost to the project, for each target species. Management measures will focus on providing the identified critical habitat features and increasing habitat diversity for each target species. Therefore, the focus of this plan is to increase available ungulate winter forage near the reservoir and to accelerate the development of early and mid-successional forest towards late-successional forest characteristics. Mitigation will be achieved through management of existing habitats for targeted conditions, such as intensive management of existing grasslands to increase forage productivity (e.g. mowing and fertilizing), converting forest stands to grass, thinning mature forest stands to open the existing canopy and allow midstory and understory communities to develop, increasing amounts of woody debris and creating snags.

This mitigation will seek to promote the growth of late-successional forests and to support the retention and/or development of corridors linking late-successional forest stands. Tacoma's forest lands provide a unique opportunity in this respect by management of the forest lands around the reservoir and major streams for water quality, fisheries and wildlife habitat benefits. Forest lands owned by others in the upper Green River watershed are primarily managed for commercial timber production.

Terrestrial mitigation will be accomplished on Tacoma Public Utilities lands surrounding the reservoir and adjacent to the Green River and North Fork Green River. Twenty-one sites were initially identified for consideration as elk forage mitigation sites in the early planning stages when elk was the only species targeted for mitigation. The development of the mitigation planning efforts expanded to include the development of late-successional forest characteristics and the development of perennial open water habitat and sedge meadows in the upper reservoir area. The original sites identified for elk mitigation were also evaluated for their suitability to be managed for late-successional characteristics. Planning efforts also expanded beyond these 21 sites to additional forest lands owned by Tacoma near the reservoir that could be effectively managed to accelerate the development of late-successional forest characteristics, create subimpoundments and establish sedge meadows. Descriptions of these areas are summarized in Table 3.1. The general locations of the mitigation areas are provided in Figure 5.

TABLE 3.1 MITIGATION LANDS DESCRIPTION (REFER TO FIGURE 5 FOR SITE LOCATIONS)

Site	Site Description	Enhancement Measure	Area	Schedule
1	BPA right-of-way; habitat classified as grassland and young deciduous forest dominated by red alder as the right-of-way is maintained to prevent the establishment of tall-growing vegetation.	Convert young deciduous forest to grassland; manage existing grassland and converted young deciduous forest lands as "tame" pasture.	18 acres	Phase I
2	BPA right-of-way; habitat classified as grassland and young deciduous forest dominated by red alder as the right-of-way is maintained to prevent the establishment of tall-growing vegetation.	Convert young deciduous forest to grassland; manage existing grassland and converted young deciduous forest lands as "tame" pasture.	45 acres	Phase II
3	BPA right-of-way; habitat classified as grassland and young deciduous forest dominated by red alder as the right-of-way is maintained to prevent the establishment of tall-growing vegetation.	Convert young deciduous forest to grassland; manage existing grassland and converted young deciduous forest lands as "tame" pasture.	15 acres	Phase II
4	BPA right-of-way; habitat classified as grassland and young deciduous forest dominated by red alder as the right-of-way is maintained to prevent the establishment of tall-growing vegetation.	Convert young deciduous forest to grassland; manage existing grassland and converted young deciduous forest lands as "tame" pasture.	14 acres	Phase II
5	50% of the site is existing grassland, 30% supports mixed forest and 20% mature conifer forest. This area is known as Baldi Field.	Remove small stand of trees (~ 2 - 4 acres) to enlarge area of productive grassland; maintain area as a "tame" pasture.	18	Phase I
6	This site lies partially in a PSPL right-of-way, the remaining area lies adjacent to the right-of-way within TPU Conservation lands. The majority of the site currently supports young deciduous forest (80%); 15% is comprised of mature deciduous forest and 5% supports mixed forest.	Convert forest land to grassland; maintain as "tame" pasture.	11 acres	Phase II
7	This site lies partially in a PSPL right-of-way, the remaining area lies adjacent to the right-of-way within TPU Conservation lands. 60% of the site currently supports young deciduous forest, the remaining 40% is comprised of mature deciduous forest.	Convert forest land to grassland; maintain as "tame" pasture.	11 acres	Phase I

Site	Site Description	Enhancement Measure	Area	Schedule
8	This site lies partially in a PSPL right-of-way, the remaining area lies adjacent to the right-of-way within TPU Conservation lands. The site currently supports young deciduous forest and grassland.	Convert forest land to grassland; maintain existing grassland and converted forest lands as "tame" pasture.	14 acres	Phase I
9	This deciduous forest site lies within TPU's Conservation Zone.	Manage as deciduous forest, promote late-successional characteristics (thin, snag creation, increase volume of down woody debris, drill holes or provide nest boxes for cavity nesters).	10 acres	Phase I
10	Mature mixed forest within TPU's Natural Zone.	Promote late-successional characteristics (thin, snag creation, increase volume of down woody debris, drill holes or provide nest boxes for cavity nesters).	10 acres	Phase I
11	This site is comprised of mature deciduous and mixed forest stands and lies within TPU's Natural Zone.	Create sedge meadow in portion of site that will be inundated, and promote late-successional characteristics on the smaller portion of the site.	8 acres sedge, 2 acres FMM	Phase II
12	90% deciduous forest and 10% conifer forest on TPU Conservation and Natural Zones.	Convert deciduous forest to conifer, promote late-successional characteristics (plant conifers, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	10 acres	Phase I
13	65 mixed forest and 35% mature deciduous forest within TPU's Natural Zone.	Manage as deciduous forest, promote late-successional characteristics (thin, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	10 acres	Phase I
14	60% mature conifer forest and 40% mixed forest in TPU's Conservation Zone; small portion of the site lies within BPA right-of-way.	Create natural openings in portion of area under and adjacent to BPA right-of-way (~ 5 acres). Manage remainder of site as mature forest (thin, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	5 acres natural openings 15 acres forest	Phase II Phase II

Site	Site Description	Enhancement Measure	Area	Schedule
15	95% mixed forest and 5% mature conifer forest located in TPU's Conservation Zone.	Manage as mature forest, promote late-successional characteristics (thin, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	15 acres	Phase I
16	100% deciduous forest in TPU's Natural Zone.	Create sedge meadow.	10 acres	Phase I
17	80% mature deciduous forest and 20% grassland located in TPU's Natural Zone (Koss Field).	a) create pocket wetland areas through excavation adjacent to existing wetlands / springs at base of the southern slope and create snags; b) enhance existing grasslands (fertilize) and manage as "passive" pasture. a) create larger impoundments in spring areas; b) plant woody vegetation at upper reservoir edge (Oregon ash, Pacific willow, Sitka willow, red osier dogwood); and c) install nest boxes.	10 acres pocket wetlands 9 acres pasture 1 acre subim-poundment	Phase II Phase II
18	85% mature deciduous forest, 10% mixed forest and 5% mature conifer forest on TPU Natural Zone.	Manage mixed forest, promote late-successional characteristics (thin, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	5 acres	Phase I
19	The majority of the site is mature conifer and mixed forest habitat on TPU's Conservation Zone.	Manage as mature forest, promote late-successional characteristics (thin, create snags, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	15 acres	Phase I
20	Mature deciduous forest and emergent wetland located on TPU's Conservation Zone.	Preserve wetland and forest.	9 acres	Phase I

Site	Site Description	Enhancement Measure	Area	Schedule
22	Mature alder-dominated deciduous forest adjacent to the 1147 foot pool within TPU's Natural Zone.	a) create subimpoundment at mouth of Cottonwood Creek, fish passage required; b) install nest boxes, c) plant 600 plugs per acre (85% Columbia sedge / 15% inflated sedge and Kellogg sedge).	3-acre subim-poundment 5 acres of sedge plantings;	Phase I
		Plant willows and Oregon ash at elevation 1175 feet, 400 plants per acre.	Woody plantings in 3-acre Phase I subim-poundment.	Phase II
23	70% /mixed forest and 30% mature conifer forest adjacent to the 1147 foot pool within TPU's Natural Zone.	Develop shallow marsh vegetation in bench area, 600 emergents per acre (85% Columbia sedge / 15% inflated sedge and Kellogg sedge)	20 acres of sedge plantings	Phase I
		a) plant willow and Oregon ash on the southern bench area at elevation 1175 feet, 400 plants per acre; b) develop additional marsh habitat in the 1170 foot - 1177 foot zone.	1 acre of woody plantings; 6 acres of sedge plantings	Phase II

Site	Site Description	Enhancement Measure	Area	Schedule
24	18 acres of grassland / emergent wetland (upper edge of McDonald field) and 12 acres mature mixed forest and forested wetland within TPU's Natural Zone west of McDonald Creek.	a) regrade area at the base of the hill to create additional wetland habitat (forested, scrub-shrub and emergent marsh) from the seeps daylighting at the toe of the slope; b) plant Columbia sedge in upper reservoir zone (~1160 feet to 1169 feet). a) establish a more diverse sedge community and plant willows, Oregon ash and red osier dogwood in the upper reservoir zone (~1175 feet - 1177 feet); b) create subimpoundment providing nest boxes, woody debris and emergent plantings for wood ducks.	29 acres sedge plantings; 2 acres of wetland at base of slope 2 acres of sedges; 6-acre impoundment; with 4 acres of woody species plantings	Phase I Phase II
25	Grassland between McDonald Creek and Gale Creek in TPU's Natural Zone.	Sedge plantings (85% Columbia sedge, 15% inflated sedge and Kellogg sedge), 600 plugs per acre.	5 acres 2 acres	Phase I Phase II
26	Forest stands located outside of the identified sites that will be managed for late successional characteristics. These stands will be selected primarily in TPU's Conservation Zone in the North Fork corridor and southeasterly through the Gale Creek corridor. Some stands may be selected along the mainstem Green River upstream of the reservoir if these sites are selected for fisheries mitigation. These stands will primarily be mixed forest and mature conifer stands.	Manage as mature forest, promote late-successional characteristics (thin, snag creation, increase volume of woody debris, drill holes or provide nest boxes for cavity nesters).	50 acres 100acres	Phase I Phase II

Site	Site Description	Enhancement Measure	Area	Schedule
27	Forested wetland with mixed forest north of the old railroad berm in the upper end of the reservoir east of Gale Creek on Corps of Engineers land.	Create subimpoundment behind old railroad embankment (fish passage may be required); providing nest boxes, woody debris, and emergent plantings for wood ducks.	5 acres	Phase I
Fisheries Mitigation Sites	Riparian enhancement along the reservoir tributary and the mainstem Green River, side channel development and creation of additional open water features in upper Page Mill Creek.	Fisheries mitigation which enhances riparian zones, develops side channel habitat or develops and enhances open water habitat in forested habitats (Page Mill Pond) will also benefit wildlife. These measures are not detailed in this report or included in the HEP analysis as the specific measures and areas have not been finalized.	to be determined	Phase I and Phase II

3.2 MANAGEMENT MEASURES

3.2.1 Management Goals

Goal 1: to achieve no net loss of winter and early spring forage for elk (see Paragraph 3.2.2).
Goal 2: to increase the net acreage of late-successional forest in the project area (see Paragraph 3.2.3).
Goal 3: to achieve no net loss of wetlands in the project area (see Paragraph 3.2.2 and 3.2.4).

3.2.2 Elk Pasture Mitigation Lands

Additional forage will be created by 1) expanding existing meadows and creating new meadows within selected second growth forest stands surrounding the reservoir and 2) increasing the forage value of grass and shrub lands within powerline rights-of-way adjacent to the reservoir by intensive management measures as outlined below.

Based on previous studies (West 1987; Taber 1979; Merker et al. 1982; Wisdom 1986) it is assumed elk meadows can be established which are more than twice as productive than existing right-of-way and forest habitat conditions. In existing forest areas this will be accomplished by clearing, removing stumps, disking, seeding and fertilizing. The seed mixes may include perennial ryegrass, orchardgrass, white clover, tall fescue or other grass or forb species. Several different mixes will be tested prior to the pool raise to determine which species are most preferred by elk. Similarly, the powerline rights-of-way will have woody vegetation removed and the area will be disked, seeded and fertilized. Fertilization rates will depend on the soil conditions at each selected site. Soils at the selected sites will be evaluated and, if necessary, may be treated with manure and seeded with clover to improve soil conditions prior to establishing pasture grasses.

To increase the productivity of these meadows, 20% of each area would be disked, reseeded and fertilized annually. This would result in reseeding of the entire meadow area over a five year period in addition to annual mowing and fertilizing. This management strategy is referred to as "tame" pasture management. Mowing and fertilizing on a five-year rotation with no disking or reseeding is referred to as "passive" pasture management. "Tame" pasture management is assumed to result in greater forage value and require less forest land to be converted to meadow habitat to replace the lost forage habitat. The value of each of these management approaches was factored into the incremental analysis conducted to select the most beneficial mitigation measures (see Section 3).

Evergreen trees and shrubs will be planted adjacent to the rights-of-way converted to managed pasture to screen the pasture areas from the main haul road. Woody plants in rights-of-way must necessarily be low-growing to minimize maintenance (i.e., power companies do not want plants growing up into the power lines). Thus, selected species that are short-growing could include lodgepole pine (*Pinus contorta*) or California bay laurel (*Umbellularia californica*), though the former does get tall, though grows relatively slowly, while the latter is not native, but is evergreen and produces dense hedges. Western white pine (*Pinus monticola*) may be a better choice than lodgepole pine, as it tends to grow shorter, but is susceptible to blister rust, usually killing them within 30 years. Another plant considered was Pacific yew (*Taxus brevifolia*), but biologists indicate it is a favorite forage plant of elk, and would likely not survive. A few of this species may nevertheless be planted, as it would create a dense screen that likely would never grow tall enough to require maintenance by the power company (in case they weren't too heavily browsed by elk).

Potential elk mitigation sites on Tacoma-owned lands were identified by Dick Ryan, TPU forester, based on soil conditions, site access, site topography and site index values (Raedeke 1996). These mitigation sites are close to the impact area, located at lower elevations to be available as winter forage, and located on the north side of the reservoir on level sites or south-facing slopes to provide maximum winter light conditions (Figure 5 and Table 3.1).

The identified mitigation sites were given a numerical reference to allow for analysis of site potential. Not all of the initially identified sites were required to replace elk forage lost as a result of both Phase I and Phase II pool raises. Sites were selected based on the HEP analysis and an incremental analysis (see Section 4 and Annex II). Selected sites and management measures required to mitigate for Phase I and Phase II impacts are listed below. Phase I mitigation includes 79 acres managed as "tame" pasture, and 144 acres managed as mature forest. Phase II mitigation is provided by 10 acres managed as "tame" pasture and 100 acres managed as mature forest.

a. Phase I

Five sites (79 acres) were selected for development of elk pastures. Another five sites would be developed as emergent wetlands, which also provide elk forage habitat. Sites recommended for pasture management are reviewed below. Forest management sites are reviewed in Paragraph 3.3.3.

Sites 1, 2, 7, and 8- Each site is located within an existing powerline right-of-way and is currently maintained in grass and shrub habitat. Several sites allow for the conversion of adjacent forest habitat to elk meadow. All of these areas would be managed as "tame" pastures. An estimated 61 acres could be converted and managed as "tame" within these three sites.

Site 5 - Eighteen acres of existing grassland and forest habitat adjacent to Baldi Field (an existing natural meadow area) would be converted to "tame" pasture habitat.

Sites 16, 22, 23, 24, and 25 - Site 16 is on the south side of the reservoir, currently comprised of mature deciduous forest that will die as a result of the pool raise. The other four sites are in the upper limits of the new conservation pool in the vicinity of Cottonwood Creek (Site 22), north of Eagle Gorge in the "cedar swamp" area (Site 23), adjacent to MacDonald field (Site 24) and between MacDonald Creek and Gale Creek (Site 25); each of these four sites is currently vegetated by emergent wetland that will be lost as a result of inundation. At each site, shallow marsh vegetation would be developed in the upper reservoir elevation zone (see Paragraph 3.4.2 for more details), planting inflated sedge (*Carex vesicaria*), Kellogg sedge (*C. lenticularis*), and Columbia sedge (*C. aperta*) between on the bench areas between elevation 1160 feet MSL and 1167 feet MSL. Collectively it is estimated these sites would provide 69 acres of shallow emergent vegetation which should provide early spring forage opportunities for elk.

Inflated sedge and Kellogg sedge have been shown to withstand inundation depths up to 10 feet if the plants are exposed for at least 45 days at the end of the growing season. Columbia sedge has been shown to survive extended periods of inundation during the growing season up to depths of 60 feet if exposed for at least 40 days at the end of the growing season (see the HHD Reservoir Inundation Zone Revegetation Plan developed for the 1135 Project, Appendix B, Beak 1996). Therefore, only Columbia sedge is expected to be viable after the implementation of Phase II (an additional 10 feet of inundation). Therefore, 85% of the sedge plantings, or 25 acres, will be comprised of Columbia sedge. This will limit impacts of the Phase I emergent wetland mitigation plantings to 4 acres with the 10-foot Phase II pool raise.

The ability of the inundated areas to support vegetation is dependent on the depth and duration of inundation, especially during the growing season. Studies conducted to date suggest that a variety of willows can tolerate inundation depths of up to four feet. Green ash has been found to do well under immersion of 10 feet or less if it is exposed for 40 days or more during the growing season. Columbia sedge has been found to tolerate inundation depths up to 60 feet and is known to do well with a 40-day growing season. Inflated sedge and Kellogg sedge can tolerate inundation depths up to 10 feet and are likely to require at least a 45-day growing season. Both Kellogg and inflated sedges apparently reproduce by seed and vegetatively within the seasonal inundation zone at the Cedar River reservoir. Other sedges have been found to require longer periods of exposure during the growing season. For example, slough sedge appears to requires a growing season of 75 days.

The referenced growing season is assumed to be the number of days exposed after inundation. The current and proposed operation of the HHD reservoir pool exposes the upper reservoir area in the early growing season (March and early April) and again in the later part of the growing season (mid-August through September). The early growing season exposure is assumed to enhance survival.

Based on the proposed Phase I operating scheme, it may be feasible to establish Columbia sedge to depths of 1150 feet MSL (42 days exposed during the late growing season) and Kellogg and inflated sedges to 1160 feet MSL (75 days exposed during the late growing season) (Table 3.2.1). Phase II operation may allow Columbia sedge to be established to depths of 1162 feet MSL (38 days at the end of the growing season) and Kellogg and inflated sedges to 1167 feet MSL (49 days at the end of the growing season). Therefore, Columbia sedge planted to depths of 1162 feet MSL during Phase I would likely survive in Phase II. Kellogg sedge and inflated sedge planted in Phase I would likely survive slightly below 1167 feet MSL and should be able to be established in the entire zone of the Phase II 10-foot pool raise.

TABLE 3.2.1 GROWING DAYS AVAILABLE AT VARIOUS POOL ELEVATIONS FOR PHASE I AND PHASE II

Pool Elev.	Active Storage1 Avg. TL Days	Active Storage[e]1 Avg. First Date	Active Storage[e]1 Avg. Last Day	Days Exposed Early Growing Seas[n]2	Days Exposed Late Growing Seas[n]2	Total Growing Season Days Expose[d]2
1141' Phase I	163	30 March	8 September	30	22	52
Phase II	198	231 March	6 October	23	0	21
1147' Phase I	143	6 April	26 August	37	34	71
Phase II	185	27 March	27 September	27	3	30
1150' Phase I	132	10 April	19 August	41	42	83
Phase II	176	29 March	20 September	29	10	39
1160' Phase I	78	27 April	17 July	58	75	133
Phase II	146	7 April	31 August	38	30	68
1162' Phase I	55	1 May	2 July	62	94	156
Phase II	137	9 April	23 August	40	38	78
1167' Phase I	5	17 May	19 June	79	103	182
Phase II	120	13 April	13 Aug	44	49	92
1170' Phase I	0	N/A	N/A	--	--	214
Phase II	106	14 April	4 Aug	45	57	102
1177' Phase I	0	N/A	N/A	--	--	214
Phase II	52	20 April	21 June	51	101	152

1 From 4 March 1997 reservoir operations modeling final report prepared by CH2M Hill using Phase II alternative 2 data.
2 Growing season extends from 1 March through 30 September.

Phase I would impact 80 acres of existing emergent wetland habitat, 6 acres of forested wetland and 2 acres of shrub-scrub wetland habitat. Sixty-nine acres of emergent wetland habitat would be re-established in the Phase I upper reservoir between 1147 feet MSL and 1167 feet MSL with plantings of Columbia sedge to 1147 feet MSL and inflated sedge and Kellogg sedge to depths of 1162 feet MSL. Phase II would impact 5 acres of existing emergent wetland, 5 acres of forested wetland, 1 acre of shrub-scrub wetland and would inundate the 4 acres of sedge planted for Phase I emergent wetland mitigation.

b. Phase II

Three elk meadow sites would be developed to mitigate for the lost elk forage resulting from the pool raise to elevation 1177 feet MSL. The sedge communities (except Columbia sedge) established for Phase I mitigation, would be lost at Phase II.

Sites 3 - A powerline right-of-way site managed as a "tame" pasture is estimated to provide an additional 10 acres of "tame" pasture.

Sites 11, 23, 24 and 25 - Plant 18 acres of inflated sedge, Kellogg sedge, and Columbia sedge between elevation 1167 feet MSL and 1177 feet MSL.

3.2.3 Late Successional Forest Lands

The overall goal of late-successional forest land management is to accelerate the development of late-successional characteristics (large diameter snags and down wood, multi-story canopy, and increased understory cover and diversity) in conifer and mixed forest stands on Tacoma-owned lands near the HHD reservoir to increase the acreage of timber stands managed as late-successional forest habitat in the upper Green River watershed.

Late-successional management would benefit several species, including the target species elk, pileated woodpecker, and red-backed vole. Although numerous other species will benefit from the increase in seed and fruit bearing shrubs and grasses, and increase in snags, down woody debris, and cavities (i.e., secondary cavity nesters), red-back vole and pileated woodpecker were chosen to represent the increased down woody debris coverage and large snag habitat features, respectively, provided by late-successional forest. Elk represent the increase in ungulate forage production in these stands.

The pileated woodpecker represents primary cavity nesters that need larger diameter snags (> 20-inches diameter) in a variety of decay stages. Excavators typically use snags in decay stages 1 and 5 for foraging, and decay stages 2 to 4 for nesting (Mannan et al. 1980, Schreiber and deCalesta 1992, Bevis 1994, Neitro 1985). Excavators as a group avoid snags less than 20 feet tall (Thomas et al. 1979, Bull 1986). Most cavities are excavated in snags greater than 15 inches dbh (Scott 1979, Raphael and White 1984).

Optimum conditions for the red-back vole are considered to be mature coniferous forest with at least 60% canopy cover and 20% or more of the forest floor covered with woody debris at least a 3-inch diameter. The existing stands support little down woody debris; average woody debris coverage is visually estimated to be approximately 5%.

The increase in palatable understory shrubs and grasses resulting from canopy openings will also provide forage for deer and elk. These forest stands will also continue to provide ungulate thermal cover.

Following are specific criteria for management of late-successional forests:

Provide at least 0.5 snags per acre (minimum 20-inches dbh) for primary cavity nesters.

Provide raptor perch trees and snags at the reservoir perimeter.

Provide 20% woody debris groundcover per acre with at least 3-inch diameter down logs.

Specific measures for mixed and conifer stands:

1) Thin even-age class stands to stimulate mid-story and understory species development.

Commercial thin 30 year old stands favoring multiple species (including non-merchantable trees, deciduous trees and shrubs). Average conifer density of 100 trees per acres.

Commercial thin 50 to 60 year old stands. Removal of dominant cohort retaining an average of 75 coniferous trees per acre. Retain deciduous and non-merchantable species. Retain down logs greater than 3 inches diameter to ensure at least a 20% ground cover of coarse woody debris. Create cavities or snags in at least one 20-inch dbh tree per acre.

Variable density thinning of dominant and second age cohorts in stands 70 to 90 years old to achieve 36 dominant cohorts per acre. Cavity trees retained and one additional tree per acre killed to create a snag. Down woody debris target is 20 percent cover density provided by wood greater than 3 inches diameter.

2) Snag Management and Creation

Provide snags in small groups across the landscape, rather than a uniform distribution (Bull and Meslow 1977, Raphael and White 1984, Neitro et al. 1985, Li and Martin 1991, Lundquist and Mariani 1991, Conway and Martin 1993).

Provide snags in a variety of size classes, decay classes, tree species and location. Six to 15 large (> 25 inches dbh) snags and cavity trees per acre and 6 - 20 small (< 24 inches dbh) snags per acres has been recommended by Carey (1996). Some researchers recommend even distribution of snags across the landscape (Thomas et al. 1979, Neitro et al. 1985); others have noted preferences for clumps of snags (i. e. reduces forage time) (Raphael and White 1984). Ten snags of various sizes per acre will be created on individual acres identified as a snag cluster area. Roughly 10% of the forest management area will be identified as snag cluster areas.

Snags in decay stages 1 and 5 are generally used for nesting, decay stages 2, 3 and 4 are more frequently used for foraging (Mannan et al. 1980, Schreiber and deCalesta 1992, Bevis 1994, Neitro 1985).

Decay Stage 1: 0 - 6 years after tree death
Decay Stage 2: 7 - 18 years after tree death
Decay Stage 3: 19 - 50 years after tree death
Decay Stage 4: 51 - 125 years after tree death
Decay Stage 5: 126+ years after tree death (Cline et al., in Brown 1985)

Manage for natural snag development. Snag creation can be an effective short-term solution to augment snag numbers in snag-poor areas.

Inoculating live trees with fungi can successfully kill trees and introduce decay, which in turn produces snags suitable for nesting and foraging within approximately six years. Fungal inoculation has been found to be relatively ineffective since less than half of the trees die and produced a high rate of fall. (Bull and Partridge 1986).

Girdling tends to produce longer standing snags that can provide suitable nesting and foraging habitat. Girdling can also be ineffective in snag creation in comparison to topping with a chainsaw, and result in higher fall rate.

Herbicide can be used to kill trees. Herbicide-killed trees were found to decay faster than trees killed by girdling, resulting in trees falling within 3 to 4 years of treatment (Connor et al. 1983; Bull and Partridge 1986). This treatment introduces the possibility of transmitting herbicide through ingestion of contaminated insects. Herbicide treated trees were found to be used less for foraging than girdled trees (Bull and Partridge 1986).

Trees topped with a chainsaw have been found to have the lowest rate of falling and to be used more frequently for nesting and foraging than other snag creation techniques (Bull and Partridge 1986).

Install snag trees to provide larger diameter snags if existing stand conditions do not support trees with diameter of at least 20 inches. Snag trees should support at least 5 limbs and have a minimum height of 40 feet (ten feet of which would be embedded).

Retain larger (>20 inches dbh) flooded trees to provide perch or nest trees for raptors. Create snags at the reservoir perimeter to replace future loss of fallen flooded snags.

Cut or drill cavities or erect nest boxes to provide nesting holes until created snags have sufficiently decayed to allow primary excavators to drill holes.

Cavity entrance size:

SPECIES	HORIZONTAL	VERTICAL
Pileated Woodpecker	3.25	3.5
Lewis' woodpecker	2 -2 7/8 (diameter)	
Hairy woodpecker	2	2.5
Downy woodpecker	1.25 (diameter)	
Three-toed woodpecker	2	1.75
Red-breasted sapsucker	1.25 - 1.5 (diameter)	
Northern Flicker	3 (diameter)	

Nest boxes are generally not used by primary cavity nesters. Successes have primarily been with bluebirds and wood ducks; other species such as pygmy nuthatch, tree swallow, violet green swallow, chickadee and white-breasted nuthatch have used nest boxes to some extent (Brawn and Balda 1983). Placement of nest boxes should consider the need for adequate thermal protection (Maser et al. 1981). Maintain for 10 years, then re-evaluate need based on availability of natural cavities.

3) Down Woody Debris Placement

20% cover of coarse woody debris (>3 inches diameter) on the forest floor is considered optimum for the red-back vole (Huff et al. 1992). 15% woody debris coverage was found to be adequate coverage for western Olympic Peninsula forest stands (Carey and Johnson 1995). A minimum of 4 pieces per acre greater than 24 inches diameter and more than 50 feet long was reported by USDA Forest Service (1993).

Select various methods of snag creation to provide a varied rate of down woody material resulting from snag trees falling down (e.g., trees killed by herbicide have been observed to fall within 3 to 4 years after treatment). Down woody debris would be placed over 20% of the mature managed forest areas, to achieve a ground cover of 15%.

4) Canopy openings.

In areas dominated by conifers, create variously sized openings in the canopy. Selectively interplant shade tolerant tree species in smaller openings to accelerate development of a midstory canopy and interplant plant shrub species (average 50 plants per acre) including hazelnut (*Corylus cornuta*), evergreen huckleberry (*Vaccinium ovatum*), red-flowering current (*Ribes sanguineum*) and Oregon grape (*Mahonia nervosa*). Seed larger openings (>1/4 acre) to grasses for elk forage.

5) Select for conifers.

Areas dominated by deciduous tree species will be managed to replace the deciduous species with conifers. This will be accomplished by falling the deciduous trees, selectively leaving as down woody debris, and controlling stump resprouting with manually applied herbicide treatment. These areas would subsequently be planted with conifer species at 300 seedlings per acre.

Mitigation Sites

All sites identified for late successional management will be inventoried to develop site specific management treatments for the existing stand conditions to meet targeted stand conditions for snags, down woody debris, stand density, etc. The preliminary mitigation assessment assumed equal benefit gain for all forest stands, although some existing stands currently support more late successional characteristics than others. The next stage of the mitigation planning effort will include a more extensive and expanded inventory of site-specific stand conditions.

a. Phase I

Eight sites (143 acres) will be managed for accelerated late-successional characteristics between the North Fork Green River and Gale Creek and selected areas south of the reservoir. The sites are **9, 10, 12, 13, 15, 18, 19, and 26** (Figure 5 Mitigation lands).

b. Phase II

Forest manipulation in Phase II (65 acres) would occur on sites **14** and **26**.

3.2.4 Wetlands

Impacts to forested, scrub-shrub, and emergent wetland habitats are evaluated on a replacement basis by acreage and function of the impacted areas. Replacement of the emergent wetland habitat is proposed in the newly established upper inundation zone (described in Paragraph 3.2.2), while forested and scrub-shrub wetland habitats are primarily located along the reservoir perimeter.

The goal for forested wetland mitigation is to create areas of year-round open water for wood ducks, hooded mergansers, and other wetland cavity nesters. Oregon ash (*Fraxinus latifolia*), Pacific willow (*Salix lasiandra*), and red-osier dogwood (*Cornus stolonifera*) will be planted along the shore of the mitigation ponds. Year-round ponds would have a depth of at least 12 inches, and would support aquatic plants to provide food for wood ducks, teal, and mallards. Logs would also be placed in the ponds to provide perches for waterfowl using the ponds. Scrub-shrub wetlands are comprised almost entirely of Sitka willow (*Salix sitchensis*). A few low-gradient areas have been identified at the margin of the new reservoir levels where willows will be planted. In some areas, a few Oregon ashes will be planted to mix with the willows.

Mitigation Sites

Mitigation criteria:

Establish cottonwood, Oregon ash and willow at the reservoir edge and riparian corridors - Phase I and Phase II.

Plant willow, cottonwood, Oregon ash and red osier cuttings - (per Appendix B of the 1135 reservoir revegetation plan).

Protect against foraging by elk and deer for first 3 - 5 years.

Subimpoundments at the upper perimeter of the reservoir would make year round open water available in the upper reservoir area for wildlife species such as wood ducks and amphibians. Subimpoundments would be created at Sites **22** and **27** during Phase I. A subimpoundment would be built in the vicinity of the Cottonwood Creek outlet to the reservoir (Site **22**), incorporating the following features and techniques:

Construct berms, to allow fish passage as necessary.

Plant wetland species - willow, red osier dogwood, Oregon ash, bulrush, and Columbia, Kellogg and inflated sedges.

Perch trees retained and snags created at the perimeter of the subimpoundment.

Place down woody debris, minimum 8 inches diameter and 15 feet long - 20 pieces per acre.

Create cavities and/or erect nest boxes (at least 4 per acre).

The subimpoundment at Site 27 would only be functional during Phase I operation. Vegetation in the subimpoundment area would not survive the Phase II inundation regime leaving a non-vegetated open water pool behind the berm.

In Phase II, wetland habitat will be established or expanded by excavation of "pocket areas" in seep areas (sites **17, 23,** and **24**) and opening canopy to allow shrub species to establish.

Excavate soils per site specific plans developed as access to site allows.

Create snags - 7 per acre.

Selectively thin canopy to promote understory and herbaceous vegetation growth.

Plant wetland species per a site-specific plan developed for the selected areas during the next mitigation planning phase.

Emergent wetland habitat in the upper reservoir inundation zone will be re-established by planting 600 sedge plugs per acre (described in greater detail in Paragraph 3.2.2).

Phase I: Plant 69 acres of sedges to partially mitigate for the expected loss of 90.57 acres. Of the 69 mitigation acres, 85% would be Columbia sedge, and 15% would be Kellogg and inflated sedges. Planting of sedges would be at **Sites 16, 22, 23, 24, and 25.** Columbia sedge (39 acres) will be planted between 1147 and 1165 feet MSL, while Kellogg and inflated sedges will be planted near the upper zone of the Phase I pool in the 1165 feet MSL to 1167 feet MSL range (21 acres).

Phase II: Additional plantings totaling 18 acres of Columbia, Kellogg and inflated sedges between 1167 feet MSL and 1177 feet MSL will be done at **Sites 11, 23, 24, and 25**. Kellogg and inflated will be placed in the upper portion of this zone above 1170 feet MSL.

In some cases soils will be transferred from existing wetlands that will be inundated and will be too far below the full reservoir level to support vegetation, to areas suitable for establishment of emergent wetland habitat (based on proposed reservoir operation and number of growing days not inundated). Soils should be transferred only to areas that do not require stump removal; this may limit topsoil transfer to the McDonald field area and selected areas of Site 16.

3.3 RESTORATION

Additional riparian measures and open water habitat measures developed for fisheries mitigation and enhancement. These measures could include expanding open water habitat in the Page Mill Pond; creation of side channel habitat; and riparian management areas along the mainstem Green River. These proposals will benefit wildlife species as well as fish species. Analysis of these opportunities will be conducted during the next mitigation development stage (Plans and Engineering Design). The benefits of these measures have not been included in the wildlife HEP analysis or detailed in this appendix as the benefits are assigned 100% to fish mitigation.

SECTION 4 HABITAT EVALUATION PROCEDURES (HEP)

4.1 BACKGROUND

Habitat Evaluation Procedures (HEP) is a tool to aid in identification of baseline resources in a defined project area. HEP can also be used to predict the range of potential impacts that would result from a project, and can aid in development of an appropriate mitigation plan to offset the project impacts. HEP uses an index of habitat quality, which is estimated with the use of indicator animal species that best represent the affected habitats. This section summarizes the use of HEP to quantify impacts to the Phase I and Phase II projects, as well as the benefits derived from implementation of mitigation measures.

4.2 METHODS

4.2.1 General

Habitat types were identified in 1983 through the use of aerial photography and ground truthing (Shapiro, 1985). Acreages of the habitat types were calculated from the maps that were developed. Following identification of habitat types, species of animals were selected to indicate the quality of the various habitat types; these **indicator species** also represent the life requisite needs for a wide range of species. Ten species were selected for the HHD project (see Table 4.2.1). In 1986, models that graphically illustrate the life requisites provided by each habitat type were used at randomly selected sites at the project to obtain a score of the habitat quality for each species. The resulting scores – called the Habitat Suitability Index (HSI) – are usually scaled from 0 to 1 (1 being best). Key information is stored in the HSI score: for example, an HSI of .9 for an existing habitat indicates the habitat is excellent for an indicator species, and the loss of that habitat may be difficult to replace. On the other hand, a score of .1 for an existing habitat indicates the existing habitat is poor for an indicator species; if mitigation for that species is required, it may be relatively easy to improve on what was lost. HSI scores are multiplied by the habitat acreage to result in a unit-less number ironically called Habitat Units (HU's). HSI's and HU's are shown in tabular form, with the HU's usually being the basis of comparison throughout a HEP analysis. For example, HU's are used to compare baseline (existing condition) to the with-project condition (impact analysis).

TABLE 4.2.1 INDICATOR SPECIES AND HABITAT TYPES REPRESENTED BY THEM

SPECIES	HABITAT TYPES
Pacific Chorus (Tree) Frog (*Pseudacris regilla*)	all habitat types*
Green-winged Teal (*Anas carolinensis*)	mature conifer; young conifer; mature deciduous; young deciduous; mixed forest; emergent marsh; upland shrub; upland grassland; managed mature forest
Sharp-shinned Hawk (*Accipiter striatus*)	mature conifer; mixed forest; forested swamp; managed mature forest
Downy Woodpecker (*Picoides pubescens*)	mature conifer; young conifer; mature deciduous; young deciduous; mixed forest; forested swamp; shrub swamp; managed mature forest
Pileated Woodpecker (*Dryocopus pileatus*)	mature conifer; mature deciduous; forested swamp; managed mature forest; mixed forest
Black-capped Chickadee (*Parus atricapillus*)	mature conifer; young conifer; mature deciduous; young deciduous; mixed forest; forested swamp; shrub swamp; managed mature forest
Mink (*Mustela vison*)	all habitat types within 100 meters of stream and reservoir
Douglas Squirrel (*Tamiasciurus douglasi*)	mature conifer; mixed forest; forested swamp; managed mature forest
Red-backed Vole (*Clethrionomys gapperi*)	mature conifer; young conifer forest; mixed forest; managed mature forest
Rocky Mountain Elk (*Cervus canadensis*)	all habitat types
Wood Duck (*Aix sponsa*)	forested swamps

*Habitat types are: mature conifer; young conifer; mature deciduous; young deciduous; mixed forest; forested swamp; shrub swamp; emergent marsh; upland shrub; upland grassland

4.2.2 Indicator versus Target Species

Indicator species are those used in the HEP analysis to *indicate*, or represent, the habitat. Species that are selected as indicator species also represent a broad range of species that utilize a habitat in similar ways. For example, black-capped chickadee is an indicator of the quality of tree limb diversity and small snag habitat, and thus represents those habitat components for all other species that forage on small twigs and/or nest in cavities in small snags. Careful selection of species that maximizes coverage of habitat components and reduces the number of species that need to be addressed assures that all habitats are addressed by the models.

Target species are species that may be selected specifically for mitigation needs. These species may be selected on the basis of severity of impact; or, for their regional biological importance or uniqueness; or because they are important to the general public. These may or may not be the same species selected as indicator species for the baseline HEP analysis.

Target species drive a mitigation planning effort: knowing the species focuses the plan on those specific habitat alterations or improvements that will provide a direct benefit to the target species. Target species may also be selected to measure whether a mitigation plan has successfully replaced lost habitats that are considered to be of high value in a particular area. Target species used in mitigation planning for the HHD project are Rocky Mountain elk, red-backed vole, pileated woodpecker, and wood duck. The target species represent, respectively, pastures and adjacent wooded habitats; mature forests (elk, vole and woodpecker); and forested wetlands. The replacement of these three habitats will satisfactorily mitigate for the majority of habitat losses (i.e., those considered to be the most important habitats for the area) resulting from the additional water storage project.

4.2.3 HSI Derivation and Rationale for Target Species Use in HEP Analysis

This section describes the rationale used to assess HSI's for target species in TY0. See Paragraph 4.7 for a detailed discussion of how the HSI's change over the life of the project.

1) **Derivation.** HSI's used in this analysis were obtained from field measurements at randomly selected locations around the reservoir (see Schroer, 1991). These HSI's were used at TY0. As time goes on, habitats succeed into different habitat types. As forests mature, HSI's change for species that utilize multiple habitat types (e.g., elk, red-backed vole and pileated woodpecker). To derive the overall HSI for each species at a particular target year, the HSI for each habitat type is multiplied by the area of that type; the resulting products (habitat units (HU's)) for each habitat type are added, and divided by the total acreage of all the relevant habitat types for each species. This

calculation is done for every target year (0, 1, 10, 25, and 50), under every alternative (without-project; with Phase I, without mitigation; with Phase I, with mitigation; with Phase II, without mitigation; and with Phase II with mitigation), for each species. Table 4.2.2 shows the HSI's for appropriate habitats for these target species in TY0 (or existing condition).

TABLE 4.2.2 HSI'S FOR SELECTED MITIGATION TARGET SPECIES AT TY0

	HSI's			
	Rocky Mountain Elk	Red-backed Vole	Pileated Woodpecker	Wood Duck
FC (mature conifer)**	0.1	0.63	0	0
FCY (young conifer)	0.25	0.01	0	0
FD (mature deciduous)	0.1	0	0	0
FDY (young deciduous)	0.25	0	0	0
FM (mixed forest)**	0.1	0.18	0	0
FO (forested swamp)	0.1	0	0	0.5
SS (shrub swamp)	0.25	0	0	0
EM (emergent marsh)	0.5	0	0	0
S (upland shrub)	0.25	0	0	0
G (upland grassland)	0.5	0	0	0

2) Rationale. Estimation of future HSI's is professional judgment based on known life histories and habitat requirements for a particular species. The following discussion provides the rationale for the approach used, and for the HSI's that were derived for each target species.

a) Rocky Mountain Elk

Elk heavily graze the upland grass meadows in the old MacDonald field near the reservoir and forage on the emergent wetland vegetation in the upper reservoir adjacent to MacDonald field. Deer and elk also feed in natural forest openings and in clearcut areas, including the grass and shrub habitat in the powerline rights-of-way near the Project Area. The forage quality of these forests is rated at a lower value due to the lack of understory vegetation resulting from the relatively closed canopy of these stands. The forest stands are also used for cover. The reservoir area is used for winter forage and cover habitat by deer and elk which winter below 2,200 feet MSL in the upper Green River reservoir. Some deer and elk remain in the lower elevations year round.

The greatest impact to ungulate forage results from the inundation of the grassland at MacDonald field and the emergent wetland habitat (HSI values of 0.5). The limited forage provided by the forested lands in the project vicinity is also lost with the inundation of these lands (HSI values ranging from 0.1 to 0.25). Habitat suitability of the particular

forest seral stages, as well as the shrub and grassland habitats, is assumed to remain stable and not increase over the 50-year project period.

After much interagency discussion, the decision was made to focus elk mitigation on replacement of pastures. Thus, the HEP analysis only addresses forage HSI's.

TABLE 4.2.3 FORAGE HSI'S FOR ELK IN UTILIZED HABITATS, TY0

Cover Type	HSI (TY0)
Mature Conifer Forest	.1
Young Conifer Forest	.25
Mature Deciduous Forest	.1
Young Deciduous Forest	.25
Mixed Forest	.1
Upland Shrub	.25
Grassland	.5
Forested Wetland	.1
Scrub-Shrub Wetland	.25
Emergent Wetland	.5

Existing pastures, existing sedge meadows, and created sedge meadows, are all given an HSI of .5 (pastures included under "grassland" and "emergent wetland" in table 4.2.3; sedge meadows included under "emergent wetland"). This is based on the assumption that natural and created grass and emergent marsh areas provide a more nutritional and palatable food source than in forested sites, and are more readily available over a large area.

"Passive pastures" (receive fertilizer once every five years): .75 (passive pastures are a mitigation component and are not included in Table 4.2.3; the only passive pasture would be created in Phase II, at Site 17). By simply adding fertilizer once every five years, the palatability and nutritional content of the grass is improved dramatically (Raedeke, 1996).

"Tame pastures" (receive tilling and seeding over 25% of pasture each year, and fertilizer each year): 1.0 (this is a mitigation component and not reflected in Table 4.2.3; tame pastures are included under "grassland" on Table 4.7.1). Fertilizing each year and replacing the forage every fourth year provides the best palatability and nutritional content.

Young forests (deciduous and coniferous): .25. Young forests still have a grass component that pioneered following clearcutting. The grass is sparser than on grasslands, and is likely slightly less palatable and nutritious; thus, an HSI of .25 is assigned.

Mature forests (all types): .1. The grass under young forests gradually disappears as the forests mature and block out more sunlight. Thus, little forage is available, it is sparse where it is available, and probably not very nutritious.

Shrublands (wetland and upland): .25. These are similar in character to young forests. Sunlight still reaches the ground, and the grass is still available; but it is less palatable and nutritious than on the grasslands.

b. Red-backed Vole

The red-back vole is dependent on coniferous forest habitat. Optimum habitat for the western subspecies of the red-back vole is considered to be coniferous forest with large diameter trees providing a canopy closure in excess of 60%, at least 20% of the ground cover is woody debris (≥ 3-inch dbh) and an understory with limited grass cover. There is a positive correlation between red-back vole numbers and amount of woody debris. Major food sources for the western subspecies are lichen and hypogeous fungi (the reproductive bodies of mycorrhiza (soil fungi)). Woody debris provides cover and a source for establishment of mycorrhizal fungi. The western red-back vole is more numerous in coniferous forests with shrub understory than grass or sedge understory (Allen 1983). The existing mature forests in the project area do not support large amounts of woody debris – the estimated percent woody debris cover is 5%. This percentage was not calculated in the field, but was simply an ocular estimate.

TABLE 4.2.4 HSI'S FOR RED-BACKED VOLE IN UTILIZED HABITATS, TY0

Cover Type	HSI (TY0)
Mature Conifer	.63
Young Conifer	.01
Mixed Forest	.18

Red-backed voles are mature coniferous forest inhabitants. They require numerous, large (>12" diameter) fallen logs on the ground for foraging and other like requisites. The existing mature forest in the project area is still young (70-90 years of age), and does not generally have many large logs. An HSI of .63 for mature conifer was determined in the field through the use of the model. Young coniferous forest may be used incidentally by voles, but does not provide the proper components necessary for the animal to survive, hence a low HSI of .01. Mixed forest, by virtue of the fact it contains coniferous trees and may have large logs on the ground is also considered as vole habitat, but still has a low HSI of .18.

c. Pileated Woodpecker

The pileated woodpecker is a primary cavity nester that needs larger diameter snags (> 20-inches diameter) in a variety of decay stages for nesting; however, smaller trees, logs, and

stumps are utilized for feeding. Most pileated woodpecker nest cavities are excavated in snags greater than 15 inches dbh (Scott 1979, Raphael and White 1984).

Although the density of large snags (>20 inches dbh) in unmanaged forest has been reported to be 2.5 snags per acre (USFS 1991), optimum snag density requirements for the pileated woodpecker HEP model is met at 0.5 snag per acre (USFWS 1983). Based on limited sampling of the forested stands identified as potential mitigation sites (two samples plots per forest type) mature mixed forest and forested wetland stands were found to support at least 0.5 snag (> 20-inches dbh) per acre. No large snags were found in the mature conifer and mature deciduous plots (Schroer 1991).

TABLE 4.2.5 HSI'S FOR PILEATED WOODPECKER IN UTILIZED HABITATS, TY0

Cover Type	HSI (TY0)
Mature Conifer Forest	0
Mature Deciduous Forest	0
Mixed Forest	.95
Forested Wetland	.45

The lack of large snags in existing mature conifer and deciduous stands is due to the fact that in fact, the forests classified as mature in the project area are in fact younger forests (less than 100 years old). This fact led to field findings in selected plots of no large snags in mature conifer and deciduous forests—hence an HSI of 0. Large snags are currently available in the mature mixed forest stands and forested wetland habitat, resulting in an HSI in mixed forests of .95. However, canopy closure in the forested wetland limits the suitability of these stands for pileated woodpeckers (59% closure, $\geq$ 70% closure is considered optimum), reducing the HSI to .45.

d. Wood Duck

The wood duck had not been considered as a HEP indicator or target species for this project as it was not known to nest in the project area until a Corps employee discovered a brood in a backwater slough in the summer of 1994. Following that discovery, it seemed that this would be the best wildlife species to represent forested wetlands, even though no field data had been specifically collected for this species. Thus, HSI's are based on purely visual inspection of forested wetland habitats in the project area. Wood ducks require 24 - 36 inches dbh snags near open water, and less than 20% of the total cover in forest, as well as an abundance of aquatic plants and floating logs, as well as quiet water, for optimal nesting, cover and forage habitat. At present, there are few snags of large size, and the forest canopy comprises nearly 100% over most of the forested wetlands. The existing HSI is rated .5, as there are few floating logs, little aquatic vegetation, and somewhat limited cavities for nesting.

4.3 RECENT HISTORY OF ANALYSIS AT HHD PROJECT

The HHD study was suspended before the HEP data collected in 1986 could be analyzed. The study was re-initiated in 1989; the new HEP team (consisting of representatives from the U.S. Fish and Wildlife Service, the U.S. Forest Service, the Washington Department of Fish and Wildlife, the Muckleshoot Indian Tribe, the Tacoma Public Utilities Water Division, and the U.S. Army Corps of Engineers) agreed to use the 1986 HEP species list and data, with three exceptions: 1) pileated woodpecker was added to the list to provide a species to represent large snags; 2) it was felt the mink data was inadequate and needed to be re-collected; and, 3) the elk model used in 1986 was based on summer habitat. The new team felt that winter habitat was more critical in the project area, so data was collected using a model that emphasized the winter habitat needs of elk.

Field measurements were made for these three species by representatives from the Corps and USFWS in 1991. The Corps performed the data analyses and sent out the initial results for agency review in late 1992. Upon review of that analysis, a flaw in the elk model was discovered. Several team meetings were held to discuss potential solutions. Ken Raedeke and Associates, Inc. (Raedeke) were hired to develop a simple model tailored to the specific and somewhat unique habitat conditions in the HHD reservoir basin. The model was completed and agreed upon by team members in early 1995. Although HEP is intended to encompass a broad range of species and habitats, the interagency team concluded in 1995 that concerns for elk losses at HHD outweighed considerations for other species, and a mitigation plan that focused on elk needed to be developed. Therefore, a menu of mitigation sites and management options, with an emphasis on elk mitigation was developed by Raedeke. The elk HSI scores used for this HEP analysis are based on the elk mitigation proposals specified in the Raedeke plan.

In 1996, several members of the interagency team were replaced by new members. All three of the new members expressed the concern that other species were not being represented well by the mitigation plan. Thus, Beak Consultants, Inc. (Beak) was hired to assist the Corps with development of the mitigation measures for wildlife species other than elk. The mitigation plan that has been developed and the HEP analysis both address a wide range of species, including elk.

The original 1983 map was digitized in 1995 on a Geographic Information System (GIS), which allows more precise estimation of the acreage of each habitat type. The acreages identified from this 1995 GIS mapping were used for the first year (1983) of calculations on the tables in this section.

4.4 BASELINE CONDITIONS

Habitat types are based on the 1983 map developed for the original HEP. The first year of the Phase I project is assumed to be the year 2002. Thus, 19 years separate these years, and the forest is changing through seral stages throughout this period. This is why acreages of the habitat types varies between the 1983 map and TY0. Target year 0 (TY0) acreages represent the condition that will exist just prior to implementation of the Phase I project. The seral changes are based on successional patterns described by Fleming (1996).

The baseline – or without-project – condition is defined as the existing project with the Section 1135 project (a probable 6-foot pool raise that would occur before the year 2000) in place, and subsequent impacts to the existing habitats that lie within the 1141 foot to 1147 foot elevation contours. Woody vegetation and emergent marsh that exist today below 1147 feet are not expected to survive with the implementation of the 1135 project. Thus, Phase I impacts are taken from above elevation 1147 feet, and the acres inundated by the 1135 project are not accountable to Phase I. Table 3 (Annex I) identifies the acreages of all habitat and non-habitat areas in the project area (note: elevations 1170 feet and 1180 feet are used to represent the Phase I (1167 feet) and Phase II (1177 feet) projects, respectively, since the precise contours of these projects have not been mapped). It is important to note that the project area limits were randomly defined by the 1220 foot elevation contour line by the 1986 HEP team. Since then, it became obvious that mitigation areas could not all be sited below 1220 foot elevation. Some of the potential mitigation sites identified by Raedeke Associates, Inc. (1995) are found above the 1220 foot contour. In addition, it became clear that additional forest lands would be needed to mitigate for voles and other mature forest species. Thus, 300 acres of forested habitat above elevation 1220 feet, in addition to the 195 acres already identified on specific mitigation sites, were added to accommodate additional mitigation lands. This results in a project area of 2396.71 acres, roughly 500 acres more than the area encompassed below the 1220 foot contour.

An element which has direct bearing on the baseline and impact analysis is the City of Tacoma's Forest Land Management Plan (Forest Plan) (July, 1996). This plan documents the timber acreage on Tacoma lands in the Green River watershed, describes the forest management policy on three different management zones, and provides harvest schedules for these zones. The three management zones of the plan are called natural, conservation, and commercial. The long term goal in the natural zone is to allow natural succession of forests to reach the mature and old growth seral stages, and continue to provide habitat for associated fish and wildlife species. Thus, the 3779 forested acres in the Natural Management Zone will be protected from harvest. (Ryan, 1996). In the conservation zone, forest management will be "directed at maintaining or improving the health and vigor of the vegetative cover for wildlife habitat production. The long-term goal for this zone is to accelerate the development of existing even-age single-storied stands into late successional multi-storied forest habitats." (Ryan, 1996). The 3300 forested acres in the

Conservation Zone will have regulated forest practices of approximately 41 acres per year to achieve the above goals; once the forest stands reach about 100 years of age, no further harvesting will be conducted. Harvest of timber would be allowed in the commercial zone, where the goal is to produce timber at a sustainable level. The 2240 forested acres in the Commercial Zone will have approximately 39 acres per year harvested. (Ryan, 1996).

Tacoma's Forest Plan fits perfectly to the prescriptions proposed in the mitigation plan. But if the Forest Plan is considered "a given" for the without- and with-project conditions, the HEP analysis shows no increase in HU's for the red-backed vole from the "without mitigation" condition to the "with mitigation" condition, because of the emphasis of the Forest Plan on mature forest development. Thus, for analysis purposes, the Forest Plan was not considered in the baseline condition, nor for the fifty year life of the project, either without or with the Phase I and Phase II projects. (Note that Tacoma is not obligated to implement the Forest Plan – it could abandon the plan at any time. Thus, by assuming Tacoma would not implement the Forest Plan, and then require the Forest Plan to be implemented as part of the mitigation plan, benefits can be shown and implementation of the Forest Plan would be assured). Therefore, a regulated harvest throughout Tacoma's timber lands is assumed to occur on all timbered lands in the project area.

Based on Tacoma's project harvest rate, the acres of harvest during each harvest cycle are assumed to total 50 acres of coniferous trees, and 50 acres of hardwood trees) in the vicinity of the reservoir. For simplicity, harvest cycles are assumed to occur once every 13 years (rather than a smaller cut every year). Thus, using this analysis, 200 acres each of coniferous trees and hardwood (deciduous) trees would be harvested near the reservoir over 50 years (the project life is considered to be 50 years) (cuts would occur in years 1, 14, 27, and 40). Note that the above scenario is one of countless scenarios, and is used as a reasonable approach that could be taken by a land manager. This approach allows meaningful comparisons between the without mitigation and with mitigation scenarios. Table 4 (in Annex I) documents the process through which the harvest without forest plan scenario was developed, and Table 5 (in Annex I) shows the resulting changes to the acreages of all habitat types over the 50 year project life, without implementation of Tacoma's forest plan. The changes in acreages are also based on a successional model developed by Fleming (1996) (see Table 6 in Annex I). The 1983 acres shown on Table 5 are those from the last column in Table 3, "Totals" (in Annex I).

Harvest in the above analysis is defined as clearcut. TFW and WAC regulations require the re-planting of Douglas fir seedlings within 3 years following harvest. Thus, in TY1, until planting is achieved, the clearcut lands are classified as grassland (since grasses and herbaceous vegetation dominate the area for several years until the fir seedlings grow a few feet). By year 10, the seedlings are dominant, and the clearcut lands are called young conifer. The clearcut areas would remain classified as young conifer throughout the life of the project. This is consistent with Franklin and Dyrness (1973), who consider that coniferous forests are still young at age 70.

4.5 WITH-PROJECT, WITHOUT MITIGATION CONDITION: ACREAGES OF HABITAT TYPES

TY0 is the same as for the baseline, or without-project condition, and represents the habitat acreages in the year immediately preceding TY1. TY1 is the year in which the project is implemented (2001). Losses of habitat type acreages as a result of inundation are shown in bold type on Table 1 in Annex I. Implementation of Phase I (reservoir to 1167) results in losses in TY1 of 14.29 acres of "mature conifer" (most of these forests in the project area are not truly mature, but are mostly greater than 70 years in age; the term is used here to distinguish it from young coniferous forest, which are considered to be less than 70 years old); 147.94 acres of mature deciduous forest would be inundated, and 48.49 acres of mixed coniferous and deciduous forest would be inundated. Note that the loss of conifer forest is relatively small (7% of its total in the project area), while deciduous forest – the most abundant habitat between elevation 1147 feet and 1167 feet – loses relatively a lot (about 23% of its project area total). These are singled out here as the principal habitats targeted for management in the mitigation plan to enable direct comparisons to the mitigation plan. The losses to deciduous forest are not regarded as significant, as there are no target animal species that rely primarily on deciduous forest for their well-being; not only that, but deciduous forest does not remain deciduous forest for long (usually – there are exceptions). Typically (though not always) deciduous forest is slowly overtaken by coniferous trees, first becoming a mixed forest, then a totally coniferous forest. Thus deciduous forest is considered to be an early transitional seral stage leading to mature conifer forest. As deciduous forest matures, becoming mixed, the mixed forests are targeted in the mitigation plan for conversion to mature conifer forest, which is important to most of the indicator species used in the baseline analysis, and is certainly important to both elk and red-backed voles. Thus the focus of the mitigation plan (discussed in the next section), is on these target species and habitats important to them. Table 7 (in Annex I) shows the successional changes of the vegetated habitats over the 50 year project life following implementation of Phase I without the forest plan and without mitigation. Table 9 (in Annex I) shows the changes including Phase II acreages, without the forest plan and without mitigation.

4.6 HEP ANALYSIS

4.6.1 Project Alternatives

Analysis of HEP data involves the development of Project Alternatives (PA's). PA1 represents the project alternative without-project condition or, existing condition, projected over the next 50 years. PA2 is the with-project condition, without mitigation. Both PA1 and PA2 assume timber harvesting without Tacoma's Forest Plan, as explained

in paragraph 4.4, and management of riparian buffer zones per state Forest Practices Rules (WAC 222-30-020-(3)). PA3 represents the with-project condition incorporating the mitigation plan; in this case, including implementation of Tacoma's Forest Land Management Plan.

4.6.2 Results of Impact Analysis

The HEP analysis focuses on four species: Rocky Mountain elk (*Cervus elaphus*); red-backed vole (*Clethrionomys gapperi*); pileated woodpecker (*Dryocopus pileatus*); and wood duck (*Aix sponsa*), which represent the range of habitats considered to be of most importance to wildlife in the area. HSI's used in the analysis for each habitat type are determined for 1983 conditions based on the published models as shown in Raedeke (1996). HSI's change over time due to changing habitat conditions. These changes are shown on a series of tables (found in Annex I, except for summary tables included in this section). The resultant HSI's for each target year are used to calculate HU's. The HEP software calculates average annual HU's (AAHU's), which is an average of HU's over the 50 year project life. The AAHU's for each species in each PA is compared to the AAHU's of the same species in a different PA. The impact analysis for implementation of Phase I showed a loss of 78.09 AAHU's for elk, 73.51 AAHU's for red-backed voles, 174.82 AAHU's for pileated woodpecker, and 3.31 AAHU's for wood ducks (all summarized on Table 4.6.1).

The implementation of Phase II significantly reduces the amount of forest in the project area, but has minor effects on wetlands and pastures. Phase II results in additional losses of AAHU's for all four target species (98.92 to elk – note that this is additive to Phase I impacts, for the total of -177.01 shown on Table 4.6.1; 131.79 for red-backed voles; 274.52 for pileated woodpeckers; and 2.43 for wood ducks).

TABLE 4.6.1. AVERAGE ANNUAL HABITAT UNIT (AAHU) VALUE IMPACTED IN PHASE I AND PHASE II

	Elk AAHUs	Red-Back Vole AAHUs	Pileated Woodpecker AAHUs	Wood Duck AAHUs
Phase I	-78.09	-73.51	-174.82	-3.31
Phase II	-27.85	-58.28	-99.71	-2.43
Total, both Phases	**-105.94**	**-131.79**	**-274.53**	**-5.74**

4.7 MITIGATION PLAN ACREAGES SUMMARIZED

The mitigation plan is presented in two parts: Phase I and Phase II. Table 1 (in Annex 1) shows the acreages of inundation of all vegetated habitats for both of these phases. Table 7 (in Annex 1) shows the specific successional changes to vegetated habitats resulting from implementation of Phase I, without mitigation. Table 8 (in Annex 1) shows how implementation of the mitigation plan would affect the acreages of the various habitat types; this table includes the mature forest acres improved on the mitigation sites, as well as implementation of 50 acres of managed forest outside of designated mitigation sites and included under Tacoma's Forest Plan. In addition, 89 acres of pasture will be added for elk grazing.

Table 9 (in Annex 1) shows the acreages impacted with implementation of Phase II, without mitigation; and Table 10 (in Annex 1) shows the effects of mitigation implementation in Phase II. Mitigation includes 100 acres of managed forest (i.e., 50 acres plus the 50 acres already designated for Phase I), and 89 acres of pasture (79 acres in Phase I, 10 acres in Phase II).

In order to effectively mitigate for the four selected target species, the following measures will be undertaken. Elk represent most habitats, but especially require grasslands on which to forage, and mature forests for hiding, thermal, and forage cover, and young forest for hiding cover. To maximize the quality of habitat for elk, pastures will be created from underneath power lines (thus minimizing the effect of further loss of forest habitat) and through some minimal treatments of adjacent forests. Pastures will be created by removing forests on relatively flat ground, then seeding to pasture grasses. Pasture sites were selected on the following criteria: 1) gain in habitat units; 2) nearness to MacDonald field and to the reservoir; 3) aspect and slope; 4) interspersion with nearby forested habitats (cover); 5) and cost, including construction of access road, if any; or requirement of pre-treatment of meadow (especially if poor soils—all of the sites on the south side of the reservoir have fair or poor soils for pastures). Based on these criteria, sites 1 (18 acres), 2 (18 acres), 5 (18 acres), 7 (11 acres), and 8 (14 acres) were selected for pasture creation.

With respect to interspersion of habitats, figure 4.7.1 shows how elk use increases with the nearness of forage areas to cover areas. Large areas of cover with little or no nearby open forage areas receive very little use, and large open areas of forage with no nearby cover areas also receive very little use. The existing pastures are not too large (<200 yards across) and are surrounded by forests, or the reservoir in the case of MacDonald field. The new pastures will also be surrounded by forests, though site 1 will merely be screened from a road by trees on one side. Interspersion with mitigation will therefore be maintained from the existing condition. Figure 4.7.2 shows a (less than optimal) example of interspersion of habitats in a managed forest landscape. This figure shows roads passing through the center of forage areas, or along the edge between cover and forage areas. This situation is largely avoided by the choice of mitigation sites at HHD.

Several mixes of pasture grasses will be tested on several plots of existing pasture (Baldi Field) two years prior to the pool raise. The best performing mix (both in terms of growth and elk use) will be selected for mass seeding on the newly created pastures. However, some sites have relatively poor soils, and the best performing mix on Baldi Field may not be the best mix on a site with poorer soils. So on those sites with poorer soils, mixes will be selected that have been formulated for use on poor soils. In addition, fertilizers will be used to promote the growth of pasture plants. Elk in the watershed are known to be selenium-deficient, so a fertilizer with a selenium component will be used on the pastures. At least two years prior to the pool raise, both Baldi and MacDonald fields will be fertilized with a high nitrogen content fertilizer, as well as high in potassium and phosphorus to promote nutritional plant growth. Salt blocks will be set out to further attract elk to the meadows (although the elk exclusion cage analysis indicates that each meadow already receives regular use). Baldi field will need to be thatched with a spring-tooth harrow; the thatch will be bailed and removed.

Existing roads adjacent to the created pastures will be screened with shrubs and low-growing trees to provide elk with some privacy while grazing. Forested habitats of all seral stages will surround the pastures, and some of the older mixed and coniferous forests will be managed to "accelerate" the maturity of the forests to mimic conditions found in very mature forests. Since the managed forests will result in a healthy shrub layer, it is anticipated that elk will find enough hiding cover for calf production and other needs, even though young coniferous and young deciduous forests will be allowed to mature, and will not be replaced, over the 50 year life of the project.

Pastures selected on power line rights-of-way (Sites 1, 2, 7 and 8 in Phase I, site 6 in Phase II) will require burning to eradicate Scot's broom (*Cytisus scoparius*), which is becoming a dominant invasive shrub in the right-of-way areas. Tilling and seeding can proceed following burning.

Red-backed voles and pileated woodpeckers represent mature forests in which fallen large logs and dead snags and tree limbs are numerous, and the ground cover of herbaceous plants and woody shrubs is diverse. Thus, the mitigation plan will manage forested areas to produce additional snags, logs, and forest openings (the latter will result in a more diverse understory); many different sizes of nest boxes will also be placed throughout the managed forests.

Wood ducks represent forested swamps, which may be used by the other three target species as well. Forested swamps near the upper level of the reservoir will be managed to maintain the water levels through sub-impoundments; snags will result from the increased inundation, so water-tolerant trees such as Oregon ash and willows will be planted to replace the drowned trees; nest boxes for wood ducks will be placed throughout the sub-impoundment areas; other animals, such as hooded mergansers, screech owls, and flying squirrels are also expected to use the nest boxes. The mitigation plan is discussed in detail in Section 3.

Target species' HSI's are discussed individually in the sections that follow. Mitigation site locations are shown on Figure 4. Incremental analysis (see Annex II) was performed to select the most cost-effective sites that would meet mitigation requirements for both phases (also see Table 15 in Annex I, a summary table of AAHU's, without project, with Phase I, and with Phase II).

4.7.1 Selected Plan

a) Elk. The mitigation proposal for elk focuses on two areas: 1) improving the quality and quantity of forage areas, and 2) increasing the amount of optimal cover (i.e., mature forest) in the study area. HSI's for elk were developed by Raedeke Associates, Inc, and are based on forage quality only, because forage availability is considered to be the limiting factor for elk in the vicinity of the reservoir. The HSI's are relatively generic in the sense that they do not look closely at the species of grasses and other herbaceous plants available for forage, nor at the percent cover (i.e., density) of these plants. Rather, the HSI's are based on factors such as whether the site is fertilized, seeded, and otherwise treated (such as with lime) at frequent (annual) intervals. A pasture that is treated with all of the above rates an HSI of 1. Pastures treated with less frequency are rated .75, and untreated pastures (including existing sedge meadows and created sedge meadows) rate a .5. HSI's for forested habitats are primarily based on their forage value, and rate either .1 or .25. Since elk are a multi-habitat user, the overall HSI for elk must be averaged over all the habitats used by elk. It is worth noting that maximizing forest for optimal habitat actually decrease the overall HU's for elk. This results from the fact that forests are rated in this exercise only for their forage value, which is .1 or at best .25—less than the worst forage area HSI of .5. Thus, by adding more areas of .1 habitat (coniferous forest), the HU's for the mitigation plan are reduced. As a result, additional pasture area is needed to fully mitigate for lost forage values. This is why mitigation pasture is about twice the area of existing pasture. HSI's of forage value in the various habitats used by elk are displayed in Table 4.7.1.

TABLE 4.7.1 COMPARISON OF ELK HSI VALUES BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PROJECT WITH MITIGATION OVER A 50-YEAR PERIOD

Cover Type	YR 1 No Project HIS	YR 1 Project + Mitigation HSI	YR 10 No Project HSI	YR 10 Project + Mitigation HSI	YR 25 No Project HSI	YR 25 Project + Mitigation HSI	YR 50 No Project HSI	YR 50 Project + Mitigation HSI
Mature Conifer Forest	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Young Conifer Forest	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mature Deciduous Forest	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Young Deciduous Forest	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mixed Forest	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Managed Mature Conifer Forest	0.1	0.1	0.1	0.2	0.1	0.25	0.1	0.25
Managed Mature Deciduous Forest	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2
Managed Mature Mixed Forest	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2
Upland Shrub	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Grassland*	0.5	.75/1.0	0.5	.75/1.0	0.5	.75/1.0	0.5	1.0
Forested Wetland	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Shrub-Scrub Wetland	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Emergent Wetland	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

*Passive pasture = .75; tame pasture = 1.0

Table 13 (a-m, in Annex I) shows the HSI's for various habitat types and the resultant overall HSI, shown at the bottom of each table. The acreages and HSI's change over time: Tables 13a-13e show the without-project changes; 13f-13i show the with-project, without mitigation changes; and 13j-13m show the with-project, with mitigation changes. Phase II HSI and acreage changes are similarly displayed in Table 14 (a-h, in Annex I). The resultant HSI's were used in the calculation of AAHU's displayed in Tables 11, 12, 15, 16, and 17 (all in Annex I), and summarized in Table 4.7.2.

TABLE 4.7.2 COMPARISON OF ELK HABITAT VALUE (AAHUS) FOR THE 50-YEAR ANALYSIS PERIOD BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PHASE I AND PHASE II OF THE PROJECT WITH MITIGATION

	Project Area Impact Elk AAHUs	Mitigation Lands Elk AAHUs	Resulting Elk AAHUs (Mitigation - Impact)
Phase I	-78.09	+81.96	+3.87
Phase II	-27.85	+30.37	+2.52
TOTAL:	**-105.94**	**+112.33**	**+6.39**

As currently planned, elk pastures will be created at sites 1, 2, 5, 7, and 8; planting of sedge meadows at sites 22, 23, 24, and 25 would further enhance the foraging availability for elk. In addition, mature forests would be managed at sites 9, 10, 12, 13, 15, 17, 18, 19, and 26. The comparison between PA3 and PA1 for Phase I is shown on Table 16 (in Annex I).

The loss resulting from implementation of Phase II is replaced by creation of a pasture at Site 3.

b) Red-backed Vole. This analysis is dependent on implementation of Tacoma's Forest Plan, as well as specific mitigation sites dedicated to mature forest management. These sites are 9, 10, 12, 13, 15, 18, and 19 (Figure 4), and were selected utilizing incremental analysis (Annex II). Like the Rocky Mountain elk, the red-backed vole is a multi-habitat user; the HSI's for these separate habitat types are averaged. Table 18 (a-m, in Annex I) shows these results for the red-backed vole, beginning with the without-project condition, followed by the with-project, without mitigation condition, and then by the with-project, with mitigation condition (for Phase I). Table 19 (a-h, in Annex I) shows the changes for red-backed vole in Phase II. Refer to Tables 11, 12, 16, and 17 (all in Annex I) for the comparisons between PA1 to PA2, and PA1 to PA3. Table 15 (in Annex I) summarizes the AAHU's lost to the projects and gained from mitigation.

As the forest matures, more trees fall to the ground, more openings occur in the canopy, allowing more herbaceous plants to grow on the forest floor (thus providing additional food and cover). Thus, even without mitigation, the HSI for mature conifer goes up over time, to .7 in TY25, and .8 in TY50. With mitigation – which includes the introduction of

logs to the forest floor, as well as creating openings in the canopy – a "new" habitat type called managed mature forest was identified to clearly define the effect of the mitigation effort; therefore, the HSI for mature conifer changes as it does without mitigation, as this is mature conifer that remains untouched by mitigation effort. The HSI for managed mature forest starts in TY1 at .7, as it is only slightly better than existing conditions when first created. This is because the logs need to rot for a time, and the herbaceous plants need time to establish after the canopy openings are made. By TY10, the HSI is .75; TY25 – .8; TY50 – .9. Note that the HSI's on non-mitigated forest types remains the same as the without-project condition. The HSI's are the same for both Phase I and Phase II mitigation efforts.

TABLE 4.7.3 COMPARISON OF RED-BACKED VOLE HSI VALUES BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PROJECT WITH MITIGATION OVER A 50-YEAR PERIOD

Cover Type	YR 1 No Project HSI	YR 1 Project + Mitigation HSI	YR 10 No Project HSI	YR 10 Project + Mitigation HSI	YR 25 No Project HSI	YR 25 Project + Mitigation HSI	YR 50 No Project HSI	YR 50 Project + Mitigation HSI
Mature Conifer Forest	0.63	0.63	0.63	0.63	0.7	0.7	0.8	0.8
Young Conifer Forest	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mature Deciduous Forest								
Young Deciduous Forest								
Mixed Forest	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.1
Managed Mature Conifer Forest		0.7		0.75		0.8		0.9
Managed Mixed Forest		0.25		0.4		0.6		0.8
Upland Shrub								
Grassland								
Forested Wetland								
Shrub-Scrub Wetland								
Emergent Wetland								

The proposed mitigation results in an increase in red-back vole habitat within the project area with the Phase I proposal. Phase II will result in a loss of red-back vole habitat. However, the overall value of Phase I and Phase II combined will result in a gain of approximately 10 AAHUs (Table 4.7.4). The suitability of the conifer stands for red-back vole habitat will increase as the amount of downed woody debris is increased in the stands (Table 4.7.4). The value of the woody debris for the red-back vole increases over time as the woody debris rots and supports increased fungi production. The value of the managed mixed stands will also increase with the increase of conifer canopy cover.

TABLE 4.7.4 COMPARISON OF RED-BACKED VOLE (RBV) HABITAT VALUE (AAHUS) FOR THE 50-YEAR ANALYSIS PERIOD BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PHASE I AND PHASE II OF THE PROJECT WITH MITIGATION

	Project Area Impact RbV AAHUs	Mitigation Lands RbV AAHUs	Resulting RbV AAHUs (Mitigation - Impact)
Phase I	-73.51	+131.23	+57.72
Phase II	-58.28	+10.93	-47.35
TOTAL:	**-131.79**	**+142.16**	**+10.37**

c) Pileated Woodpecker. The HEP model for pileated woodpecker is rather insensitive to small changes in snag densities. Without the project, as more snags are expected as the forests mature, by FY10 the HSI's increase from 0 to .1 for mature conifer and mature deciduous forests. However, in the 15 years between TY10 and TY25, enough snags are expected in mature conifer forest to boost the HSI up to .95 in TY25. The HSI for mature deciduous only increases to .3, because appropriate snags tend to be fewer in deciduous forests. The HSI for mature conifer increases again in TY50, to 1.0, while the HSI for deciduous forest increases only to .4. Mixed forest is rated .95 in TY1, based on the HEP field data, and remains .95 until year 25, when it increases to 1.0. Forested wetland is rated at .45 in TY1, and is not expected to change over the next 50 years.

Mitigation sites used for pileated woodpecker are the same as those for red-backed vole (9, 10, 12, 13, 15, 18, and 19 (Figure 4). With mitigation, new snags will be available almost immediately (some will not be appropriate for several years, but others should be ready for excavation when they are erected (Western red cedar, and perhaps cottonwood, for example)). Thus, in TY1, HSI for managed mature conifer forest will be .3, changing to .5 in TY10, and 1.0 in both TY25 and TY50. Managed mature deciduous does not increase as rapidly or as high, being .3 in TY1, .5 in TY10, .7 in TY25, and .8 in TY50. Managed mature mixed forests have the same HSI's as existing mixed forest. The HSI's on mitigation sites are the same as for the managed mature forests. HSI's are displayed in Table 4.7.5.

TABLE 4.7.5 COMPARISON OF PILEATED WOODPECKER HSI VALUES BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PROJECT WITH MITIGATION OVER A 50-YEAR PERIOD

Cover Type	YR 1 No Project HSI	YR 1 Project + Mitigation HSI	YR 10 No Project HSI	YR 10 Project + Mitigation HSI	YR 25 No Project HSI	YR 25 Project + Mitigation HSI	YR 50 No Project HSI	YR 50 Project + Mitigation HSI
Mature Conifer Forest	0	0	0.1	0.1	0.95	0.95	1.0	1.0
Young Conifer Forest								
Mature Deciduous Forest	0	0	0.1	0.1	0.3	0.3	0.4	0.4
Young Deciduous Forest								
Mixed Forest	0.95	0.95	0.95	0.95	1.0	1.0	1.0	1.0
Managed Mature Conifer Forest		0.3		0.5		1.0		1.0
Managed Mature Deciduous Forest		0.3		0.5		0.7		0.8
Managed Mature Mixed Forest		0.95		0.95		1.0		1.0
Upland Shrub								
Grassland								
Forested Wetland	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Shrub-Scrub Wetland								
Emergent Wetland								

The Phase I analysis for pileated woodpecker (shown in Tables 20 a-m, in Annex I) indicates a relatively large loss of 174.82 AAHU's. Nevertheless, the mitigation effort of managing forests to accelerate the structure to mimic mature forests results in a gain of 184.22 AAHU's, and thus a positive benefit of 9.4 AAHU's. In Phase II, however, even though HSI's improve through the life of the mitigation project, the amount of forest available for manipulation to mitigate for the loss of habitat for pileated woodpecker is reduced to the point that mitigation for this species cannot be achieved within the project area. Several HEP scenarios were considered, from manipulation of 50 acres of forest (i.e., 50 acres in Phase II in addition to the 50 acres of managed forest in Phase I), to a near maximum scenario of 200 acres of FC to FCM in each TY1 and TY10. This latter scenario gave the pileated woodpecker the best AAHU score after TY50, but it is still well in the negative (under-mitigated). On the other hand, all scenarios are sufficient to mitigate for the other target species, though maximizing managed forest also is best for elk and red-backed vole. AAHU's for the 50 acre scenario and the maximum managed forest scenario are shown in Table 4.7.6.

TABLE 4.7.6 COMPARISON OF PILEATED WOODPECKER (PW) HABITAT VALUE (AAHUS) FOR THE 50-YEAR ANALYSIS PERIOD BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PHASE I AND PHASE II OF THE PROJECT WITH MITIGATION

	Project Area Impact PW AAHUs	Mitigation Lands PW AAHUs	Resulting PW AAHUs (Mitigation - Impact)
Phase I	-174.82	+184.22	+9.4
Phase II—with 50 acres of managed forest	-99.71	+4.99	-94.72
Phase II—maximizing managed forest	*-99.71*	*+70.44*	*-29.27*
TOTAL	**-274.53**	**+189.21**	**-85.32**

Although the maximum managed forest scenario is best, City of Tacoma has indicated that forest surveys it has conducted show that only about 100 acres are appropriate for management. For this reason, the 50-acre scenario (50 acres each in Phase I and Phase II) is selected as the mitigation effort.

d) Wood Duck. Wood duck habitat value remains unchanged over the 50 year analysis period as the scrub-shrub wetland habitat in the project area will not develop into forested wetland habitat and young trees will provide replacement snags for those that fall over.

Wood ducks utilize permanently ponded or summer ponded forested wetlands for breeding. This species currently breeds at a system of ponds at the upstream end of the

reservoir. Existing forested wetland areas in the project area are few, and are compromised by fluctuating water levels, or too little water in early summer. Snags and logs of sufficient size are not abundant, so that the HSI in TY0 is .5.

With mitigation, the HSI would be 1.0, as logs, snags, and aquatic vegetation would all be added, along with a stable water level regime (within subimpoundments). Nest boxes will be erected and maintained until suitable cavity sites are available (estimated to be about 10 years). HSI's are summarized in Table 4.7.7.

TABLE 4.7.7 COMPARISON OF WOOD DUCK HSI VALUES BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PROJECT WITH MITIGATION OVER A 50-YEAR PERIOD

Cover Type	YR 1 No Project HSI	YR 1 Project + Mitigation HSI	YR 10 No Project HSI	YR 10 Project + Mitigation HSI	YR 25 No Project HSI	YR 25 Project + Mitigation HSI	YR 50 No Project HSI	YR 50 Project + Mitigation HSI
Mature Conifer Forest								
Young Conifer Forest								
Mature Deciduous Forest								
Young Deciduous Forest								
Mixed Forest								
Managed Mature Forest								
Upland Shrub								
Grassland								
Forested Wetland	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0
Shrub-Scrub Wetland								
Emergent Wetland								

One site (22) would be implemented during Phase II to replace lost HU's from that project. However, implementation of Phase II would result in the inundation of site 17, increasing the mitigation need for Phase II; sites for forested wetland mitigation are extremely limited. Two sites will be developed for fish mitigation that will also have benefits for wildlife – it is projected that the acreage would be sufficient for this purpose, and the HSI would be 1. Mitigation site locations are shown on Figure 4.

These areas will be inundated by the Phase I project. However, this results in a loss of only 3.31 AAHU's. The mitigation plan is to develop a subimpoundment and to develop other forested wetlands at two other sites in the project area, for a gain of 9.18 AAHU's. Incremental analysis indicates that sites 17 and 24 would mitigate the lost AAHU's in Phase I (see Annex II). Table 22 (a-c, in Annex I) shows the HSI's for wood duck in Phase I, and the AAHU's are shown in Tables 11, 12, 16, and 17 (all in Annex I) and summarized in Table 4.7.8.

TABLE 4.7.8 COMPARISON OF WOOD DUCK HABITAT VALUE (AAHUS) FOR THE 50-YEAR ANALYSIS PERIOD BETWEEN EXISTING CONDITIONS (NO PROJECT) AND PHASE I AND PHASE II OF THE PROJECT WITH MITIGATION

	Project Area Impact PW AAHUs	Mitigation Lands PW AAHUs	Resulting PW AAHUs (Mitigation - Impact)
Phase I	-3.31	+9.18	+5.87
Phase II	-2.43	+.53	-1.9
TOTAL:	**-5.74**	**+9.71**	**+3.97**

4.8 RECOMMENDATIONS

The following selection of sites is recommended for full mitigation of Phase I impacts:

Pastures and Emergent Marsh	**Forest Management**	**Forested Wetlands**
Sites	Sites	Sites
1 (BPA right of way (ROW)	9 (forested, south side)	22
2 (BPA right of way (ROW)	10 (forested, south side)	
5 (BPA right of way (ROW)	12 (forested, north side)	
7 (PSPL right of way (ROW)	13 (forested, north side)	
8 (PSPL right of way (ROW)	15 (forested, north side)	
16 (reservoir sedge plantings)	18 (forested, north side)	
22 (reservoir sedge plantings)	19 (forested, north side)	

23 (reservoir sedge plantings)
24 (reservoir sedge plantings)
25 (reservoir sedge plantings)
26 (forested, north side)

Phase II would utilize the following sites:

Pastures and Emergent Marsh	**Forest Management**	**Forested Wetlands**
Sites	Sites	Sites
3 (BPA right of way (ROW)	14 (forested, north side)	17*
11 (sedge plantings)	26 (forested, north side)	23*
23		24*
24		
25		

*Sites 17, 22, and 24 contain wooded portions that can be enhanced as forested swamps through the addition of berms, and the planting of wetland trees and aquatic vegetation.

ANNEX I. HEP TABLES

TABLE 1–Acres of Habitat Inundated by Phase I and Phase II Projects		
	1147'-1170'**	1170'-1180'**
	(Phase I)	(Phase II)
FC (mature conifer)	**14.29**	**5.98**
FCY (young conifer)	**0.77**	**13.64**
FD (mature deciduous)*	**147.94**	**85.65**
FDY (young deciduous)	**10.93**	**4.71**
FM (mixed forest)	**48.49**	**28.13**
FO (forested swamp)	**6.68**	**4.92**
SS (shrub swamp)	**2.14**	**0.87**
EM (emergent marsh)	**10.28**	**0**
S (upland shrub)	**1.52**	**0.79**
G (upland grassland)	**11.54**	**2.16**
OW (open water)	**14.69**	**8.3**
T (talus/rock)	**1.78**	**1.32**
MF (mudflat)	**2.45**	**0.09**
ML (mossland)	**0.1**	**0**
R (railroads/roads)	**1.68**	**1.56**
RB (riverbed)	**5.23**	**3.34**
Total Habitat	**280.51**	**161.46**
*FD includes FD1 (alder) and FD2 (cottonwood) (Shapiro, 1985)		
**Bolded numbers are acreages inundated by Phase I and Phase II projects		
(i.e., 1147-1170, and 1170-1180)		
12/19/96		

TABLE 2--Analysis of Loss: Inundated Acreages of Existing Sedges and Planted Carex Aperta (from 1135 project)--Phase I and Phase II

Total acres below 1141', existing, are 108.58; 10 acres of Carex aperta are added for Section 1135 project--Total 118.58.

Another 6.61 acres exist between 1141' and 1147', and 18.5 acres of C. aperta are added for Sec. 1135. However, 29.91 acres die as a result of inundation by the new pool, resulting in a net loss of 4.8 acres (29.91 minus 25.11). Total at 1147', following pool raise: 118.58-4.8=113.78.

Phase I would inundate another 22' (to 1169'), and an additional 10.29* acres of emergent marsh, for a new total of 124.07 acres. Phase I would effectively eliminate all sedges except C. aperta (28.5 acres remaining) and about 50% of the newly inundated marsh, or about 5 acres. C. aperta can withstand inundation of up to 50', so all C. aperta planted below 1147' (28.5 acres) would be expected to survive. Therefore, only about 33.5 acres of sedges would exist following implementation of Phase I. 69 acres of sedges would be planted as mitigation to partially offset this loss, to total 102.5 acres.

In Phase II no wetland areas would be inundated; however, between 1169' and 1177', all 5.28 acres of non-C. aperta sedges remaining above 1169' would die as a result of implementation of Phase II, as would about 20% (16 acres) of the mitigation sedges, for a loss of about 21.28 acres. These acres would be partially off-set by planting 18 acres of sedges, for a final total of 99.22 acres.

*Includes .01 acre emergent wetland above 1180', which otherwise would be left out of calculations.

11/20/97

TABLE 3--Acreage calculations by habitat type, Howard Hanson Dam

	Below 1105'	1105'-1141'	1141'-1147'	Existing (1983 map) Subtotal	1147'-1170'** (Phase I)	Existing plus Phase I Subtotal	1170'-1180'** (Phase II)	Existing plus Phase I plus Phase II Subtotal	1180'-1220'	Forest Plan above 1220' Area***	Totals	
FC (mature conifer)	0	0.31	1.48	1.79	**14.29**	16.08	**5.98**	22.06	26.67	145	193.73	FC (mature conifer)
FCY (young conifer)	0	0	0	0	**0.77**	0.77	**13.64**	14.41	35.15	0	49.56	FCY (young conifer)
FD (mature deciduous)*	0.07	13.44	22.99	36.5	**147.94**	184.44	**85.65**	270.09	321.44	50	641.53	FD (mature deciduous)
FDY (young deciduous)	0	0.5	1.24	1.74	**10.93**	12.67	**4.71**	17.38	37.91	100	155.29	FDY (young deciduous)
FM (mixed forest)	0.01	4.29	20.13	24.43	**48.49**	72.92	**28.13**	101.05	117.62	200	418.67	FM (mixed forest)
FO (forested swamp)	0	1.2	0.61	1.81	**6.68**	8.49	**4.92**	13.41	1.62	0	15.03	FO (forested swamp)
SS (shrub swamp)	0	7.81	4.3	12.11	**2.14**	14.25	**0.87**	15.12	1.75	0	16.87	SS (shrub swamp)
EM (emergent marsh)****	0.15	118.43	25.11	143.69	**10.28**	153.97	**0**	153.97	0.01	0	153.98	EM (emergent marsh)
S (upland shrub)	0	0	0.09	0.09	**1.52**	1.61	**0.79**	2.4	5.71	0	8.11	S (upland shrub)
G (upland grassland)	0	1.77	2.24	4.01	**11.54**	15.55	**2.16**	17.71	11.42	0	29.13	G (upland grassland)
OW (open water)	266.14	169.76	3.27	439.17	**14.69**	453.86	**8.3**	462.16	25.84	0	488	OW (open water)**
T (talus/rock)	0.01	1.13	1.01	2.15	**1.78**	3.93	**1.32**	5.25	6.37	0	11.62	T (talus/rock)
MF (mudflat)	0.45	52.02	7.59	60.06	**2.45**	62.51	**0.09**	62.6	0	0	62.6	MF (mudflat)
ML (mossland)	0	81.13	0.28	81.41	**0.1**	81.51	**0**	81.51	0	0	81.51	ML (mossland)
R (railroads/roads)	0	0.04	0.17	0.21	**1.68**	1.89	**1.56**	3.45	24.96	0	28.41	R (railroads/roads)
RB (riverbed)	0	22.4	1.15	23.55	**5.23**	28.78	**3.34**	32.12	10.55	0	42.67	RB (riverbed)
Total Habitat	266.83	474.23	91.66	832.72	**280.51**	1113.23	**161.46**	1274.69	627.02	495	2396.71	

*FD includes FD1 (alder) and FD2 (cottonwood) (Shapiro, 1985)

**Bolded numbers are acreages inundated by Phase I and Phase II projects (i.e., 1147-1170, and 1170-1180)

***Not mapped, but estimated from aerial photographs and minimal ground-truthing, and includes 193.5 acres of mitigation sites above 1220. Thus, approximately 300 acres in this column are Forest Plan lands used for mitigation.

****Emergent acreage for 1983 subtotal includes 28.5 acres of Carex aperta planted below 1147'.

2/6/97

TABLE 4--HARVEST SCHEDULE (WITHOUT FOREST PLAN AND WITHOUT PROJECT)

There would be four harvest cycles during the life of the project, and at 50 acres/cycle of conifer and 50 acres/cycle of hardwood, 200 acres of conifer would be cut, and 200 acres of hardwood.

Harvest years would be TY1, TY14, and TY27, and TY40. Thus, 100 acres each of conifer and hardwood would be harvested between TY25 and TY50.

Habitats will be modified as follows:

	TY0 (2202	TY1	TY10	TY25	TY50
FC	401.275	351.275	628.67	783.065	850.74
FCY	49.56	49.56	100	200	400
FD	361.91	361.91	180.955	0	0
FDY	75.905	75.905	75.905	75.905	75.905
FM	505.67	455.67	408.79	335.35	67.675

In TY1, FC is equal to TY0 minus 50 (harvested) acres; FM is equal to TY0 minus 50 (harvested) acres; the 100 acres harvested convert to grassland.

In TY10, FC is equal to TY1 plus 1/2 of TY1 FM (227.835) plus TY1 FCY (49.56); FCY gains 100 acres from succession resulting from grassland being overtaken by the conifer seedlings. FM in TY10 equals 1/2 of TY1 FM plus 1/2 TY1 FD (180.955)

In TY25, FC equals TY10 FC plus 1/2 TY10 FM (204.395) minus 50 (harvested) acres; FM equals 1/2 TY10 FM plus TY10 FD (180.955) minus 50 (harvested) acres; FCY gains 100 acres.

In TY50, FC equals TY25 FC plus 1/2 TY25 FM (167.675) minus 100 (harvested) acres; FM in TY50 equals 1/2 TY25 FM minus 100 (harvested) acres; the 200 acres harvested become FCY in TY50.

Note that this analysis assumes that young coniferous stays "young" beyond 50 years (i.e., the 100 acres of clearcut planted to conifer seedlings in TY1 is still classified as FCY in TY50). This is based on analyses of succession in Franklin and Dyrness, 1973.

The above analysis is based on Fleming's successional model (Table 20 in DRAFT Mitigation Concepts, 4/19/96)

10/29/97

TABLE 5--Successional Changes to Habitat, Without Project, and Without Tacoma's Forest Plan *						
	1983 (high pool elev. 1141')	TY0 (2001) (high pool at elev. 1147'	TY1 (2002)	TY10 (2011)	TY25 (2026)	TY50 (2051)
FC (mature conifer)**	193.73	401.275	351.275	628.67	783.065	850.74
FCY (young conifer)	49.56	49.56	49.56	100	200	400
FD (mature deciduous)	641.53	361.91	361.91	180.955	0	0
FDY (young deciduous)	155.29	75.905	75.905	75.905	75.905	75.905
FM (mixed forest)**	418.67	505.67	455.67	408.79	335.35	67.675
FO (forested swamp)	15.03	13.22	13.22	13.22	13.22	13.22
SS (shrub swamp)	16.87	4.76	4.76	4.76	4.76	4.76
EM (emergent marsh)***	124.07	124.07	124.07	124.07	124.07	124.07
S (upland shrub)	8.11	8.02	8.02	8.02	8.02	8.02
G (upland grassland)	29.13	25.12	125.12	25.12	25.12	25.12
Subtotal, vegetated area	1651.99	1569.51	1569.51	1569.51	1569.51	1569.51
reservoir, railroads, and roads	714.81	797.29	797.29	797.29	797.29	797.29
Total plus reservoir and railroads and roads	2366.8	2366.8	2366.8	2366.8	2366.8	2366.8
*Based on Fleming (Table 20, Succession Model...)(4/19/96), and starting from existing condition at 1147' elevation						
**Harvested acres of FC and FM become upland grassland for 5 years following harvest, then convert to young coniferous forest (planted with conifer seedlings about a year following harvest). In succeeding target years the successional pattern follows Fleming.						
***Utilizes total emergent acreage for project area up to 1220' elevation.						
11/20/97						

Table 6 Succession model, rules for advancing cover types, Howard Hanson Dam, Additional Water Storage Project						
Cover Type	1983*	TY0(2001)	TY1(2002)	TY10(2011)	TY25(2026)	TY50(2051)
FC (Conifer Forest)	GIS Map**	FC in 1983+1/2 FM in 1983	FC in TY 0	in TY1+1/2 FM in TY1+FCY in TY1	FC in TY10+1/2 FM in TY10	FC in TY25+1/2 FM in TY25
FCY (Young Conifer Forest)	GIS Map**	FCY in 1983	FCY in TY0	0, all converted to FC	0	0
FD (Deciduous Forest)	GIS Map**	1/2 FD in 1983+1/2 FDY in 1983	FD in TY 0	1/2 FD in TY 1	0, converted to FM	0
FDY (Young Deciduous Forest)	GIS Map**	1/2 of FDY in 1983	FDY in TY0	FDY in TY 1	FDY in TY 10	FDY in TY 25
FM (Mixed Forest Conifer Forest)	GIS Map**	1/2 FM in 1983+1/2 FD in 1983	FM in TY0	1/2 FM in TY1+1/2 FD in TY1	1/2 FM in TY10+FD in TY10	1/2 FM in TY25
Shrub and Scrub/Shrub	GIS Map**	S + PSS in 1983	S+PSS in TY 0	S + PSS in TY 1	S + PSS in TY 10	S + PSS in TY 25
G (Grass)	GIS Map**	G in 1983	G in 1983	G in TY1	G in TY10	G in TY25
PFO (Palustrine Forest)	GIS Map**	PFO in 1983	PFO in 1983	PFO in TY 1	PFO in TY 10	PFO in TY 25

* Shapiro cover-type map based on 1983 aerial photographs
**Revised cover-type GIS Map, Ryan (1995)

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TABLE 7b—Successional Changes to Habitat, With Phase I Project, without mitigation, without Forest Plan*							
	1983	TY0 (2001)	TY1 (2002)	TY10 (2011)	TY25 (2026)	TY50 (2051)	
FC (mature conifer)**	193.73	401.275	336.985	589.365	694.6525	700.78875	
FCY (young conifer)	49.56	49.56	48.79	100	200	400	
FD (mature deciduous)	641.53	361.91	213.97	106.985	0	0	
FDY (young deciduous)	155.29	75.905	64.975	64.975	64.975	64.975	
FM (mixed forest)**	418.67	505.67	407.18	310.575	212.2725	6.13625	
FO (forested swamp)	15.03	13.22	6.54	6.54	6.54	6.54	
SS (shrub swamp)	16.87	4.76	2.62	2.62	2.62	2.62	
EM (emergent marsh)***	124.07	124.07	33.5	33.5	33.5	33.5	
S (upland shrub)	8.11	8.02	6.5	6.5	6.5	6.5	
G (upland grassland)	29.13	25.12	113.58	13.58	13.58	13.58	
Subtotal of vegetated area	1651.99	1569.51	1234.64	1234.64	1234.64	1234.64	
reservoir, railroads, and roads	714.81	797.29	1132.16	1132.16	1132.16	1132.16	
Total	2366.8	2366.8	2366.8	2366.8	2366.8	2366.8	
*Acres in TY1 derived by subtracting inundated acres of Phase I shown in Table 7a							
**Harvested acres of FC and FM become upland grassland for 5 years following harvest, then convert to young coniferous forest (planted with conifer seedlings about a year following harvest). In succeeding target years the successional pattern follows Fleming.							
***Emergent total in TY1 and future years assumes survival of existing marsh down to elevation 1160 (5.25 acres) plus 28.5 acres of Carex aperta below 1147.							
From Fleming (Table 20, Succession Model) 4/19/96), and from Succession Table, Without Project (this report)							
11/20/97							

TABLE 8-Successional Changes to Habitat, With Phase I (based on the utilization of 50 acres of FMM to meet mitigation goals)					
	TY0	TY1 (PHASE I)	TY10	TY25 (2026)	TY50 (2051)
FC (mature conifer)*	401.275	340.885	580.19	718.8025	831.46375
FCM (mitigation site mature conifer)**	0	17.5	37.375	56.2	74.5
FCY (young conifer)*	49.56	48.79	0	0	0
FDM (mitig. site mature deciduous)**	0	35.55	17.775	0	0
FD (mature deciduous)*	361.91	173.42	86.71	0	0
FDY (young deciduous)*	75.905	0	0	0	0
FM1 (mitig. site mixed forest)**	0	39.75	37.65	36.6	18.3
FM (mixed forest)*	505.67	381.03	277.225	225.3225	112.66125
FMM (managed mature forest)**	0	50	50	50	50
FO (forested swamp)***	13.22	12.54	12.54	12.54	12.54
SS (shrub swamp)*	4.76	2.62	2.62	2.62	2.62
EM (emergent marsh)****	124.07	102.5	102.5	102.5	102.5
S (upland shrub)*	8.02	6.5	6.5	6.5	6.5
G (upland grassland)*****	25.12	92.555	92.555	92.555	92.555
Subtotal	1569.51	1303.64	1303.64	1303.64	1303.64
Reservoir	797.29	1063.16	1063.16	1063.16	1063.16
Total	2366.8	2366.8	2366.8	2366.8	2366.8

*Phase I causes following acreage losses: FC--14.29; FCY--.77; FD--147.94; FDY--10.93; FM--48.49; FO--6.68; SS--2.14; EM--10.28; S--1.52; G--11.54.

**In Phase I, converted 17.5 acres of FC to FCM, 35.55 acres of FD to FDM, and 39.75 acres of FM to FM1. 25 acres of FC and 25 acres of FM are converted to FMM

***Forested swamp loses 6.68 acres to pool raise, and is mitigated by subimpoundments totalling 6 additional acres; 6 acres are taken from FM.

****Emergent total in TY1 and future years assumes survival of existing marsh down to elevation 1160 (5.28 acres) plus 28.5 acres of *Carex aperta* below 1147, plus 69 acres of mitigation.

*****Upland grassland loses 11.54 acres to 1170' pool; and adds 78.975 acres for elk pasture mitigation; the 78.975 acres are taken from the following habitat types: FDY--64.975 acres; FD--5 acres; FM--5.4 acres; FC--3.6 acres

From Fleming (Table 20, Succession Model)(4/19/96), and from Succession Table, Without Project (this report)

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TABLE 9–Successional Changes to Habitat, With Phase I and Phase II Projects, without mitigation, without Forest Plan*						
	1983	TY0 (2001)	TY1 (2002)	TY10 (2011)	TY25 (2026)	TY50 (2051)****
FC (mature conifer)**	193.73	401.275	331.005	555.68	632.5225	573.525
FCY (young conifer)	49.56	49.56	35.15	100	200	400
FD (mature deciduous)	641.53	361.91	128.32	64.16	0	0
FDY (young deciduous)	155.29	75.905	60.265	60.265	60.265	60.265
FM (mixed forest)**	418.67	505.67	379.05	253.685	141.0025	0
FO (forested swamp)	15.03	13.22	1.62	1.62	1.62	1.62
SS (shrub swamp)	16.87	4.76	1.75	1.75	1.75	1.75
EM (emergent marsh)***	124.07	124.07	12.22	12.22	12.22	12.22
S (upland shrub)	8.11	8.02	5.71	5.71	5.71	5.71
G (upland grassland)	29.13	25.12	111.42	11.42	11.42	11.42
Subtotal vegetated area	1651.99	1569.51	1066.51	1066.51	1066.51	1066.51
reservoir, railroads, and roads	714.81	797.29	1300.29	1300.29	1300.29	1300.29
Total	2366.8	2366.8	2366.8	2366.8	2366.8	2366.8

*TY1 acres are derived by subtracting the inundated Phase II acres shown in Table 7a.

**Harvested acres of FC and FM become upland grassland for 5 years following harvest, then convert to young coniferous forest (planted with conifer seedlings about a year following harvest). In succeeding target years the successional pattern follows Fleming.

***Emergent total in TY1 and future years assumes survival of existing marsh down to elevation 1160 (5.25 acres) plus 28.5 acres of Carex aperta below 1147.

****In TY50, only 70.50125 acres of FM remain following succession to FC; this then is assumed to be harvested, leaving 29.49875 acres of harvest to complete the 100 acre harvest cycles; this acreage is removed from FC

From Fleming (Table 20, Succession Model)(4/19/96), and from Succession Table, Without Project (this report)

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TABLE 10--Successional Changes to Habitat, With Phase I and Phase II Projects, With Mitigation						
	1983	TY0 (2001)	TY1 (2002)	TY10 (2011)	TY25 (2026)	TY50 (2051)
FC (mature conifer)*	193.73	401.275	275.905	487.505	595.1725	668.44875
FCM (mitigation site mature conifer)**	0	0	76.5	99.375	119.7	138.75
FCY (young conifer)*	49.56	49.56	35.15	0	0	0
FDM (mitig. site mature deciduous)**	0	0	35.55	17.775	0	0
FD (mature deciduous)*	641.53	361.91	77.77	38.885	0	0
FDY (young deciduous)*	155.29	75.905	0	0	0	0
FM1 (mitig. site mixed forest)**	0	0	45.75	40.65	38.1	19.05
FM (mixed forest)*	418.67	505.67	352.9	215.335	146.5525	73.27625
FMM (managed mature forest)**	0	0	50	50	50	50
FO (forested swamp)***	15.03	13.22	10.62	10.62	10.62	10.62
SS (shrub swamp)*	16.87	4.76	1.75	1.75	1.75	1.75
EM (emergent marsh)****	124.07	124.07	99.22	99.22	99.22	99.22
S (upland shrub)*	8.11	8.02	5.71	5.71	5.71	5.71
G (upland grassland)*****	29.13	25.12	100.395	100.395	100.395	100.395
Subtotal vegetated area	1651.99	1569.51	1167.22	1167.22	1167.22	1167.22
reservoir, railroads, and roads	714.81	797.29	1199.58	1199.58	1199.58	1199.58
Total	2366.8	2366.8	2366.8	2366.8	2366.8	2366.8

*Phase I causes following acreage losses: FC--14.29; FCY--.77; FD--147.94; FDY--10.93; FM--48.49; FO--6.68; SS--2.14; EM--10.28; S--1.52; G--11.54. Phase II causes following acreage losses: FC--5.98; FCY--13.64; FD--85.65; FDY--4.71; FM--28.13; FO--4.92; SS--.87; EM--0; S--.79; G--2.16.

**In Phase I, converted 17.5 acres of FC to FCM, 35.55 acres of FD to FDM, and 39.75 acres of FM to FM1; and 25 acres each of FC and FM to FMM.

In Phase II, converted additional 59 acres of FC to FCM, and an additional 6 acres of FM to FM1, in TY1.

***Forested swamp is inundated by both pool raises--1.62 acres remain above 1180' reservoir. The loss is mitigated by the addition of 9 acres of subimpounded forested swamp.

****Emergent total in TY1 and future years assumes survival of existing marsh down to elevation 1160 (5.28 acres) plus 28.5 acres of *Carex aperta* below 1147, plus 69 acres of mitigation in Phase 1. In Phase II, 21.28 acres would die, and would be replaced with 18 acres.

*****In Phase I upland grassland loses 11.54 acres to 1170' pool; and adds 78.975 acres for elk pasture mitigation; the 78.975 acres are taken from the following habitat types: FDY--64.975 acres; FD--5 acres; FM--5.4 acres; and FC--3.6 acres. In Phase II upland grassland loses 2.16 acres to 1180' pool; and adds 10 acres of pasture; 10 acres are taken from FD.

From Fleming (Table 20, Succession Model)(4/19/96), and from Succession Table, Without Project (this report)

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Table 11 -Form D: Net change in AAHU's

Study Name: HHD Pool Raise, Phase I
Action: PA 2 WITH project without mitigation
Compared to: PA 1 WITHOUT project
Period of analysis: 50

Evaluation Species		AAHU's	AAHU's	Net
ID#	Name	With Action	Without Action	Change
1	Rocky Mountain Elk	190.14	268.23	-78.09
2	Red-Backed Vole	488.15	561.66	-73.51
3	Pileated Woodpeaker	657.5	832.32	-174.82
4	Wood Duck	3.3	6.61	-3.31

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Table 12 - Form D: Net change in AAHU's

Study Name: Phase II, HHD, with four species
Action: PA 2 WITH project, without mitigation
Compared to: PA 1 WITHOUT project
Period of analysis: 50

Evaluation Species		AAHU's	AAHU's	Net
ID#	Name	With Action	Without Action	Change
1	Rocky Mountain Elk	162.29	268.23	-105.94
2	Red-Backed Vole	429.87	561.66	-131.79
3	Pileated Woodpeaker	557.79	832.31	-274.52
4	Wood Duck	0.87	6.6	-5.73

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TABLE 13A--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project				
Evaluation Species	Rocky Mountain Elk				
Target Year	0				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	401.275	0.1	40.1275		
FCY (young conifer)	49.56	0.25	12.39		
FD (mature deciduous)	361.91	0.1	36.191		
FDY (young deciduous)	75.905	0.25	18.97625		
FM (mixed forest)	505.67	0.1	50.567		
FO (forested swamp)	13.22	0.1	1.322		
SS (shrub swamp)	4.76	0.25	1.19		
EM (emergent marsh)	124.07	0.5	62.035		
S (upland shrub)	8.02	0.25	2.005		
G (grassland)	25.12	0.5	12.56		
Totals	1569.51		237.36375		
Mean HSI (total HU/total acreage)		0.151234302			
11/10/97					

TABLE 13B--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project				
Evaluation Species	Rocky Mountain Elk				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	351.275	0.1	35.1275		
FCY (young conifer)	49.56	0.25	12.39		
FD (mature deciduous)	361.91	0.1	36.191		
FDY (young deciduous)	75.905	0.25	18.97625		
FM (mixed forest)	455.67	0.1	45.567		
FO (forested swamp)	13.22	0.1	1.322		
SS (shrub swamp)	4.76	0.25	1.19		
EM (emergent marsh)	124.07	0.5	62.035		
S (upland shrub)	8.02	0.25	2.005		
G (grassland)	125.12	0.5	62.56		
Totals	1569.51		277.36375		
Mean HSI (total HU/total acreage)		0.176719964			
11/10/97					

TABLE 13C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project				
Evaluation Species	Rocky Mountain Elk				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	628.67	0.1	62.867		
FCY (young conifer)	100	0.25	25		
FD (mature deciduous)	180.955	0.1	18.0955		
FDY (young deciduous)	75.905	0.25	18.97625		
FM (mixed forest)	408.79	0.1	40.879		
FO (forested swamp)	13.22	0.1	1.322		
SS (shrub swamp)	4.76	0.25	1.19		
EM (emergent marsh)	124.07	0.5	62.035		
S (upland shrub)	8.02	0.25	2.005		
G (grassland)	25.12	0.5	12.56		
Totals	1569.51		244.92975		
Mean HSI (total HU/total acreage)		0.156054915			
11/10/97					

TABLE 13D–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project				
Evaluation Species	Rocky Mountain Elk				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	783.065	0.1	78.3065		
FCY (young conifer)	200	0.25	50		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	75.905	0.25	18.97625		
FM (mixed forest)	335.35	0.1	33.535		
FO (forested swamp)	13.22	0.1	1.322		
SS (shrub swamp)	4.76	0.25	1.19		
EM (emergent marsh)	124.07	0.5	62.035		
S (upland shrub)	8.02	0.25	2.005		
G (grassland)	25.12	0.5	12.56		
Totals	1569.51		259.92975		
Mean HSI (total HU/total acreage)		0.165612038			
11/10/97					

TABLE 13E–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project				
Evaluation Species	Rocky Mountain Elk				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	850.74	0.1	85.074		
FCY (young conifer)	400	0.25	100		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	75.905	0.25	18.97625		
FM (mixed forest)	67.675	0.1	6.7675		
FO (forested swamp)	13.22	0.1	1.322		
SS (shrub swamp)	4.76	0.25	1.19		
EM (emergent marsh)	124.07	0.5	62.035		
S (upland shrub)	8.02	0.25	2.005		
G (grassland)	25.12	0.5	12.56		
Totals	1569.51		289.92975		
Mean HSI (total HU/total acreage)		0.184726284			
11/10/97					

TABLE 13F--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	336.985	0.1	33.6985		
FCY (young conifer)	48.79	0.25	12.1975		
FD (mature deciduous)	213.97	0.1	21.397		
FDY (young deciduous)	64.975	0.25	16.24375		
FM (mixed forest)	407.18	0.1	40.718		
FO (forested swamp)	6.54	0.1	0.654		
SS (shrub swamp)	2.62	0.25	0.655		
EM (emergent marsh)	33.5	0.5	16.75		
S (upland shrub)	6.5	0.25	1.625		
G (grassland)	113.58	0.5	56.79		
Totals	1234.64		200.72875		
Mean HSI (total HU/total acreage)		0.162580793			
12/13/96					

TABLE 13G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	589.365	0.1	58.9365		
FCY (young conifer)	100	0.25	25		
FD (mature deciduous)	106.985	0.1	10.6985		
FDY (young deciduous)	64.975	0.25	16.24375		
FM (mixed forest)	310.575	0.1	31.0575		
FO (forested swamp)	6.54	0.1	0.654		
SS (shrub swamp)	2.62	0.25	0.655		
EM (emergent marsh)	33.5	0.5	16.75		
S (upland shrub)	6.5	0.25	1.625		
G (grassland)	13.58	0.5	6.79		
Totals	1234.64		168.41025		
Mean HSI (total HU/total acreage)		0.136404336			
1/10/97					

TABLE 13H–FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	694.6525	0.1	69.46525		
FCY (young conifer)	200	0.25	50		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	64.975	0.25	16.24375		
FM (mixed forest)	212.2725	0.1	21.22725		
FO (forested swamp)	6.54	0.1	0.654		
SS (shrub swamp)	2.62	0.25	0.655		
EM (emergent marsh)	33.5	0.5	16.75		
S (upland shrub)	6.5	0.25	1.625		
G (grassland)	13.58	0.5	6.79		
Totals	1234.64		183.41025		
Mean HSI (total HU/total acreage)		0.148553627			
1/10/97					

TABLE 13I–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	700.7888	0.1	70.078875		
FCY (young conifer)	400	0.25	100		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	64.975	0.25	16.24375		
FM (mixed forest)	6.13625	0.1	0.613625		
FO (forested swamp)	6.54	0.1	0.654		
SS (shrub swamp)	2.62	0.25	0.655		
EM (emergent marsh)	33.5	0.5	16.75		
S (upland shrub)	6.5	0.25	1.625		
G (grassland)	13.58	0.5	6.79		
Totals	1234.64		213.41025		
Mean HSI (total HU/total acreage)		0.172852208			
1/10/97					

TABLE 13J–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Rocky Mountain Elk			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	340.885	0.1	34.0885	
FCM (mitigation site mature conifer)	17.5	0.1	1.75	
FCY (young conifer)	48.79	0.25	12.1975	
FDM (mitig. site mature deciduous)	35.55	0.1	3.555	
FD (mature deciduous)	173.42	0.1	17.342	
FDY (young deciduous)	0	0.25	0	
FM1 (mitig. site mixed forest)	39.75	0.1	3.975	
FM (mixed forest)	381.03	0.1	38.103	
FMM (managed mature forest)	50	0.1	5	
FO (forested swamp)	12.54	0.1	1.254	
SS (shrub swamp)	2.62	0.25	0.655	
EM (emergent marsh)	102.5	0.5	51.25	
S (upland shrub)	6.5	0.25	1.625	
G (grassland)	92.555	1	92.555	
Totals	1303.64		263.35	
Mean HSI (total HU/total acreage)		0.202011291		
11/21/97				

TABLE 13K–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Rocky Mountain Elk			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	580.19	0.1	58.019	
FCM (mitigation site mature conifer)	37.375	0.2	7.475	
FCY (young conifer)	0	0.25	0	
FDM (mitig. site mature deciduous)	17.775	0.2	3.555	
FD (mature deciduous)	86.71	0.1	8.671	
FDY (young deciduous)	0	0.25	0	
FM1 (mitig. site mixed forest)	37.65	0.2	7.53	
FM (mixed forest)	277.225	0.1	27.7225	
FMM (managed mature forest)	50	0.2	10	
FO (forested swamp)	12.54	0.1	1.254	
SS (shrub swamp)	2.62	0.25	0.655	
EM (emergent marsh)	102.5	0.5	51.25	
S (upland shrub)	6.5	0.25	1.625	
G (grassland)	92.555	1	92.555	
Totals	1303.64		270.3115	
Mean HSI (total HU/total acreage)		0.207351339		
11/21/97				

TABLE 13L--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Rocky Mountain Elk			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	718.8025	0.1	71.88025	
FCM (mitigation site mature conifer)	56.2	0.25	14.05	
FCY (young conifer)	0	0.25	0	
FDM (mitig. site mature deciduous)	0	0.2	0	
FD (mature deciduous)	0	0.1	0	
FDY (young deciduous)	0	0.25	0	
FM1 (mitig. site mixed forest)	36.6	0.2	7.32	
FM (mixed forest)	225.3225	0.1	22.53225	
FMM (managed mature forest)	50	0.25	12.5	
FO (forested swamp)	12.54	0.1	1.254	
SS (shrub swamp)	2.62	0.25	0.655	
EM (emergent marsh)	102.5	0.5	51.25	
S (upland shrub)	6.5	0.25	1.625	
G (grassland)	92.555	1	92.555	
Totals	1303.64		275.6215	
Mean HSI (total HU/total acreage)		0.21142455		
11/21/97				

TABLE 13M–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Rocky Mountain Elk			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	831.4638	0.1	83.146375	
FCM (mitigation site mature conifer)	74.5	0.25	18.625	
FCY (young conifer)	0	0.25	0	
FDM (mitig. site mature deciduous)	0	0.2	0	
FD (mature deciduous)	0	0.1	0	
FDY (young deciduous)	0	0.25	0	
FM1 (mitig. site mixed forest)	18.3	0.2	3.66	
FM (mixed forest)	112.6613	0.1	11.266125	
FMM (managed mature forest)	50	0.25	12.5	
FO (forested swamp)	12.54	0.1	1.254	
SS (shrub swamp)	2.62	0.25	0.655	
EM (emergent marsh)	102.5	0.5	51.25	
S (upland shrub)	6.5	0.25	1.625	
G (grassland)	92.555	1	92.555	
Totals	1303.64		276.5365	
Mean HSI (total HU/total acreage)		0.212126431		
11/21/97				

TABLE 14A–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	331.005	0.1	33.1005		
FCY (young conifer)	35.15	0.25	8.7875		
FD (mature deciduous)	128.32	0.1	12.832		
FDY (young deciduous)	60.265	0.25	15.06625		
FM (mixed forest)	379.05	0.1	37.905		
FO (forested swamp)	1.62	0.1	0.162		
SS (shrub swamp)	1.75	0.25	0.4375		
EM (emergent marsh)	12.22	0.5	6.11		
S (upland shrub)	5.71	0.25	1.4275		
G (grassland)	111.42	0.5	55.71		
Totals	1066.51		171.53825		
Mean HSI (total HU/total acreage)		0.160840733			
11/20/97					

TABLE 14B–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	555.68	0.1	55.568		
FCY (young conifer)	100	0.25	25		
FD (mature deciduous)	64.16	0.1	6.416		
FDY (young deciduous)	60.265	0.25	15.06625		
FM (mixed forest)	253.685	0.1	25.3685		
FO (forested swamp)	1.62	0.1	0.162		
SS (shrub swamp)	1.75	0.25	0.4375		
EM (emergent marsh)	12.22	0.5	6.11		
S (upland shrub)	5.71	0.25	1.4275		
G (grassland)	11.42	0.5	5.71		
Totals	1066.51		141.26575		
Mean HSI (total HU/total acreage)		0.132456095			
11/20/97					

TABLE 14C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	632.5225	0.1	63.25225		
FCY (young conifer)	200	0.25	50		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	60.265	0.25	15.06625		
FM (mixed forest)	141.0025	0.1	14.10025		
FO (forested swamp)	1.62	0.1	0.162		
SS (shrub swamp)	1.75	0.25	0.4375		
EM (emergent marsh)	12.22	0.5	6.11		
S (upland shrub)	5.71	0.25	1.4275		
G (grassland)	11.42	0.5	5.71		
Totals	1066.51		156.26575		
Mean HSI (total HU/total acreage)		0.146520661			
11/20/97					

TABLE 14D--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation				
Evaluation Species	Rocky Mountain Elk				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	573.525	0.1	57.3525		
FCY (young conifer)	400	0.25	100		
FD (mature deciduous)	0	0.1	0		
FDY (young deciduous)	60.265	0.25	15.06625		
FM (mixed forest)	0	0.1	0		
FO (forested swamp)	1.62	0.1	0.162		
SS (shrub swamp)	1.75	0.25	0.4375		
EM (emergent marsh)	12.22	0.5	6.11		
S (upland shrub)	5.71	0.25	1.4275		
G (grassland)	11.42	0.5	5.71		
Totals	1066.51		186.26575		
Mean HSI (total HU/total acreage)		0.174649792			
11/20/97					

TABLE 14E--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Rocky Mountain Elk		
Target Year	1		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	275.905	0.1	27.5905
FCM (mitigation site mature conifer)	76.5	0.1	7.65
FCY (young conifer)	35.15	0.25	8.7875
FDM (mitig. site mature deciduous)	35.55	0.1	3.555
FD (mature deciduous)	77.77	0.1	7.777
FDY (young deciduous)	0	0.25	0
FM1 (mitig. site mixed forest)	45.75	0.1	4.575
FM (mixed forest)	352.9	0.1	35.29
FMM (managed mature forest)	50	0.1	5
FO (forested swamp)	10.62	0.1	1.062
SS (shrub swamp)	1.75	0.25	0.4375
EM (emergent marsh)	99.22	0.5	49.61
S (upland shrub)	5.71	0.25	1.4275
G (grassland)	100.395	1	100.395
Totals	1167.22		253.157
Mean HSI (total HU/total acreage)		0.216888847	
11/21/97			

TABLE 14F–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Rocky Mountain Elk		
Target Year	10		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	487.505	0.1	48.7505
FCM (mitigation site mature conifer)	99.375	0.2	19.875
FCY (young conifer)	0	0.25	0
FDM (mitig. site mature deciduous)	17.775	0.2	3.555
FD (mature deciduous)	38.885	0.1	3.8885
FDY (young deciduous)	0	0.25	0
FM1 (mitig. site mixed forest)	40.65	0.2	8.13
FM (mixed forest)	215.335	0.1	21.5335
FMM (managed mature forest)	50	0.2	10
FO (forested swamp)	10.62	0.1	1.062
SS (shrub swamp)	1.75	0.25	0.4375
EM (emergent marsh)	99.22	0.5	49.61
S (upland shrub)	5.71	0.25	1.4275
G (grassland)	100.395	1	100.395
Totals	1167.22		268.6645
Mean HSI (total HU/total acreage)		0.230174689	
11/21/97			

TABLE 14G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Rocky Mountain Elk		
Target Year	25		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	595.1725	0.1	59.51725
FCM (mitigation site mature conifer)	119.7	0.25	29.925
FCY (young conifer)	0	0.25	0
FDM (mitig. site mature deciduous)	0	0.2	0
FD (mature deciduous)	0	0.1	0
FDY (young deciduous)	0	0.25	0
FM1 (mitig. site mixed forest)	38.1	0.2	7.62
FM (mixed forest)	146.5525	0.1	14.65525
FMM (managed mature forest)	50	0.25	12.5
FO (forested swamp)	10.62	0.1	1.062
SS (shrub swamp)	1.75	0.25	0.4375
EM (emergent marsh)	99.22	0.5	49.61
S (upland shrub)	5.71	0.25	1.4275
G (grassland)	100.395	1	100.395
Totals	1167.22		277.1495
Mean HSI (total HU/total acreage)		0.237444098	
11/21/97			

TABLE 14H--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Rocky Mountain Elk		
Target Year	50		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	668.4488	0.1	66.844875
FCM (mitigation site mature conifer)	138.75	0.25	34.6875
FCY (young conifer)	0	0.25	0
FDM (mitig. site mature deciduous)	0	0.2	0
FD (mature deciduous)	0	0.1	0
FDY (young deciduous)	0	0.25	0
FM1 (mitig. site mixed forest)	19.05	0.2	3.81
FM (mixed forest)	73.27625	0.1	7.327625
FMM (managed mature forest)	50	0.25	12.5
FO (forested swamp)	10.62	0.1	1.062
SS (shrub swamp)	1.75	0.25	0.4375
EM (emergent marsh)	99.22	0.5	49.61
S (upland shrub)	5.71	0.25	1.4275
G (grassland)	100.395	1	100.395
Totals	1167.22		278.102
Mean HSI (total HU/total acreage)		0.238260139	
11/21/97			

TABLE 15–Summary of Average Annual Habitat Units (AAHU's) of Impact, and Mitigated, for both Phase I and Phase II Projects							
	Without Project AAHU's	Phase I* Impact AAHU's	Phase I* Mitigation AAHU's (compared to without project condition)	Phase I* Mitigation AAHU's (compared to impacts) (with project condition)	Phase II** Impact AAHU's	Phase II** Mitigation AAHU's (compared to without project condition)	Phase II** Mitigation AAHU's (compared to impacts) (with project condition)
Elk	268.23	190.14	272.1	272.1	162.29	274.62	274.62
		-78.09	**3.87**	**81.96**	**-105.94**	**6.39**	**112.33**
Red-backed Vole	561.66	488.15	619.38	619.38	429.87	572.03	572.03
		-73.51	**57.72**	**131.23**	**-131.79**	**10.37**	**142.16**
Pileated Woodpecker	832.32	657.5	841.72	841.72	557.79	747	747
		-174.82	**9.4**	**184.22**	**-274.53**	**-85.32**	**189.21**
Wood Duck	6.61	3.3	12.48	12.48	0.87	10.58	10.58
		-3.31	**5.87**	**9.18**	**-5.74**	**3.97**	**9.71**

*The goal of mitigation is to compensate for the impacts. Since the impacts are based on the reduction from the without project condition, so too the benefits are compared to the without project condition. If the benefits are on the "plus" side, mitigation replaces 100% of the losses. For example, for the red-backed vole in Phase II, it appears the mitigation is far short of meeting the losses (131.23 AAHU's of losses, "only" 10.37 AAHU's in benefits). Note instead that the actual AAHU's for the with project condition are 429.87 (or 131.79 fewer than the without project condition), and the actual AAHU's with mitigation are 572.03 (or 10.37 greater than without project, AND 142.16 GREATER than with project–so that the actual mitigation BENEFIT is 142.16 AAHU's, which more than replaces the 131.79 AAHU's lost to the project).

**note that Phase II impacts are additive to Phase I impacts. For example, for elk, the actual impact of Phase II is 105.94 minus 78.09, or 27.85 AAHU's. Similarly, the total benefit to elk of Phase II mitigation is 6.39 minus 3.87, or 2.52 AAHU's.

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Table 16 - Form D: Net change in AAHU's

Study Name: HHD pool raise, Phase I
Action: PA 3 WITH project, with 50 acres of managed forest, and 79 acres of pasture
Compared to: PA 1 WITHOUT project
Period of analysis: 50

Evaluation Species		AAHU's	AAHU's	Net
ID#	Name	With Action	Without Action	Change
1	Rocky Mountain Elk	272.1	268.23	3.87
2	Red-Backed Vole	619.38	561.66	57.72
3	Pileated Woodpeaker	841.72	832.32	9.4
4	Wood Duck	12.48	6.61	5.87

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Table 17 - Form D: Net change in AAHU's

Study Name: HHD Phase II
Action: PA 3 WITH Project, with mitigation
Compared to: PA 1 WITHOUT Project
Period of analysis: 50

Evaluation Species		AAHU's	AAHU's	Net
ID#	Name	With Action	Without Action	Change
1	Rocky Mountain Elk	274.62	268.23	6.39
2	Red-Backed Vole	572.03	561.66	10.37
3	Pileated Woodpeaker	747	832.31	-85.31
4	Wood Duck	10.58	6.6	3.98

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TABLE 18A--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project, with or without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	0				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	401.275	0.63	252.80325		
FCY (young conifer)	49.56	0.01	0.4956		
FM (mixed forest)	505.67	0.18	91.0206		
Totals	956.505		344.31945		
Mean HSI (total HU/total acreage)		0.359976634			
12/16/96					

TABLE 18B--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	351.275	0.63	221.30325		
FCY (young conifer)	49.56	0.01	0.4956		
FM (mixed forest)	455.67	0.18	82.0206		
Totals	856.505		303.81945		
Mean HSI (total HU/total acreage)		0.354719996			
12/16/96					

TABLE 18C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	628.67	0.63	396.0621		
FCY (young conifer)	100	0.01	1		
FM (mixed forest)	408.79	0.18	73.5822		
Totals	1137.46		470.6443		
Mean HSI (total HU/total acreage)		0.413767781			
1/10/97					

TABLE 18D--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	783.065	0.7	548.1455		
FCY (young conifer)	200	0.01	2		
FM (mixed forest)	335.35	0.18	60.363		
Totals	1318.415		610.5085		
Mean HSI (total HU/total acreage)		0.463062465			
1/10/97					

TABLE 18E–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	Without Project, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	850.74	0.8	680.592		
FCY (young conifer)	400	0.01	4		
FM (mixed forest)	67.675	0.18	12.1815		
Totals	1318.415		696.7735		
Mean HSI (total HU/total acreage)		0.528493304			
1/10/97					

TABLE 18F--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	336.985	0.63	212.30055		
FCY (young conifer)	48.79	0.01	0.4879		
FM (mixed forest)	407.18	0.18	73.2924		
Totals	792.955		286.08085		
Mean HSI (total HU/total acreage)		0.360778165			
12/16/96					

TABLE 18G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	589.365	0.63	371.29995		
FCY (young conifer)	100	0.01	1		
FM (mixed forest)	310.575	0.18	55.9035		
Totals	999.94		428.20345		
Mean HSI (total HU/total acreage)		0.428229144			
1/10/97					

TABLE 18H--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	694.6525	0.7	486.25675		
FCY (young conifer)	200	0.01	2		
FM (mixed forest)	212.2725	0.18	38.20905		
Totals	1106.925		526.4658		
Mean HSI (total HU/total acreage)		0.475611085			
1/10/97					

TABLE 18I--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I					
Proposed Action	With Project, Without Mitigation, without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	700.7888	0.8	560.631		
FCY (young conifer)	400	0.01	4		
FM (mixed forest)	6.13625	0.18	1.104525		
Totals	1106.925		565.735525		
Mean HSI (total HU/total acreage)		0.511087495			
1/10/97					

TABLE 18J--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With 50 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	340.885	0.63	214.75755	
FCM (mitigation site mature conifer)	17.5	0.7	12.25	
FCY (young conifer)	48.79	0.01	0.4879	
FM1 (mitig. site mixed forest)	39.75	0.25	9.9375	
FM (mixed forest)	381.03	0.18	68.5854	
FMM (managed mature forest)	50	0.7	35	
Totals	877.955		341.01835	
Mean HSI (total HU/total acreage)		0.388423496		
10/29/97				

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TABLE 18K--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With 50 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	580.19	0.63	365.5197	
FCM (mitigation site mature conifer)	37.375	0.75	28.03125	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	37.65	0.4	15.06	
FM (mixed forest)	277.225	0.18	49.9005	
FMM (managed mature forest)	50	0.75	37.5	
Totals	982.44		496.01145	
Mean HSI (total HU/total acreage)		0.504877092		
10/29/97				

TABLE 18L--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With 50 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	718.8025	0.7	503.16175	
FCM (mitigation site mature conifer)	56.2	0.8	44.96	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	36.6	0.6	21.96	
FM (mixed forest)	225.3225	0.18	40.55805	
FMM (managed mature forest)	50	0.8	40	
Totals	1086.925		650.6398	
Mean HSI (total HU/total acreage)		0.598605976		
10/29/97				

TABLE 18M--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With 50 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	831.4638	0.8	665.171	
FCM (mitigation site mature conifer)	74.5	0.9	67.05	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	18.3	0.8	14.64	
FM (mixed forest)	112.6613	0.18	20.279025	
FMM (managed mature forest)	50	0.9	45	
Totals	1086.925		812.140025	
Mean HSI (total HU/total acreage)		0.747190492		
10/29/97				

TABLE 19A–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation, Without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	1				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	331.005	0.63	208.53315		
FCY (young conifer)	35.15	0.01	0.3515		
FM (mixed forest)	379.05	0.18	68.229		
Totals	745.205		277.11365		
Mean HSI (total HU/total acreage)		0.371862306			
12/16/96					

TABLE 19B–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation, Without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	10				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	555.68	0.63	350.0784		
FCY (young conifer)	100	0.01	1		
FM (mixed forest)	253.685	0.18	45.6633		
Totals	909.365		396.7417		
Mean HSI (total HU/total acreage)		0.43628433			
1/10/97					

TABLE 19C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation, Without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	25				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	632.5225	0.7	442.76575		
FCY (young conifer)	200	0.01	2		
FM (mixed forest)	141.0025	0.18	25.38045		
Totals	973.525		470.1462		
Mean HSI (total HU/total acreage)		0.48293182			
1/10/97					

TABLE 19D--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II					
Proposed Action	With Project, Without Mitigation, Without Forest Plan				
Evaluation Species	Red-backed Vole				
Target Year	50				
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**		
FC (mature conifer)	573.525	0.8	458.82		
FCY (young conifer)	400	0.01	4		
FM (mixed forest)	0	0.18	0		
Totals	973.525		462.82		
Mean HSI (total HU/total acreage)		0.475406384			
1/10/97					

TABLE 19E--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, With 100 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	275.905	0.63	173.82015	
FCM (mitigation site mature conifer)	76.5	0.7	53.55	
FCY (young conifer)	35.15	0.01	0.3515	
FM1 (mitig. site mixed forest)	45.75	0.25	11.4375	
FM (mixed forest)	352.9	0.18	63.522	
FMM (managed mature forest)	50	0.7	35	
Totals	836.205		337.68115	
Mean HSI (total HU/total acreage)		0.403825796		
11/20/97				

TABLE 19F--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, With 100 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	487.505	0.63	307.12815	
FCM (mitigation site mature conifer)	99.375	0.75	74.53125	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	40.65	0.4	16.26	
FM (mixed forest)	215.335	0.18	38.7603	
FMM (managed mature forest)	50	0.75	37.5	
Totals	892.865		474.1797	
Mean HSI (total HU/total acreage)		0.531076591		
11/21/97				

TABLE 19G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, With 100 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	595.1725	0.7	416.62075	
FCM (mitigation site mature conifer)	119.7	0.8	95.76	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	38.1	0.6	22.86	
FM (mixed forest)	146.5525	0.18	26.37945	
FMM (managed mature forest)	50	0.8	40	
Totals	949.525		601.6202	
Mean HSI (total HU/total acreage)		0.633601222		
11/21/97				

TABLE 19H--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, With 100 acres of Forest Plan Mitigation			
Evaluation Species	Red-backed Vole			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	668.4488	0.8	534.759	
FCM (mitigation site mature conifer)	138.75	0.9	124.875	
FCY (young conifer)	0	0.01	0	
FM1 (mitig. site mixed forest)	19.05	0.8	15.24	
FM (mixed forest)	73.27625	0.18	13.189725	
FMM (managed mature forest)	50	0.9	45	
Totals	949.525		733.063725	
Mean HSI (total HU/total acreage)		0.772032042		
11/21/97				

TABLE 20A--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	Without Project			
Evaluation Species	Pileated Woodpecker			
Target Year	0			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	401.275	0	0	
FD (mature deciduous)	361.91	0	0	
FM (mixed forest)	505.67	0.95	480.3865	
FO (forested swamp)	13.22	0.45	5.949	
Totals	1282.075		486.3355	
Mean HSI (total HU/total acreage)		0.379334672		
11/10/97				

TABLE 20B–FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	Without Project, Without Forest Plan			
Evaluation Species	Pileated Woodpecker			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	351.275	0	0	
FD (mature deciduous)	361.91	0	0	
FM (mixed forest)	455.67	0.95	432.8865	
FO (forested swamp)	13.22	0.45	5.949	
Totals	1182.075		438.8355	
Mean HSI (total HU/total acreage)		0.371241672		
11/10/97				

TABLE 20C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	Without Project, Without Forest Plan			
Evaluation Species	Pileated Woodpecker			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	628.67	0.1	62.867	
FD (mature deciduous)	180.955	0.1	18.0955	
FM (mixed forest)	408.79	0.95	388.3505	
FO (forested swamp)	13.22	0.45	5.949	
Totals	1231.635		475.262	
Mean HSI (total HU/total acreage)		0.385878933		
11/10/97				

TABLE 20D--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	Without Project, Without Forest Plan			
Evaluation Species	Pileated Woodpecker			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	783.065	0.95	743.91175	
FD (mature deciduous)	0	0.3	0	
FM (mixed forest)	335.35	1	335.35	
FO (forested swamp)	13.22	0.45	5.949	
Totals	1131.635		1085.21075	
Mean HSI (total HU/total acreage)		0.958975951		
11/10/97				

TABLE 20E--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	Without Project, Without Forest Plan			
Evaluation Species	Pileated Woodpecker			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	850.74	1	850.74	
FD (mature deciduous)	0	0.4	0	
FM (mixed forest)	67.675	1	67.675	
FO (forested swamp)	13.22	0.45	5.949	
Totals	931.635		924.364	
Mean HSI (total HU/total acreage)		0.992195441		
11/10/97				

TABLE 20F–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	336.985	0	0	
FD (mature deciduous)	213.97	0	0	
FM (mixed forest)	407.18	0.95	386.821	
FO (forested swamp)	6.54	0.45	2.943	
Totals	964.675		389.764	
Mean HSI (total HU/total acreage)		0.404036593		
11/10/97				

TABLE 20G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	589.365	0.1	58.9365	
FD (mature deciduous)	106.985	0.1	10.6985	
FM (mixed forest)	310.575	0.95	295.04625	
FO (forested swamp)	6.54	0.45	2.943	
Totals	1013.465		367.62425	
Mean HSI (total HU/total acreage)		0.362739956		
11/10/97				

TABLE 20H–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	694.6525	0.95	659.919875	
FD (mature deciduous)	0	0.3	0	
FM (mixed forest)	212.2725	1	212.2725	
FO (forested swamp)	6.54	0.45	2.943	
Totals	913.465		875.135375	
Mean HSI (total HU/total acreage)		0.958039306		
11/10/97				

TABLE 20I--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	700.7888	1	700.78875	
FD (mature deciduous)	0	0.4	0	
FM (mixed forest)	6.13625	1	6.13625	
FO (forested swamp)	6.54	0.45	2.943	
Totals	713.465		709.868	
Mean HSI (total HU/total acreage)		0.994958407		
11/10/97				

TABLE 20J--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	340.885	0	0	
FCM (mitigation site mature conifer)	17.5	0.3	5.25	
FDM (mitig. site mature deciduous)	35.55	0.3	10.665	
FD (mature deciduous)	173.42	0	0	
FM1 (mitig. site mixed forest)	39.75	0.95	37.7625	
FM (mixed forest)	381.03	0.95	361.9785	
FMM (managed mature forest)	50	0.3	15	
FO (forested swamp)	12.54	0.45	5.643	
Totals	1050.675		436.299	
Mean HSI (total HU/total acreage)		0.415255907		
10/29/97				

TABLE 20K--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	580.19	0.1	58.019	
FCM (mitigation site mature conifer)	37.375	0.5	18.6875	
FDM (mitig. site mature deciduous)	17.775	0.5	8.8875	
FD (mature deciduous)	86.71	0.1	8.671	
FM1 (mitig. site mixed forest)	37.65	0.95	35.7675	
FM (mixed forest)	277.225	0.95	263.36375	
FMM (managed mature forest)	50	0.5	25	
FO (forested swamp)	12.54	0.45	5.643	
Totals	1099.465		424.03925	
Mean HSI (total HU/total acreage)		0.385677807		
10/29/97				

TABLE 20L--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	718.8025	0.95	682.862375	
FCM (mitigation site mature conifer)	56.2	1	56.2	
FDM (mitig. site mature deciduous)	0	0.7	0	
FD (mature deciduous)	0	0.3	0	
FM1 (mitig. site mixed forest)	36.6	1	36.6	
FM (mixed forest)	225.3225	1	225.3225	
FMM (managed mature forest)	50	1	50	
FO (forested swamp)	12.54	0.45	5.643	
Totals	1099.465		1056.627875	
Mean HSI (total HU/total acreage)		0.961038209		
10/29/97				

TABLE 20M--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	831.4638	1	831.46375	
FCM (mitigation site mature conifer)	74.5	1	74.5	
FDM (mitig. site mature deciduous)	0	0.8	0	
FD (mature deciduous)	0	0.4	0	
FM1 (mitig. site mixed forest)	18.3	1	18.3	
FM (mixed forest)	112.6613	1	112.66125	
FMM (managed mature forest)	50	1	50	
FO (forested swamp)	12.54	0.45	5.643	
Totals	1099.465		1092.568	
Mean HSI (total HU/total acreage)		0.993726949		
10/29/97				

ABLE 21A--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	1			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	331.005	0	0	
FD (mature deciduous)	128.32	0	0	
FM (mixed forest)	379.05	0.95	360.0975	
FO (forested swamp)	1.62	0.45	0.729	
Totals	839.995		360.8265	
Mean HSI (total HU/total acreage)		0.429557914		
11/10/97				

ABLE 21B--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	10			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	555.68	0.1	55.568	
FD (mature deciduous)	64.16	0.1	6.416	
FM (mixed forest)	253.685	0.95	241.00075	
FO (forested swamp)	1.62	0.45	0.729	
Totals	875.145		303.71375	
Mean HSI (total HU/total acreage)		0.347043918		
11/10/97				

ABLE 21C--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	25			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	632.5225	0.95	600.896375	
FD (mature deciduous)	0	0.3	0	
FM (mixed forest)	141.0025	1	141.0025	
FO (forested swamp)	1.62	0.45	0.729	
Totals	775.145		742.627875	
Mean HSI (total HU/total acreage)		0.958050268		
11/10/97				

ABLE 21D--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Pileated Woodpecker			
Target Year	50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FC (mature conifer)	573.525	1	573.525	
FD (mature deciduous)	0	0.4	0	
FM (mixed forest)	0	1	0	
FO (forested swamp)	1.62	0.45	0.729	
Totals	575.145		574.254	
Mean HSI (total HU/total acreage)		0.998450825		
11/10/97				

TABLE 21E–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Pileated Woodpecker		
Target Year	1		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	275.905	0	0
FCM (mitigation site mature conifer)	76.5	0.3	22.95
FDM (mitig. site mature deciduous)	35.55	0.3	10.665
FD (mature deciduous)	77.77	0	0
FM1 (mitig. site mixed forest)	45.75	0.95	43.4625
FM (mixed forest)	352.9	0.95	335.255
FMM (managed mature forest)	50	0.3	15
FO (forested swamp)	10.62	0.45	4.779
Totals	924.995		432.1115
Mean HSI (total HU/total acreage)		0.467150093	
11/21/97			

TABLE 21F--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Pileated Woodpecker		
Target Year	10		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	487.505	0.1	48.7505
FCM (mitigation site mature conifer)	99.375	0.5	49.6875
FDM (mitig. site mature deciduous)	17.775	0.5	8.8875
FD (mature deciduous)	38.885	0.1	3.8885
FM1 (mitig. site mixed forest)	40.65	0.95	38.6175
FM (mixed forest)	215.335	0.95	204.56825
FMM (managed mature forest)	50	0.5	25
FO (forested swamp)	10.62	0.45	4.779
Totals	960.145		384.17875
Mean HSI (total HU/total acreage)		0.400125762	
11/21/97			

TABLE 21 G--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Pileated Woodpecker		
Target Year	25		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	595.1725	0.95	565.413875
FCM (mitigation site mature conifer)	119.7	1	119.7
FDM (mitig. site mature deciduous)	0	0.7	0
FD (mature deciduous)	0	0.3	0
FM1 (mitig. site mixed forest)	38.1	1	38.1
FM (mixed forest)	146.5525	1	146.5525
FMM (managed mature forest)	50	1	50
FO (forested swamp)	10.62	0.45	4.779
Totals	960.145		924.545375
Mean HSI (total HU/total acreage)		0.962922658	
11/21/97			

TABLE 21H–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II			
Proposed Action	With Project, With Mitigation		
Evaluation Species	Pileated Woodpecker		
Target Year	50		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FC (mature conifer)	668.4488	1	668.44875
FCM (mitigation site mature conifer)	138.75	1	138.75
FDM (mitig. site mature deciduous)	0	0.8	0
FD (mature deciduous)	0	0.4	0
FM1 (mitig. site mixed forest)	19.05	1	19.05
FM (mixed forest)	73.27625	1	73.27625
FMM (managed mature forest)	50	1	50
FO (forested swamp)	10.62	0.45	4.779
Totals	960.145		954.304
Mean HSI (total HU/total acreage)		0.993916544	
11/21/97			

TABLE 22A--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I			
Proposed Action	Without Project, Without Forest Plan		
Evaluation Species	Wood Duck		
Target Year	0--50		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FO (forested swamp)	13.22	0.5	6.61
Totals	13.22		6.61
Mean HSI (total HU/total acreage)		0.5	
12/18/96			

TABLE 22B--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I			
Proposed Action	With Project, Without Mitigation		
Evaluation Species	Wood Duck		
Target Year	1--50		
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**
FO (forested swamp)	6.54	0.5	3.27
Totals	6.54		3.27
Mean HSI (total HU/total acreage)		0.5	
12/18/96			

TABLE 22C–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE I				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Wood Duck			
Target Year	1--50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FO (forested swamp)	12.54	1	12.54	
Totals	12.54		12.54	
Mean HSI (total HU/total acreage)		1		
12/18/96				

TABLE 23A–FORM A–HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, Without Mitigation			
Evaluation Species	Wood Duck			
Target Year	1--50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FO (forested swamp)	1.62	0.5	0.81	
Totals	1.62		0.81	
Mean HSI (total HU/total acreage)		0.5		
12/18/96				

TABLE 23B--FORM A--HOWARD HANSON ADDITIONAL WATER STORAGE PROJECT, PHASE II				
Proposed Action	With Project, With Mitigation			
Evaluation Species	Wood Duck			
Target Year	1--50			
Cover Type	**Acreage**	**HSI of Cover Type**	**Habitat Units**	
FO (forested swamp)	10.62	1	10.62	
Totals	10.62		10.62	
Mean HSI (total HU/total acreage)		1		
12/18/96				

ANNEX II. INCREMENTAL ANALYSIS

Incremental analysis is an economics-based tool intended to assist with the selection of the most cost-effective measures from an array of proposed measures. For wildlife mitigation of the HHD AWS Project, the mitigation measures were divided into three groupings: Rocky Mountain Elk measures; measures for red-backed vole; and wood duck measures. For each of these, the inputs are dollars and the outputs are Average Annual Habitat Units (AAHU's) (see Section 4, Habitat Evaluation Procedures (HEP), for a definition of AAHU's and their derivation as used in this analysis). Inputs were determined by detailed cost analyses (see Annex 3, Cost Analysis, and Annex VIII, Cost Analysis Tables).

Only those sites at which measures were appropriate for a particular species were included under the separate groupings. For example, only sites 17, 22, 24, and 26 were included under wood duck, as these are the only sites at which forested swamps would be created or enhanced. The analysis compares the costs and outputs of each site against the costs and outputs of other sites, then combines the sites in every possible way to display all possible combinations of costs and outputs. In this way, the most cost effective combination of sites can be selected. Ideally, the final column of the "Final Incremental Analysis" table (the "Incremental Average Cost" column) will show an obvious increase from one set of site combinations to the next set; this is called a "break point". In the case of the wood duck, an obvious break point is after the second set, where the incremental average cost more than doubles, while the incremental output, though increasing substantially, does not increase enough to justify the incremental cost. Thus, sites 17 and 26 (A1 and D1 on the table) are selected for Phase I mitigation. It should be noted that the combination of these sites also produces outputs that meet the mitigation targets, so there is no need to search further for combinations of sites.

The break point for elk is not so obvious, and a combination was chosen that is not shown on the table. This is the combination that is third from the bottom, which includes sites 1, 2, 4, 5, 6, 7, 8, 14, 22, 23, 24, and 25. However, it was determined through HEP that site 4, though it would be productive, has a few inherent topographic features that make it less desirable than the other sites; mitigation targets for Phase I are still met even after deleting this site from consideration. Also, this set of sites was selected, even though site 4 was included, because it also contained sites 5 and 6, two sites considered more valuable for mitigation goals than site 4. Thus, the final set of sites selected meets HEP mitigation targets and is incrementally cost effective.

The red-backed vole analysis is straightforward: the set of sites third from the bottom shows a larger increase in incremental average cost to the next level, than any of the previous sets of sites. Plus, the outputs gained are somewhat less than in previous levels. Not only that, but all sites selected in this set combine to meet HEP mitigation targets.

There is no need to recombine sites. The final list of sites selected are: 9, 19, 12, 13, 15, 17, 18, 19, 20, and forest plan (see Section 4, HEP Analysis, for discussion of forest plan).

Needed For Mit.

ELK MITIGATION
Combinations for Final Incremental Analysis

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M0 N0	0.00	0.00	0.00	0.00	0.00
Z1 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M0 N0	0.00	0.00	0.00	0.00	0.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M1 N0	8.00	4.50	8.00	4.50	1.78
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L1 M1 N0	18.00	9.50	10.00	5.00	2.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M1 N0	23.50	12.00	5.50	2.50	2.20
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K1 L1 M1 N0	32.50	16.00	9.00	4.00	2.25
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	48.50	22.70	16.00	6.70	2.39
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	54.50	25.20	6.00	2.50	2.40
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	73.50	32.20	~~19.00~~	~~7.00~~	2.71
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	98.40	41.20	24.90	9.00	2.77
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	162.40	63.70	64.00	22.50	2.84
Z0 A1 B1 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	180.40	69.90	18.00	6.20	2.90 stop
Z0 A1 B1 C0 D1 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	205.40	78.00	25.00	8.10	3.09
Z0 A1 B1 C0 ~~D1~~ E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	223.40	83.80	18.00	5.80	3.10
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	248.40	91.30	25.00	7.50	3.33
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J1 K1 L1 M1 N1	254.40	91.80	6.00	0.50	12.00

19 = 204.40 — 7 = 76.8

site → 1 2 3 4 5 6 7 8 14 17 22 23 24 25

get back in at next increment

DO this set, but without 4 (D)

Out

6 back in with selected increment

* * * End of Report * * *

No major break Points — stop full mit.

GBH.u - Needed

ELK MITIGATION

Cost-Effective Least-Cost with Incremental Analysis

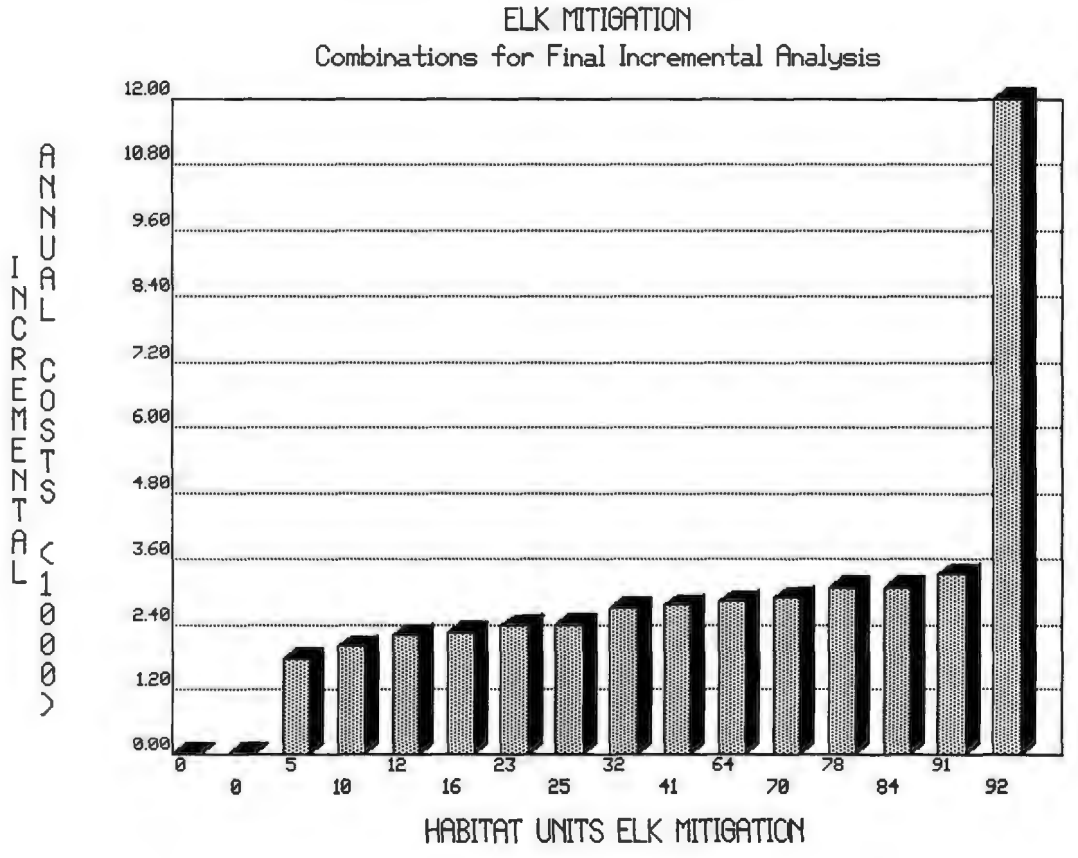
Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M0 N0	0.00	0.00	0.00	0.00	0.00
Z1 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M0 N0	0.00	0.00	0.00	0.00	0.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L0 M0 N0	5.50	2.50	5.50	2.50	2.20
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L0 M1 N0	8.00	4.50	2.50	2.00	1.25
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L1 M0 N0	10.00	5.00	2.00	0.50	4.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L0 M1 N0	13.50	7.00	3.50	2.00	1.75
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M0 N0	15.50	7.50	2.00	0.50	4.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K0 L0 M1 N0	17.00	8.50	1.50	1.00	1.50
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0 L1 M1 N0	18.00	9.50	1.00	1.00	1.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M0 N1	21.50	10.00	3.50	0.50	7.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K1 L0 M1 N0	22.50	11.00	1.00	1.00	1.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M1 N0	23.50	12.00	1.00	1.00	1.00
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K0 L1 M1 N0	27.00	13.50	3.50	1.50	2.33
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M1 N1	29.50	14.50	2.50	1.00	2.50
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K1 L1 M1 N0	32.50	16.00	3.00	1.50	2.00
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I0 J0 K0 L1 M1 N0	34.00	16.20	1.50	0.20	7.50
Z0 A0 B0 C0 D1 E0 F0 G0 H0 I0 J0 K0 L1 M1 N0	37.00	16.50	3.00	0.30	10.00
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I0 J0 K1 L1 M0 N1	37.50	16.70	0.50	0.20	2.50
Z0 A0 B0 C0 D0 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	38.50	18.50	1.00	1.80	0.56
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I0 J0 K1 L1 M1 N0	39.50	18.70	1.00	0.20	5.00
Z0 A0 B0 C0 D1 E0 F0 G0 H0 I0 J0 K1 L1 M1 N0	42.50	19.00	3.00	0.30	10.00
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	43.00	20.20	0.50	1.20	0.42
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I0 J0 K1 L1 M1 N1	45.50	21.20	2.50	1.00	2.50
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	48.50	22.70	3.00	1.50	2.00
Z0 A0 B0 C0 D1 E0 F0 G0 H0 I1 J0 K1 L1 M1 N0	51.50	23.00	3.00	0.30	10.00
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I0 J0 K0 L1 M1 N0	53.00	23.20	1.50	0.20	7.50
Z0 A1 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1 L1 M1 N1	54.40	23.50	1.40	0.30	4.67
Z0 A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	54.50	25.20	0.10	1.70	0.06
Z0 A0 B0 C0 D1 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	57.50	25.50	3.00	0.30	10.00
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N0	58.50	25.70	1.00	0.20	5.00
Z0 A0 B0 C0 D0 E0 F0 G1 H1 I1 J0 K0 L1 M1 N0	61.00	26.40	2.50	0.70	3.57
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	62.00	27.20	1.00	0.80	1.25
Z0 A1 B0 C0 D0 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	63.40	27.50	1.40	0.30	4.67
Z0 A1 B0 C0 D0 E0 F0 G0 H1 I0 J0 K1 L1 M1 N0	64.40	27.70	1.00	0.20	5.00
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N1	64.50	28.20	0.10	0.50	0.20
Z0 A0 B0 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	66.50	28.90	2.00	0.70	2.86
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	67.50	29.70	1.00	0.80	1.25
Z0 - B0 C0 D0 E0 F0 G0 H1 I0 J0 K1 L1 M1 N1	70	30.20	2.90	0.50	5

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
Z0 A0 B0 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	72.50	31.40	2.10	1.20	1.75
Z0 A1 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	73.40	31.70	0.90	0.30	3.00
Z0 A0 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	73.50	32.20	0.10	0.50	0.20
Z0 A1 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	79.40	34.20	5.90	2.00	2.95
Z0 A1 B0 C0 D1 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	82.40	34.50	3.00	0.30	10.00
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N0	83.40	34.70	1.00	0.20	5.00
Z0 A0 B0 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	85.50	35.90	2.10	1.20	1.75
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	86.90	36.20	1.40	0.30	4.67
Z0 A1 B0 C0 D0 E0 F0 G1 H1 I0 J0 K1 L1 M1 N1	88.40	36.40	1.50	0.20	7.50
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N1	89.40	37.20	1.00	0.80	1.25
Z0 A1 B0 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	91.40	37.90	2.00	0.70	2.86
Z0 A0 B0 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	91.50	38.40	0.10	0.50	0.20
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	92.40	38.70	0.90	0.30	3.00
Z0 A1 B0 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	97.40	40.40	5.00	1.70	2.94
Z0 A1 B0 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	98.40	41.20	1.00	0.80	1.25
Z0 A0 B0 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	103.50	41.70	5.10	0.50	10.20
Z0 A1 B0 C0 D0 E1 F0 G0 H1 I1 J0 K1 L1 M1 N1	104.40	42.30	0.90	0.60	1.50
Z0 A1 B0 C0 D1 E0 F0 G1 H1 I1 J0 K0 L1 M1 N0	104.90	42.40	0.50	0.10	5.00
Z0 A0 B1 C0 D0 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	107.00	42.70	2.10	0.30	7.00
Z0 A1 B0 C0 D1 E0 F0 G1 H1 I0 J0 K1 L1 M1 N1	107.40	43.40	0.40	0.70	0.57
Z0 A1 B0 C0 D0 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	109.40	43.70	2.00	0.30	6.67
Z0 A0 B0 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	109.50	44.20	0.10	0.50	0.20
Z0 A1 B0 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	110.40	44.90	0.90	0.70	1.29
Z0 A0 B1 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	112.50	45.20	2.10	0.30	7.00
Z0 A1 B0 C0 D1 E1 F0 G0 H1 I0 J0 K1 L1 M1 N1	114.40	45.30	1.90	0.10	19.00
Z0 A1 B0 C0 D0 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	115.40	46.20	1.00	0.90	1.11
Z0 A1 B0 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	116.40	47.40	1.00	1.20	0.83
Z0 A0 B1 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	118.50	47.70	2.10	0.30	7.00
Z0 A0 B1 C0 D1 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	121.50	48.00	3.00	0.30	10.00
Z0 A1 B0 C0 D0 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	122.40	48.50	0.90	0.50	1.80
Z0 A1 B0 C0 D1 E1 F0 G0 H1 I1 J0 K1 L1 M1 N1	123.40	49.30	1.00	0.80	1.25
Z0 A0 B1 C0 D1 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	126.00	49.70	2.60	0.40	6.50
Z0 A1 B1 C0 D0 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	127.40	50.00	1.40	0.30	4.67
Z0 A1 B0 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	128.40	50.70	1.00	0.70	1.43
Z0 A0 B1 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	130.50	51.40	2.10	0.70	3.00
Z0 A0 B1 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	131.50	52.20	1.00	0.80	1.25
Z0 A1 B0 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	134.40	53.20	2.90	1.00	2.90
Z0 A0 B1 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	136.50	53.90	2.10	0.70	3.00
Z0 A1 B1 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	137.40	54.20	0.90	0.30	3.00
Z0 A0 B1 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	137.50	54.70	0.10	0.50	0.20
Z0 A1 B0 C0 D1 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	141.40	55.50	3.90	0.80	4.88

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
Z0 A1 B1 C0 D0 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	143.40	56.70	2.00	1.20	1.67
Z0 A1 B1 C0 D1 E0 F0 G0 H0 I1 J0 K1 L1 M1 N1	146.40	57.00	3.00	0.30	10.00
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N0	147.40	57.20	1.00	0.20	5.00
Z0 A0 B1 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	149.50	58.40	2.10	1.20	1.75
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I1 J0 K0 L1 M1 N0	150.90	58.70	1.40	0.30	4.67
Z0 A1 B1 C0 D0 E0 F0 G1 H1 I0 J0 K1 L1 M1 N1	152.40	58.90	1.50	0.20	7.50
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I0 J0 K1 L1 M1 N1	153.40	59.70	1.00	0.80	1.25
Z0 A1 B1 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	155.40	60.40	2.00	0.70	2.86
Z0 A0 B1 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	155.50	60.90	0.10	0.50	0.20
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N0	156.40	61.20	0.90	0.30	3.00
Z0 A1 B0 C0 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	159.40	61.30	3.00	0.10	30.00
Z0 A1 B1 C0 D0 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	161.40	62.90	2.00	1.60	1.25
Z0 A1 B1 C0 D1 E0 F0 G0 H1 I1 J0 K1 L1 M1 N1	162.40	63.70	1.00	0.80	1.25
Z0 A0 B1 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	167.50	64.20	5.10	0.50	10.20
Z0 A1 B1 C0 D0 E1 F0 G0 H1 I1 J0 K1 L1 M1 N1	168.40	64.80	0.90	0.60	1.50
Z0 A1 B1 C0 D1 E0 F0 G1 H1 I1 J0 K0 L1 M1 N0	168.90	64.90	0.50	0.10	5.00
Z0 A1 B1 C0 D1 E0 F0 G1 H1 I0 J0 K1 L1 M1 N1	171.40	65.90	2.50	1.00	2.50
Z0 A1 B1 C0 D0 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	173.40	66.20	2.00	0.30	6.67
Z0 A0 B1 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	173.50	66.70	0.10	0.50	0.20
Z0 A1 B1 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N0	174.40	67.40	0.90	0.70	1.29
Z0 A1 B1 C0 D1 E1 F0 G0 H1 I0 J0 K1 L1 M1 N1	178.40	67.80	4.00	0.40	10.00
Z0 A1 B1 C0 D0 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	179.40	68.70	1.00	0.90	1.11
Z0 A1 B1 C0 D1 E0 F0 G1 H1 I1 J0 K1 L1 M1 N1	180.40	69.90	1.00	1.20	0.83
Z0 A1 B1 C0 D0 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	186.40	71.00	6.00	1.10	5.45
Z0 A1 B1 C0 D1 E1 F0 G0 H1 I1 J0 K1 L1 M1 N1	187.40	71.80	1.00	0.80	1.25
Z0 A1 B1 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N0	192.40	73.20	5.00	1.40	3.57
Z0 A1 B1 C0 D1 E1 F0 G1 H1 I0 J0 K1 L1 M1 N1	196.40	74.00	4.00	0.80	5.00
Z0 A1 B1 C0 D1 E0 F1 G1 H1 I1 J0 K1 L1 M1 N1	198.40	75.70	2.00	1.70	1.18
Z0 A1 B1 C0 D0 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	204.40	76.80	6.00	1.10	5.45
Z0 A1 B1 C0 D1 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	205.40	78.00	1.00	1.20	0.83
Z0 A1 B1 C1 D0 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	211.40	78.50	6.00	0.50	12.00
Z0 A1 B1 C0 D1 E1 F0 G1 H1 I1 J1 K1 L1 M1 N1	211.40	78.50	0.00	0.00	0.00
Z0 A1 B1 C0 D1 E1 F1 G1 H1 I1 J0 K0 L1 M1 N0	211.90	78.80	0.50	0.30	1.67
Z0 A1 B1 C1 D1 E1 F0 G0 H1 I1 J0 K1 L1 M1 N1	212.40	79.30	0.50	0.50	1.00
Z0 A1 B1 C0 D1 E1 F1 G1 H1 I0 J0 K1 L1 M1 N1	214.40	79.80	2.00	0.50	4.00
Z0 A1 B1 C0 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N0	217.40	81.30	3.00	1.50	2.00
Z0 A1 B1 C1 D1 E1 F0 G1 H1 I0 J0 K1 L1 M1 N1	221.40	81.50	4.00	0.20	20.00
Z0 A1 B1 C0 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	223.40	83.80	2.00	2.30	0.87
Z0 A1 B1 C1 D0 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	229.40	84.30	6.00	0.50	12.00
Z0 A1 B1 C0 D1 E1 F1 G1 H1 I1 J1 K1 L1 M1 N1	229.40	84.30	0.00	0.00	0.00
Z0 A1 B1 C1 D1 E1 F0 G1 H1 I1 J0 K1 L1 M1 N1	230.40	85.50	1.00	1.20	0

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
Z0 A1 B1 C1 D1 E1 F0 G1 H1 I1 J1 K1 L1 M1 N1	236.40	86.00	6.00	0.50	12.00
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J0 K0 L1 M1 N0	236.90	86.30	0.50	0.30	1.67
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I0 J0 K1 L1 M1 N1	239.40	87.30	2.50	1.00	2.50
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N0	242.40	88.80	3.00	1.50	2.00
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J0 K1 L1 M1 N1	248.40	91.30	6.00	2.50	2.40
Z0 A1 B1 C1 D1 E1 F1 G1 H1 I1 J1 K1 L1 M1 N1	254.40	91.80	6.00	0.50	12.00

* * * End of Report * * *


ELK MITIGATION
Combinations for Final Incremental Analysis
INCREMENTAL ANNUAL COSTS (1000)
12.00
10.80
9.60
8.40
7.20
6.00
4.80
3.60
2.40
1.20
0.00
0 5 10 12 16 23 32 64 78 91
0 10 16 25 41 70 84 92
HABITAT UNITS ELK MITIGATION

Shift 6 H.U.

HHD WOOD DUCK MITIGATION
Combinations for Final Incremental Analysis

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
A0 B0 C0 D0	0.00	0.00	0.00	0.00	0.00
A1 B0 C0 D0	1200.00	1.00	1200.00	1.00	1200.00
A1 B0 C0 D1	12500.00	6.00	11300.00	5.00	2260.00 SI
A1 B0 C1 D1	40400.00	12.00	27900.00	6.00	4650.00
A1 B1 C1 D1	58400.00	15.00	18000.00	3.00	6000.00

17 22 24 26
X X

Keep 17 + 26

* * * End of Report * * *

Major break point @ 6 H.U. Stop here unless Extz is fully justified.

18 Needed

HHD WOOD DUCK MITIGATION
Cost-Effective Least-Cost Combinations

	Management Measures	Cost	Output
1	A0 B0 C0 D0	0.00	0.00
2	A1 B0 C0 D0	1200.00	1.00
3	A0 B0 C0 D1	11300.00	5.00
4	A1 B0 C0 D1	12500.00	6.00
5	A1 B0 C1 D0	29100.00	7.00
6	A0 B1 C0 D1	29300.00	8.00
7	A1 B1 C0 D1	30500.00	9.00
8	A0 B0 C1 D1	39200.00	11.00
9	A1 B0 C1 D1	40400.00	12.00
10	A0 B1 C1 D1	57200.00	14.00
11	A1 B1 C1 D1	58400.00	15.00

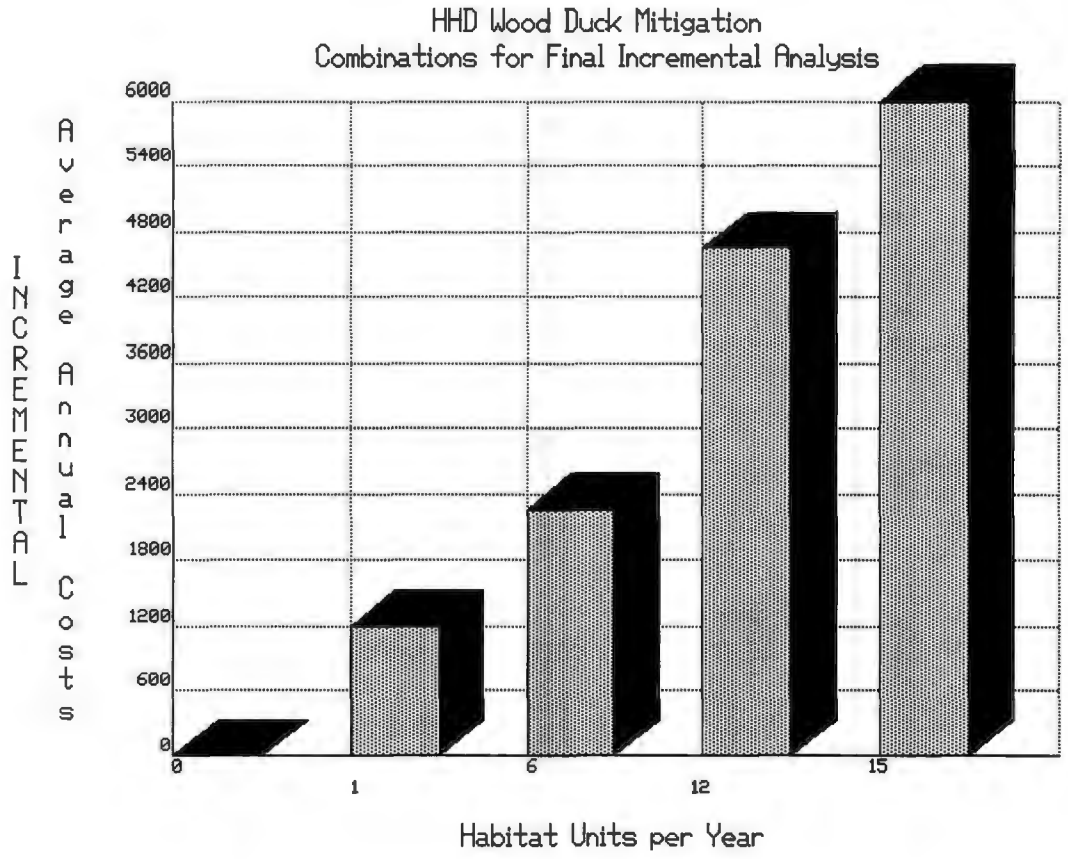
Site → 17 22 24 26

* * * End of Report * * *

HHD WOOD DUCK MITIGATION
Cost-Effective Least-Cost with Incremental Analysis

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost
A0 B0 C0 D0	0.00	0.00	0.00	0.00	0.00
A1 B0 C0 D0	1200.00	1.00	1200.00	1.00	1200.00
A0 B0 C0 D1	11300.00	5.00	10100.00	4.00	2525.00
A1 B0 C0 D1	12500.00	6.00	1200.00	1.00	1200.00
A1 B0 C1 D0	29100.00	7.00	16600.00	1.00	16600.00
A0 B1 C0 D1	29300.00	8.00	200.00	1.00	200.00
A1 B1 C0 D1	30500.00	9.00	1200.00	1.00	1200.00
A0 B0 C1 D1	39200.00	11.00	8700.00	2.00	4350.00
A1 B0 C1 D1	40400.00	12.00	1200.00	1.00	1200.00
A0 B1 C1 D1	57200.00	14.00	16800.00	2.00	8400.00
A1 B1 C1 D1	58400.00	15.00	1200.00	1.00	1200.00

* * * End of Report * * *


HHD Wood Duck Mitigation
Combinations for Final Incremental Analysis
INCREMENTAL Average Annual Costs
6000
5400
4800
4200
3600
3000
2400
1800
1200
600
0
0
1
6
12
15
Habitat Units per Year

RED BACKED VOLE

[redacted] MITITGATION - HHD

Combinations for Final Incremental Analysis

Management Measures	Cost	Output	Incremental Cost	Incremental Output	Incremental Average Cost	
A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K0	0.00	0.00	0.00	0.00	0.00	
A0 B0 C0 D0 E0 F0 G0 H0 I0 J0 K1	33000.00	90.00	33000.00	90.00	366.67	
A0 B0 C0 D0 E0 F0 G0 H1 I0 J0 K1	39800.00	97.00	6800.00	7.00	971.43	
A0 B0 C0 D0 E0 F0 G0 H1 I1 J0 K1	55600.00	111.90	15800.00	14.90	1060.40	
A0 B0 C0 D0 E0 F0 G0 H1 I0 J1 K1	55600.00	111.90	0.00	0.00	0.00	
A0 B0 C0 D0 E0 F0 G0 H1 I1 J1 K1	71400.00	126.80	15800.00	14.90	1060.40	
A0 B0 C0 D0 E0 F0 G1 H1 I1 J1 K1	85000.00	138.50	13600.00	11.70	1162.39	
A0 B0 C0 D1 E0 F0 G1 H1 I1 J1 K1	96600.00	148.30	11600.00	9.80	1183.67	
A0 B0 C0 D1 E1 F0 G1 H1 I1 J1 K1	107000.00	156.50	10400.00	8.20	1268.29	
A1 B0 C0 D1 E1 F0 G1 H1 I1 J1 K1	117600.00	164.70	10600.00	8.20	1292.68	
A1 B1 C0 D1 E1 F0 G1 H1 I1 J1 K1	128900.00	172.90	11300.00	8.20	1378.05	Keep Stop here?
A1 B1 C1 D1 E1 F0 G1 H1 I1 J1 K1	135900.00	177.00	7000.00	4.10	1707.32	
A1 B1 C1 D1 E1 F1 G1 H1 I1 J1 K1	150600.00	181.90	14700.00	4.90	3000.00	

site → 9 10 11 12 13 14 15 17 18 19 + 20 FP

* * * End of Report * * *

All sites except 11 + 14

This is acceptable!

ANNEX III. COST ANALYSIS

IV. Cost Analysis.

The mitigation plan consists of 26 designated mitigation sites, plus approximately 300 acres of forest lands on which various management treatments will be applied. Mitigation measures include pasture creation, mature forest management, and wetland creation. Each of these measures requires an assortment of treatments to accomplish the intended effect. Also, each measure requires continued operation and maintenance actions over the life of the project. The costs are shown on the accompanying tables, in sequential order starting with Site 1.

The total cost of implementing all wildlife mitigation measures would be _____.

However, not all sites would be implemented for Phase I, as the Habitat Evaluation Procedures (HEP) and incremental analyses combine to sort through the measures to find the most cost effective measures that fully satisfy mitigation goals. After the initial processing of these procedures, the cost of Phase I mitigation would be _____. Additional refinements will continue to be made throughout the remainder of this feasibility study phase.

Phase II mitigation costs, as projected at this time, would be _____.

ANNEX IV. OPERATIONS, MAINTENANCE AND EVALUATION

IV.

OPERATION AND MAINTENANCE AND EVALUATION PLAN.

A distinction between scientific evaluation and operation and maintenance (O&M) is made: the purpose of evaluation is to assure that plants and other measures of a restoration program are actually functioning for the intended purpose (e.g., to provide habitat for fish and wildlife). This is usually accomplished through scientific study at selected intervals (but usually not annually). The primary purpose of O&M, on the other hand, is to maintain plants, structures and other elements so that they continue to perform their intended functions. Thus, it may be that evaluation will disclose that the plants are not surviving; O&M will then provide the funding for replacement plants. On the other hand, routine O&M inspections can also disclose the need for maintenance of certain measures, such as woody debris structures.

A. Operation and Maintenance. The elk grazing pastures will require relatively intensive O&M: annual disking and seeding, and application of fertilizer and lime. These efforts will require the operation of a tractor and trailered equipment, such as a disc, and a seed drill. A mower may be necessary on occasion, though it is hoped that elk and other wildlife will keep the grass short. Nest boxes on forested sites will need to be checked and cleaned annually, and replaced if necessary. Berms and water control structures will need to be checked on a regular basis, probably at least monthly. Repairs will be made as necessary.

The soundness and in-situ stability of the large woody debris structures will be determined through direct observation of cables, anchors, and fasteners on the debris pieces. Assess whether the structures are still functioning as designed for fish passage, bank stability, and cover. If 10% or more of the structures have been damaged or displaced, repair and replace structures sufficient to bring the total to 100% functioning structures.

Scheduled visits: Surveys would be conducted annually soon after the last flood of the winter, and after the reservoir has been drawn down prior to refill in the spring. This is usually the month of March or early April.

Funding shall be provided to allow replacement of plants and woody debris to structures in the event of damage or destruction of plants or structures. The economic analysis requires replacement of 20% of woody debris structures every 10 years, not to exceed 100% replacement at the end of 50 years.

B. Monitoring. The elk pastures, wetlands, and in-reservoir restoration measures will be evaluated to assure successful establishment of plants and use of sites by wildlife. Monitoring of the growth of trees, shrubs, and sedges would occur in years 1, 2, 5, and 10 following planting. Monitoring differs from O&M, which will occur annually for the life of the project (50 years). Following is a schedule of evaluation actions.

1). Elk Pastures. Evaluation of pastures will be modeled after the elk exclusion cage analysis described in Section VI. The evaluation will include assessment of plant growth and density; plant nutritional content; elk pellet analysis; and assessment of pasture management, including rate of type of fertilizer application, and frequency of tilling and seeding. Monitoring results will be evaluated to determine whether pasture management is adequate (i.e., elk are using pastures according to expectations), or whether changes in pasture management might be necessary to improve elk usage of meadows.

2) Wetlands. Nest boxes would be checked in spring to determine usage by wildlife, including waterfowl, flying squirrels, and woodpeckers. If nesting is occurring, nests will be monitored to determine whether eggs hatch, and young are successfully raised. Wetlands will be monitored to determine whether water levels are stable, and to determine whether aquatic and semi-aquatic plants are surviving according to expectations.

3) Sedge Meadows. Determine survival of plants by walking through *Carex aperta* mats and willow mass plantings, and individually inspecting bald cypress and Oregon ash trees. Survival of sedges will be determined through the use of fifty .25 -m^2 quadrats, randomly placed on the mats. If survival is less than 80%, replace plants sufficient to bring total to 100% living plants. Survival of trees and willows will be determined through direct observation of plants. If lack of vigor or other signs of poor plant health are observed, these will be noted and recorded for future reference.

Scheduled visits: Surveys would be conducted the first or second week of April (no later than the third week) each monitoring year. This should follow the last floods of the winter, and thus provide a direct assessment of flood effects on the plants. The timing should also allow for initial plant growth in the spring, giving an indication of whether or not the plants are alive, and allowing an assessment of percent survival. Plus, the survey must be conducted before the last week of April because the reservoir will cover the plants after this time. This will also allow time to order or grow additional plants so that they can be planted when the reservoir is lowered in late summer.

Replacement planting will be done in late summer or early fall of each monitoring year (if planting is necessary) to allow plants to grow roots and to become acclimated to conditions prior to the growing season in spring.

ANNEX V. ELK EXCLUSION CAGE STUDY

This study was initiated in February, 1996, and will continue through 1997. The purpose of the study is to determine the level of use of the two existing pastures (MacDonald field and Baldi field) by elk. Ten cages were constructed in December, 1995 by staff from the Tacoma Water Division, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. The cages were placed on the meadows in February, 1996. Five cages were placed on each pasture. Placement was made randomly, but with some thought so as to avoid having cages close to one another. Placement was also made to cover a broad range of plants (important at MacDonald; not important at Baldi). At MacDonald field, two cages were place in sedge meadows below 1141 feet elevation (existing high reservoir); a third cage was also placed below 1141 feet, but the vegetation is mostly grasses and herbaceous plants other than sedges. The other two cages were placed above 1141 feet, which can be characterized as relatively uniform in vegetation composition (mostly "standard" pasture grasses and herbs). At each cage location, a "permanent" control site was also established. During each site visit (which occurs on or about the 15th of every month throughout the year), grass is clipped from under the cages, and placed in a bag marked with the cage number, pasture name, and date. The control sites are similarly sampled. To assure that the same size area is clipped, a copper tube ring of about 41-inch-diameter (this diameter results in an area that is 1 square meter, making data calculations simple) is placed over each area to be clipped.

The data gathered from the study will disclose the nutritional content of the sampled vegetation, as well as provide a rough index of the relative abundance of various species of herbaceous plants growing on the pastures. Some data has been analyzed by the laboratory (Wildlife Habitat Laboratory, Washington State University). To date, the most interesting information is that the ash content in plants at MacDonald field is three times higher than it is at Baldi field. Although the reason for this is not known, it is suspected that the regular flooding of MacDonald field is the main contributor to the high ash content. The implication of high ash content is that the elk may not be receiving the nutrition they need from the plants, as the ash inhibits the elk digestive system in processing of plant nutrition. This may have further implications in the calving ratios, and may even affect calf survival.

In addition to the elk exclusion cage sampling, elk pellets are also collected for analysis. This analysis will disclose the relative abundance of plants that elk choose to eat, which, when compared to the relative abundance of plants growing on the meadow, could show that some plants are preferred by elk and others are avoided by elk. This would aid in the selection of plants for the creation of new pastures when mitigating for the additional water storage project.

January 29, 1996

MEMORANDUM FOR: Record

SUBJECT: Placement of Elk Exclusion Cages at Howard Hanson Dam

1. On December 15, 1995, a team of agency employees met at Howard Hanson Dam to install elk exclusion cages on MacDonald and Baldi Meadows. Participants included:

Paul Hickey	Tacoma Water Division
Lee Berry	Watershed Inspector
Jonathan Crawford	Volunteer
Richard Fleming	Raedeke Associates
Dustin Gourlie	Raedeke Associates
Gwill Ging	U.S. Fish and Wildlife Service
Craig Trinkle	Corps of Engineers

2. The purpose of the cages is to determine the level of use of the meadows by elk. This is accomplished by measuring the amount of plant growth under the cages on a periodic basis. This is compared to an equal area of un-caged meadow; the difference in plant growth between the two areas (caged and un-caged) shows the level of use by grazing animals since the last measurement. Since no cattle or other primary grazers are present at Howard Hanson Dam, we assume elk represent 100% of the grazing activity represented. In addition, we will be sending the collected plant materials to a lab at Washington State University for analysis of nutritional content. This will tell us what the meadow plants are lacking in nutrients and will indicate what we should do to improve the meadows for elk.

In addition to placement of cages, we also collected two pellet groups from the vicinity of each cage for analysis of plant species content. The intent is to determine not only which species the elk are grazing, but to then compare that with the species composition of the meadows to determine whether some species are being selected out of proportion to their abundance. This will help us decide which species to plant in new meadows created for mitigation.

3. We placed a total of ten cages (five on each meadow). The attached maps indicate their locations: enclosure 1 is an overall map of the reservoir, showing the relative locations of the meadows; enclosure 2 is an expanded view of MacDonald Meadow; enclosure 3 is an expanded view of Baldi Meadow. The cages were numbered, and their locations described. A protocol for finding the same control sites on future visits was also established, as follows (compass points and distances were selected at random using a random number table):

MacDonald Meadow

Cage 1--in sedge/grass community at low elevation (approximately 1135'). Control site--232 degrees and 30.4 feet from SW stake of cage.

Cage 2--in sedge community, slightly lower elevation than cage 1 (about 1133'). Control site--180 degrees and 31.3 feet from SW stake.

Cage 3--in grass/*Polygonum* community near railroad grade, at about 1142' elevation. Control--118 degrees and 34.6' from SW stake.

Cage 4--in pasture grass, about one-half the distance from the railroad grade to the forested slope (or 1/2 way between Cage 3 and Cage 5). Elevation about 1162'. Control--116 degrees and 20.5' from SW stake.

Cage 5--in pasture near forested slope, high elevation (about 1175'). Control--222 degrees and 27.6' from SW stake.

Baldi Meadow

Cage 1--near bottom of access trail from Baldi Substation. Control--172 degrees and 26.7' from SW stake.

Cage 2--approximate center of large, "main" meadow, on its highest point. Control--205 degrees and 37.2' from SW stake.

Cage 3--near NE corner of "main" meadow. Control--155 degrees and 21.7' from SW stake.

Cage 4--just north of central clump of trees in "main" meadow. Control--325 degrees and 24.2' from SW stake.

Cage 5--far northwestern corner of meadow. Control--150 degrees and 26.5' from SW stake.

4. Another site visit is scheduled for February 8 to trim any plant growth that has occurred since December. None is expected, but February will represent for statistical purposes the beginning of the growing season. So plants need to be sheared to the ground, at each cage and each control. To assure that the same area is sheared at each location, a metal ring was made by COT. The ring will be placed over each plot, and only vegetation that is inside the ring will be cut. As yet, a formal strategy for statistical analysis of data has not been developed. This will be done prior to the site visit. That strategy will define when site visits should be made, and how much material will be sent to the WSU lab for nutritional analyses. The strategy will also include instructions for pellet

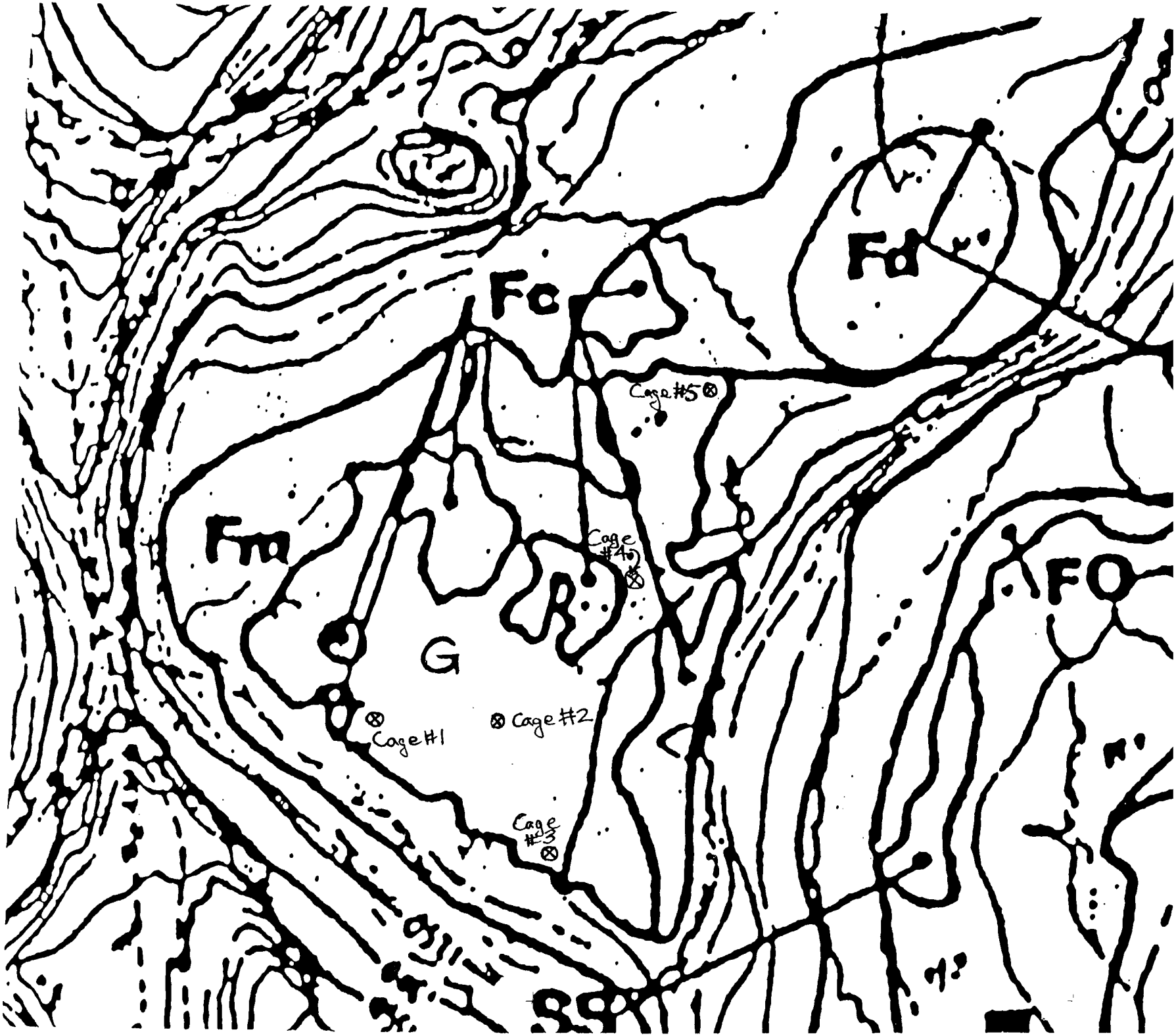
collection, including where pellets should (and should not) be collected; how many; and what should be sent to the WSU lab for analysis.

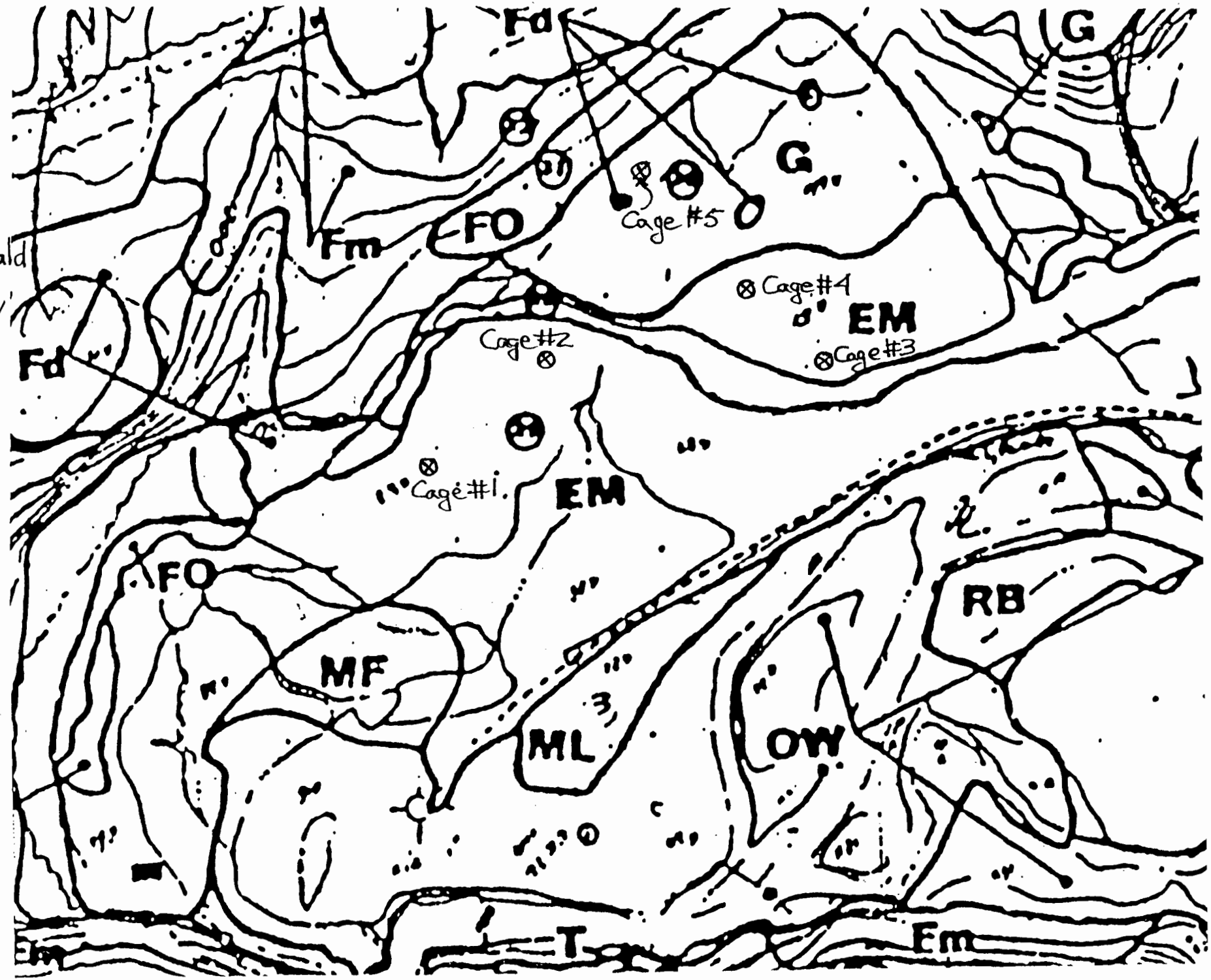
Ken Brunner

cc:
Chow (EN-PL-CP)
Northup (EN-PL-ER)
Goetz (EN-PL-ER)
Foster (EN-PL)
Olson (OP-PO-MM)
Trinkle (OP-PO-MM)

cf:
Hickey (COT)
Ging/Stagner (USFWS)
Spencer (WDFW)
Engman WDFW)
Coccoli (MIT)
Fleming (Raedeke)
King (USFS)


MacDonald Meadow
Baldi Meadow
Fdy
Fd
Fm
FO
EM
G
SS
Fc
RB
MF
ML
OW
T
ME
S
RIVER
GREEN


Baldi
Meadow
N
Fc
Fd
Fm
FO
G
Cage #1
Cage #2
Cage #3
Cage #4
Cage #5


MacDonald
Meadow
N
Fd
G
Fm
FO
Cage #5
Cage #4
EM
Cage #2
Cage #3
Cage #1
EM
FO
MF
ML
OW
RB
T
Em

MEMO

To: Ken Brunner
From: Travis Shaw
Re: Elk Study Experimental Design

This experimental design is based on the description of the physical layout we discussed several weeks ago. The analytical approach that I am recommending is based on a multifactor, mixed effects model ANOVA. A mixed model assumes that some of the factors are fixed and some are random. A fixed factor represents all possible levels of the factor (Underwood, 1981). In this study, there are only two possible levels of the factor representing the effects of grazing, caged or uncaged plots. The two meadows selected for this study can also be designated as fixed factors since these are the only two you are interested in. However, by designating meadow as a fixed factor, the conclusions of the will have to restricted to the specific meadows in the study and not extended to all meadows.

The only random factor in the analysis is time, represented by the months of the growing season. Designating time as a random factor will allow you to make broader inferences about differential grazing by elk throughout the growing season. Also, if time were a fixed factor, you would have to sample the same time each month. Time as a random factor allows you to sample anytime during the month, though for other reasons you will probably get better results if you sample about the same time each month. The designation of a factor as fixed or random influences more than the inferences that can be drawn from the analysis. The F statistic in the ANOVA is calculated differently for fixed and random factors. As a result, fixed effects models (all factors are fixed) are generally more powerful. However, the time factor in this study does not really meet the definition of a fixed factor and the logistical flexibility gained may compensate for the loss of power.

Linear Model:

$$Y_{ijkl} = \mu + M_i + C_j + T_k + MC_{ij} + MT_{ik} + CT_{jk} + MCT_{ijk} + \varepsilon_{(ijk)l}$$

Factor	Levels	Type of Factor
Meadows (M)	$i = 1..2$	**Fixed & Crossed**
Caged Plots (C)	$j = 1..2$	**Fixed & Crossed**
Month (T)	$k = 1..5$	**Random & Crossed**
Replicates	$l = 1..8$	**Random**

Estimated ANOVA Table:

Source	df	F
Meadow	1	MS_M/MS_{MT}
Caged Plots	1	MS_C/MS_{CT}
Month	7	MS_T/MS_E
MxC	1	MS_{MC}/MS_{MCT}
MxT	7	MS_{MT}/MS_E
CxT	7	MS_{CT}/MS_E
MCT	7	MS_{MCT}/MS_E
Error	128	
Total	**159**	

Statement of Hypothesis:

Factor M;

H_o: There is no significant difference between the two meadows in the amount of biomass grazed by elk.

$$H_o: \mu_1 = \mu_2 \text{ or } \tau = 0$$

H_1: There is a significant difference between the two meadows in the amount of biomass grazed by elk.

$$H_1: \mu_1 \neq \mu_2 \text{ or } \tau \neq 0$$

Factor C;

H_o: There is no significant difference in the amount of biomass grazed by elk between caged and control plots.

$$H_o: \mu_1 = \mu_2 \text{ or } \tau = 0$$

H_1: There is significant difference in the amount of biomass grazed by elk between caged and control plots.

$$H_1: \mu_1 \neq \mu_2 \text{ or } \tau \neq 0$$

Factor T;

H_o: There is no significant difference in the amount of biomass grazed by elk during the eight months of the growing season.

$$H_o: \mu_1 = \mu_{2 \ldots 8} \text{ or } \tau = 0$$

H_1: There is significant difference in the amount of biomass grazed by elk during the eight months of the growing season.

$$H_1: \mu_1 \neq \mu_{2 \ldots 8} \text{ or } \tau \neq 0$$

Interaction of Factors M & C;

H_o: Location (meadows) and caged plots do not significantly interact to affect the amount of biomass grazed by elk.
H_1: Location (meadows) and caged plots do significantly interact to affect the amount of biomass grazed by elk.

Interaction of Factors M & T;

H_o: Location (meadows) and time (months of the growing season) do not significantly interact to affect the amount of biomass grazed by elk.
H_1: Location (meadows) and time (months of the growing season) do significantly interact to affect the amount of biomass grazed by elk.

Interaction of Factors C & T;

H_o: Caged plots and time (months of the growing season) do not significantly interact to affect the amount of biomass grazed by elk.
H_1: Caged plots and time (months of the growing season) do significantly interact to affect the amount of biomass grazed by elk.

Interaction of Factors M,C & T;

H_o: There is no significant interaction between location (meadows), caged plots and time (months of the growing season).
H_1: There is a significant interaction between location (meadows), caged plots and time (months of the growing season).

This approach allows you to address a wide variety of questions. However, it is also complex and the number of levels in Factor T (months of the growing season) may lead to ambiguous results. A simpler approach to this analysis will be to eliminate the caged factor from the ANOVA model. In this case, the difference in biomass between caged and control plots would not be tested for statistical significance. The data set can then be analyzed as a two factor ANOVA comparing the two meadows and the months of the growing season. The resulting ANOVA may be easier to interpret but some information about the amount of biomass grazed by elk will be lost.

Linear Model:

$$\mathbf{Y}_{ijl} = \mu + \mathbf{M}_i + \mathbf{T}_j + \mathbf{MT}_{ij} + \varepsilon_{(ij)l}$$

Source	df	F
Meadow (M)	1	MS_M/MS_{MT}
Month (T)	7	M_{ST}/MS_E
MxT	7	MS_{MT}/MS_E
Error	64	
Total	**79**	

Either model can also be expanded to examine differences in the amount of biomass grazed by elk year round. The area enclosed by the cages can be divided into smaller experimental plots and randomly sampled during the winter. The biomass from the caged areas can then be compared with control plots of equal area. The number of smaller areas within the caged plots must equal the total number of monthly samples for the year or the above linear models will be invalid.

Since there is no difference in the way these two statistical models are sampled, my recommendation is to analyze the more complex three-way ANOVA first and use the results to guide further analysis. In this way, main factors or interactions that are not significant can then be pooled into the error term and the data reanalyzed. The concept of using a staged or tiered analysis is described in statistical texts (Winer, 1971; Keppel, 1991) and in peer reviewed literature (Underwood, 1981). This approach offers dual advantages. First, you will be able to identify the factors that are most important while conserving power in the analysis. Second, the limited resources available for the study will not be wasted if the level of replication is not adequate. Since it is impossible to estimate the magnitude of variability that will be encountered, it is prudent to adopt an experimental design that is both broad in scope yet flexible enough to yield concrete conclusions.

Cited Literature

Keppel, G. 1991. Design and analysis, third edition. Prentice Hall, Englewood Cliffs, NJ.

Underwood, A.J. 1981. Techniques of analysis of variance in experimental marine biology and ecology. Oceangr. Mar. Biol. Ann. Rev. 19:513-605.

Winer, B.J. 1971. Statistical principles in experimental design, second edition. McGraw-Hill, New York.

ANNEX VI. MEADOW VEGETATION SAMPLING STUDY

In July 1993, staff from the U.S. Fish and Wildlife Service (FWS) and the Corps of Engineers (COE) conducted a two-day survey of the herbaceous vegetation growing at MacDonald field. The attached memoranda from FWS and COE describe the results of the survey in detail.

The purpose of the sampling was to determine the composition species of herbaceous vegetation growing on the pasture. This information will aid in the selection of plants for pastures that are created as mitigation for the additional water storage project. The information gathered during that survey is critical in this regard, as MacDonald field is considered to be the best forage area for elk in the project area, and most of it will be inundated by the higher reservoir. The mitigation will attempt to replicate the kinds of plants found in this meadow, and will improve the nutrition through the application of fertilizers on a regular basis.

A related consultation occurred in 1994, with a representative of the (then) U.S. Soil Conservation Service (SCS) (now Natural Resources Conservation Service). The purpose of this consultation was to determine whether improvements could be made to either or both existing pastures (MacDonald and Baldi fields). The SCS representative indicated that it was evident that elk grazed both sites intensively due to the absence of trees and shrubs in the meadows. The solid turf (i.e., high density of herbaceous plants) that has been established over many years also prevents the establishment of seedlings. Nevertheless, it was clear to the SCS representative that the pastures could be improved through: thatching; fertilizing; harrowing; and harvesting of trees and shrubs (near the edges of the pastures, as they throw shadows onto the pastures, lowering the growth and palatability of the plants that grow along the edges). Also, salt and mineral blocks could be placed on the meadows to encourage more use by elk. A memo of this consultation is included in this section.

The results of the vegetation survey are a piece of the puzzle, that, combined with the elk exclusion cage study (Annex 5), will aid in creation of highly palatable and nutritional pastures, which will fully mitigate the loss of MacDonald field.

WILDLIFE RESOURCES

Plant Community Characterization Of A Meadow Within The Study Area

During FY 1994, staff biologists from the Corps and the Service conducted vegetation sampling and analysis to characterize the floristics of a meadow area on the north shore of Howard Hanson Reservoir. The importance of this meadow to elk is well-known, as is the likelihood that it would be entirely destroyed by the proposed pool raise. The meadow is heavily utilized by elk for foraging for most of the year. The analysis of the vegetation components was undertaken in order to identify the composition of this forage base and to help indicate the in-kind habitat values associated with the site. In turn, this type of information is important for development of in-kind mitigation requirements to offset impacts to elk.

The Service provided the Corps a PAR (dated July 29, 1994) that documented the details of the study. Briefly, vegetation composition of three plant communities was described based on a minimum level of sampling. The majority of the area is comprised of the upland meadow plant community which consists primarily of four dominant pasture grass species. These perennial grasses were probably planted when the area was farmed years ago (McDonald farm) and these grasses appear to provide most of the forage available to elk on the site. All these grasses showed signs of moderate to heavy utilization. The two remaining plant communities are associated with the reservoir margin. Vegetation composition of these communities is similar to an emergent freshwater marsh and is controlled by the annual fluctuating water levels of the reservoir. Rushes, sedges, and aquatic moss were the most conspicuous groups of plants. The majority of vegetation in these communities showed signs of utilization by elk.

Consultation With The U.S. Soil Conservation Service

On April 4, 1994 a staff member from the U.S. Soil Conservation Service (SCS) accompanied Corps and Service biologists on a reconnaissance-level inspection of the meadow area. The following is a list of some of the pertinent topics that were discussed:

1. Elk utilization of the site
2. Measuring forage quantity
3. Plant species identification
4. Sedge utilization and analysis, and
5. Planting flood tolerant sedges associated with the new shoreline.

The SCS range conservationist stated that invasion of trees and shrubs into the meadow was prevented due to the substantial elk utilization of the site. In addition, because of the lack of bare soil in the meadow due to the high density of grass, seeds from trees and shrubs that alight on the site are prevented from germinating and cannot get established. The plant floristics of the meadow were considered typical of pastures in western Washington. Discussions about measuring forage quantity focused on using exclusion cages and periodically clipping vegetation inside the cages throughout the growing season. Clipped vegetation would be air dried and weighed in order to estimate productivity of the site. Heavy duty cages were recommended as well as clipping vegetation every four to six weeks beginning in early March and continuing through the end of October.

In plant communities along the shoreline, various species of sedge grew in relatively small patches. Elk had utilized some sedges more than others. It was speculated that this may be due to elk seeking out certain minerals contained in particular sedge species. To determine if this was occurring, the range conservationist suggested conducting an analysis of the mineral content of the different sedge species. Also recommended was the planting of flood tolerant sedge species after the pool raise. Currently, various carex (sedge) species that can survive long periods of inundation and in water depths up to 60 feet, are being tested in the Pacific Northwest.

We inspected a second upland meadow located a short distance from the McDonald farm meadow. It is surrounded by forest and situated at higher elevation on a terrace above the reservoir, and therefore, would not be impacted by the project. This meadow was also farmed and has similar grass species as the lower meadow. It is being considered as a potential mitigation site for elk. The following topics were discussed:

1. Attracting elk to the site and to other mitigation sites
2. Site enhancement for elk
3. Techniques for meadow enhancement
4. Control of encroaching trees and shrubs, and
5. Potential for development of the powerline corridor to benefit elk.

Elk utilization of this meadow has also been significant, however, not to the same extent as the lower meadow. Utilization of grass appeared heavier near the center of the stand than near the margins adjacent to the forest edge. As explained by the range conservationist, the lower elk use of the meadow margin may be due to the lower productivity of these areas, which could be caused by the shadowing effect of the trees. These partially shaded areas receive less sunlight, and therefore produce less vegetation biomass and may grow less palatable forage than in the center of the stand.

To attract elk to the upper meadow site, or potentially to other elk mitigation sites, it was suggested that salt or mineral blocks be placed in these areas in advance of the pool raise. Mineral and protein supplements have been used successfully to draw livestock to upland sites and to re-distribute use over a large area. Fertilization of underutilized areas of the meadow was also suggested as a way to attract elk and redistribute their use. Another suggestion for potential mitigation sites was powerline corridors. Overstory vegetation control is already a concern in these corridors and elk may benefit if the corridors were prepared as foraging sites by planting of appropriate forage species and by fertilization. These sites could potentially become self-maintaining since elk utilization may control shrub and tree invasion. Further evaluation of this concept is needed as well as coordination with, and acceptance by, the utility company.

Several techniques to enhance the upper meadow site for mitigation purposes were suggested and these include the following:

1. Thatching
2. Fertilization
3. Harrowing, and
4. Harvesting invading trees and shrubs.

To implement most of these practices on this site road access would have to be improved. The SCS range conservationist recommended that a small area of the meadow be used to test a technique (or techniques) to determine which one would provide the best results in terms of enhancing productivity of the existing stand of grass. For example, applications of various fertilizers on small tests plots could help indicate which fertilizer would be most appropriate.

Encroachment of trees into the upper meadow has occurred. This may be affecting productivity of the site, particularly along the meadow margin. Potentially, the size of the meadow opening could be increased by cutting surrounding trees, especially at the east end of the meadow where the terrace extends towards the powerline corridor. Although, it was suggested that trees could also be cut on the hillslope at the west end of the meadow. The meadow could then extend upslope at this location.

From: Bodurtha, T. 1994. Planning Aid Report–for FY94 Feasibility Effort, Howard Hanson Dam Additional Water Storage Project, U.S. Fish and Wildlife Service, Ecological Services, Olympia, WA. 21 pp.

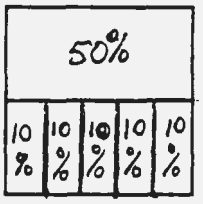
CENPS-EN-PL-ER July 9, 1993

MEMORANDUM FOR: Record

SUBJECT: Howard Hanson Dam–Elk Mitigation Investigations

1. On July 7 and 8, 1993, Tim Bodurtha and I conducted initial vegetation sampling on the MacDonald farm meadow.

2. The work entailed placing a quadrat (specifically a "Daubenmire square") at five foot intervals along a fifty-foot long transect. The quadrat is made of steel rods, one foot along each side, and with a steel rod through the center to divide the square into two equal halves; four more steel rods are equally spaced between one side and the center rod to divide one half of the square into five equal rectangles (see graphic below). The purpose of the divided spaces is to allow more accurate estimates of percentage cover by species. For example, the user can look at one of the rectangles, which represents 10% of the total square, and fairly accurately estimate the cover of one species that covers, say, 8% of the square. And so on, with plants covering 20, 45, 78, or 90%, the percentage can be easily estimated.



Daubenmire Square

Transects were located randomly, by simply walking to a random location (i.e., stopping at no particular place), then selecting a compass direction by noting the location of the second hand on a watch at a particular instant (e.g., 5 seconds after the hour is equal to 30 degrees (5/60 X 360° = 30°). Then, in similar fashion, a distance is determined by noting the second hand location; the numbeber is directly used, such as 25 seconds after equals 25 feet. The SW end point of the basal transect is then 30° and 25 feet from the point you are standing. Now the basal line is established, and the direction of the transects is determined, once again by noting the second hand location. We selected two transects per basal line, one 15 feet NW from the end point and the other 35 feet from the endpoint. Each transect is 50 feet long. We randomly selected four different sets of transects within the meadow, though admittedly the randomness was compromised somewhat by intentionally locating the transects in particular vegetation types. A rough sketch that shows approximate locations of transects and their configuration is attached.

3. All species of plants that were recorded were collected and placed in a plant press

for preservation and for future verification as to species by a botanist. The data sheets were retained by Tim Bodurtha, who will complete the data analyses within the next month. The results of the anlysis will provide us with information on the plant species mix found in the meadows where elk commonly forage. The information will be used to design replacement meadows to the same composition. A cautionary note: the composition currently present in the meadow is not necessarily the most favorable for elk, as they may prefer one species over another, and weighting toward that species may be better than what is there. However, lacking information on the diet of the elk, we cannot fine tune the mix of species any better than trying to duplicate what we know is already successful; Tim Bodurtha has stated in the past that an analysis of plant materials found in the pellets would be very useful in better determining the best mix of meadow species.

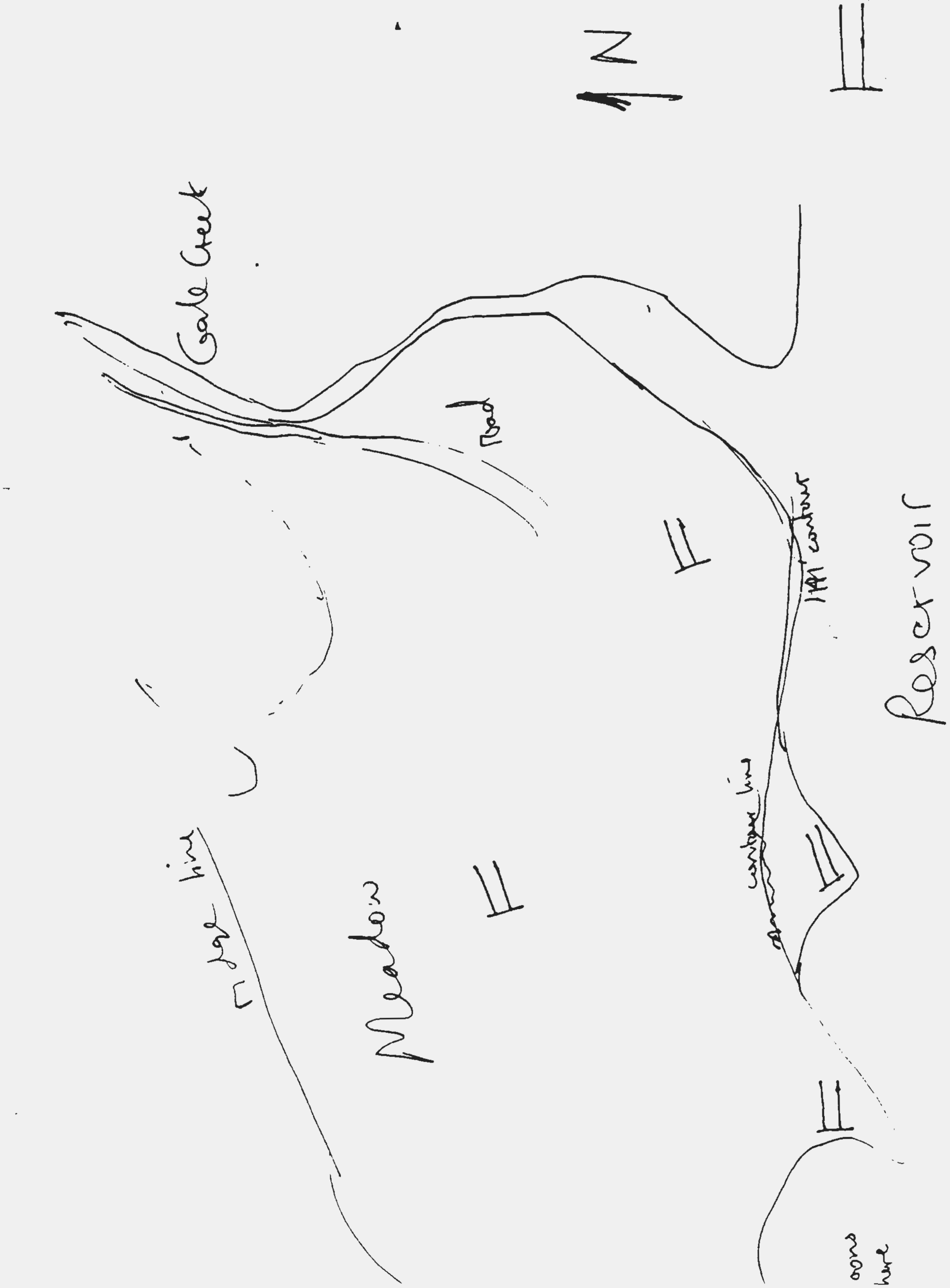
4. Another site investigation may be required for two reasons: 1) the reservoir on the 7th and 8th was at maximum (1141); much of the meadow upon which the elk depend was underwater on those days. It is highly probable the species mix in that portion of the meadow is different from what we sampled. Further, the evidence suggests that the meadow which we sampled is not highly utilized, as there was very little evidence of grazing by elk. Extensive grazing was noted only near the edge of the reservoir. 2) some of the low-lying forested areas contain an herbaceous understory which the elk utilize for forage; we may decide to sample one of the forests to more completely analyze forage components of the elk in the area.

5. General observations. Three adult common loons were calling frequently and were actively foraging on the reservoir; nesting may be ongoing. An adult bald eagle was seen several times near the meadow, and may be nesting nearby. An osprey was observed and could be heard calling often (out of view), and may be nesting nearby. No nests of any of these species has previously been documented for this project. If a bald eagle nest is present, the biological assessment may require revision. I will contact WDW to discuss whether they feel bald eagles nest in the vicinity of the reservoir, though even if a pair is nesting it is unlikely the pair would be impacted unless the nest is within the 36 foot pool raise area. Common loons are a State-sensitive species, and closely monitored by the State; if a nesting pair is present, mitigation would likely be necessary should the pool be raised. Impacts to ospreys are not anticipated.

6. Results of the data analyses will be used in planning for elk mitigation. Mitigation planning is scheduled to be done during FY94, following completion of HEP analysis. Other tasks (elk observation field cards; elk pellet transects) are in the court of WDW and I have not heard from them on these items.

Ken Brunner

cc:
McNeely (EN-PL-ER)
Northup (EN-PL-ER)
Brunner (EN-PL-ER)
Chow (EN-PL-PF)



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192
(206) 753-9440 FAX: (206) 753-9008

July 29, 1994

Lieutenant Colonel Rex N. Osborne
District Engineer
Seattle District, Army Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124
Attn: Ken Brunner, Environmental Resource Section

Re: Plant Community Characterization of an Elk Meadow at Howard Hanson Reservoir

Dear Colonel Osborne:

The Fish and Wildlife Service (Service) is providing you this planning aid letter (PAL) to aid in the feasibility-level wildlife investigations related to the proposed Howard Hanson Additional Water Storage Project. The following information summarizes the results of vegetation data collected on a meadow area that would be inundated by the proposed project and that is currently heavily utilized by elk. We stated in our October 8, 1993 PAL that results of this work would be forthcoming in Fiscal Year 1994.

DESCRIPTION OF THE MEADOW AREA

The meadow area is located on the north shore, west of Gale Creek, in the upper half of Howard Hanson Reservoir in the Green River drainage, King County, Washington. The site is approximately 24 acres in size and generally warmer than the surrounding terrain because of its southern aspect and moderated temperatures from the close proximity of the reservoir. Elevation is between 1,135 and 1,200 feet. Soils have been mapped as udifluvents (Soil Conservation Service 1992) which are deep, well-drained soils of low stream terraces and drainageways that are formed in alluvium. Runoff is very slow and permeability moderately rapid to rapid. These soils are typically associated with timber growing sites with the main limitations affecting timber harvest chiefly caused by flooding and occasional heavy snowpack.

Historically, the area has been farmed (McDonald farm) and has been used as a logging camp and railroad workers camp (Shapiro and Associates Inc. 1985). Presently, the habitat has been heavily grazed by elk which keeps shrubs and trees from becoming established. Many of the grasses are pasture grasses, probably planted on the drier upland areas when the site was originally

farmed. Weedy forbs are also present, particularly on the more disturbed sites. A band of vegetation, characteristic of an emergent freshwater marsh, occurs along the shoreline margin just below the filled pool elevation of 1141 feet and down to about elevation 1,120 feet. At lower elevations mudflats and occasional patches of aquatic moss occur on the exposed sections of the reservoir.

METHOD

Staff from the Service and the Army Corps of Engineers (Corps) collected vegetation composition data on July 7 and 8, and on September 30, 1993. A total of six 50 x 50 foot macroplots were located in representative stands in distinct plant communities which were identified following a reconnaissance survey of the area. Within each macroplot two 50-foot transects were randomly located. Along each transect ten 1-foot square microplots were systematically placed every 5 feet and canopy coverage and frequency data recorded on individual plants rooted within each microplot.

Canopy coverage is defined as 'the vertical projection of the aboveground parts onto the ground' and is an approximation of the area over which a plant exerts its influence upon other components of the ecosystem (Daubenmire 1959). In the microplots, canopy coverage was recorded independently for each species as one of six coverage classes (0-5, 5-25, 25-50, 50-75, 75-95, and 95-100%). The midpoints of these coverage classes were later used in calculating average percent coverage of the taxa encountered in the six macroplots. For further details of the method of analysis see Daubenmire (1959). Frequency was determined by the presence or absence of a plant in a microplot. Frequency values were calculated from the number of microplots in which the species was present in relation to the total number of microplots sampled in the representative stand.

Of the six macroplots, two were located in the upland meadow plant community, two in the juncus plant community along the reservoir margin, and two in the moss/quackgrass plant community, which was the vegetated mudflat area below the elevation of the juncus plant community. Canopy coverage and frequency values for each plant species encountered were averaged from all transects in the two macroplots sampled in each plant community.

RESULTS

Results are presented in Tables 1, 2, and 3. . When possible, plants were identified to the species level, particularly for dominant and co-dominant plants; otherwise, unknown plants were grouped by life form (i.e., grasses, forbs, sedges, and rushes).

The upland meadow plant community consisted mostly of grasses which constituted greater than 80% of the vegetation cover. Four grasses that were observed with similar coverage and frequency, and that dominated all vegetation on the site included red fescue, timothy, quackgrass, and redtop. Dominant forbs included white clover, plantago, false-dandelion, and tansy

VI 9

ragwort. In the juncus plant community; soft rush, a common indicator of wet meadows in the Pacific Northwest; and a grass species, redtop, were co-dominant plants. Coverage of sedges and forbs in this community was relatively minor, although the sedge community may have been more prominent if it had not been grazed and had developed to maturity. As expected, moss comprised the majority of the vegetation component of the moss/quackgrass community followed by quackgrass. Sedges and forbs were present but inconspicuously low in coverage. The sedge, common spikerush, which is common in wetter portions of meadows dominated by soft rush, occurs in this community even though soft rush was not present.

DISCUSSION

Nearly all the grasses and the majority of sedges of the plant communities in the meadow area showed heavy utilization by elk. Some elk studies have reported on the relative forage value of a few of the grass species that were found in these plant communities. For example, redtop, orchardgrass, and red fescue were ranked highly valuable for Roosevelt elk (Nelson and Leege 1982), and Kufeld (1973) reported that timothy and several Agropyron species (wheatgrasses) ranked valuable to highly valuable in his study of Rocky Mountain elk food habitats. Of the forbs, white clover was ranked as highly valuable in the summer diet of Rocky Mountain elk (Kufeld 1973). In the Cedar River watershed, Paige (1988) reported that the spring diet of the elk herd using the Eagle Ridge Meadow (ERM) consisted mostly of sedges and conifers. In contrast, the diet of the herd using the Cedar River delta consisted of sedges, shrubs, and conifers, but sedges comprised about twice the amount of forage compared to the ERM.

The diet of elk is highly variable and depends upon local availability of forage, but in general, where both grasses and shrubs are available, elk usually prefer grasses until it becomes less available. Most researchers agree that grass is the most important forage class for elk during spring green-up months, usually constituting more than 85 percent of the diet. Grasses and forbs constituted 75-90 percent of the spring diet of Roosevelt elk on the Olympic Peninsula in Washington state (Nelson and Leege 1982). As grasses mature in summer, forbs become more important and, to some extent, leaves of some shrubs (Peek 1982). In some cases, high use of grass communities continues throughout the summer (Boyd 1970). In late summer and fall, dried grasses and shrubs become predominant in the elk diet. On some ranges, fall precipitation initiates growth of green grass and elk again turn to grass as the primary forage (McArthur 1977). Browse can become more important in winter diets. The winter diet of Roosevelt elk in western Oregon consisted of 56 percent browse with trailing blackberry, grasses, sedges, and salal being the preferred species (Harper 1971).

The Service has maintained that the meadow area is a special area for elk. It is postulated that elk use this site disproportionately more than surrounding areas. It receives year-round use by elk; however, the largest concentrations occur during winter. Although it appears to be a primary foraging area during winter and spring for migratory and non-migratory elk, it could be an important calving and breeding area as well. Several characteristics that

probably contribute to quality of this habitat for elk include the following: (1) relatively high forage value, (2) close proximity to water, (3) close proximity to thermal and escape cover, (4) relatively free from human activities, (5) moderate temperatures, (6) southerly aspect, (7) nearly flat gradient, and (8) site productivity. These factors, and probably more, influence the selection of this area by elk over other sites in the watershed.

The project will likely destroy and/or significantly alter most of the existing meadow. No other similar sites exist in the general area. We are concerned about the impacts this could cause to resident and migratory elk and are uncertain about the ability of elk to offset this loss. We anticipate that elk would continue to inhabit the area after the project is constructed, however, we are unsure at what level of productivity.

In view of past changes in the landscape and the continuing changes caused by road building and logging practices, which have significantly altered elk habitat, coupled with recreational and tribal harvests of elk in the watershed, the Service recommends that the Corps fully mitigate the loss of this meadow. The data presented in this PAL is insufficient to identify all the project-related impacts to elk from the loss or destruction of the meadow, however, it does provide a qualitative analysis of the kind of existing forage available to elk. Moreover, this information may help the development of a plan to mitigate the loss of habitat values associated with the meadow. More information should be gathered regarding the meadow (e.g. forage quantity, elk habitat use patterns) and other habitats associated with the project area.

If you have questions, please contact Tim Bodurtha of my staff at the letterhead phone/address.

Sincerely,

Lynn P. Childers

for David C. Frederick
State Supervisor

tb/jmc
Enclosures
DOD\DA\CE\SEA\Howard Hanson Reservoir

TT-11

Table 1. Vegetation components of the upland meadow plant community. Vegetation data was collected from 2 sampled stands in this community and is presented as follows: species composition, average percent canopy coverage (mean CC), and average percent frequency of occurrence (mean Fq). Common names for species are in parentheses.

SPECIES	% Mean CC	% Mean Fq
Grasses		
Agropyron repens (quackgrass)	15.5	85.0
Cynosurus cristatus (dogtail)	8.6	55.0
Festuca rubra (red fescue)	17.2	67.5
Phleum pratense (Timothy)	16.4	75.0
Dactylis glomerata (orchardgrass)	4.8	50.0
Holcus lanatus (common velvet-grass)	1.5	20.0
Agrostis alba (redtop)	18.2	67.5
Forbs		
Plantago lanceolata (plantago)	8.9	87.5
Cirsium arvense (Canada thistle)	2.9	17.5
Trifolium repens (white clover)	10.2	67.5
Ranunculus acris (meadow buttercup)	2.7	45.0
Veronica spp. (speedwell)	.2	5.0
Senecio jacobaea (tansy ragwort)	4.1	17.5
Rumex acetosella (dock)	.2	7.5
Vicia spp. (vetch)	.2	5.0
Agroseris spp. (false-dandelion)	5.1	55.0
Hieracium spp. (hawkweed)	T	2.5
Unknown forbs	2.1	37.5

"T" = trace (values below .1)

Table 2. Vegetation components of the juncus plant community. Vegetation data was collected from 2 sampled stands in this community and is presented as follows: species composition, average percent canopy coverage (mean CC), and average percent frequency of occurrence (mean Fq). Common names for species are in parentheses.

SPECIES	% Mean CC	% Mean Fq
Grasses		
Agrostis alba (redtop)	38.7	77.5
Agropyron repens (quackgrass)	13.7	70.0
Phleum pratense (Timothy)	.8	7.5
Rushes		
Juncus effucus (soft rush)	42.5	87.5
Unknown rush	T	2.5
Sedges		
Scirpus microcarpus (small-fruited bulrush)	1.2	10.0
Unknown sedge spp.	1.4	17.5
Forbs		
Plantago lanceolata (plantago)	.4	2.5
Ranunculus acris (meadow buttercup)	1.3	12.5
Veronica spp. (speedwell)	.3	10.0
Polygonum spp. (smartweed)	4.5	45.0
Unknown forbs	T	25.0

"T" = trace (values below .1)

Table 3. Vegetation components of the aquatic moss/quackgrass plant community. Vegetation data was collected from 2 sampled stands in this community and is presented as follows: species composition, average percent canopy coverage (mean CC), and average percent frequency of occurrence (mean Fq). Common names for species are in parentheses.

SPECIES	% Mean CC	% Mean Fq
Grasses		
Agropyron repens (quackgrass)	29.7	95.0
Rushes		
Juncus effucus (soft rush)	1.1	17.5
Sedges		
Eleocharis palustris (common spikerush)	.4	5.0
Unknown sedge spp.	3.0	12.5
Forbs		
Polygonum spp. (smartweed)	2.5	75.0
Unknown forbs	5.2	57.5
BRYOPHYTES (Division of non-vascular plants)		
Bryophytes (mosses)	76.0	95.0

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Page 1

USFS FIELD FORM FOR PERCENT COVERAGE

STUDY SITE NO. 01 | PLANT COMMUNITY TYPE | ELEVATION | ASPECT | SLOPE POSITION | % SLOPE

OBSERVER TIM B KEN B

DATE 07/07/81

MICROPLOT NUMBER #1

SPECIES SYMBOL	LF	PHENOLOGY	1st SUBPLOT 1	2	3	4	5	6	7	8	9	10	2nd SUBPLOT 11	12	13	14	15	16	17	18	19	20	TOTALS Σ F	F	Σ C	% C ÷ 20
Dogtail	G	Cynosurus cristatus dogtail	2					1			1	1	2	2		1	1		1		1		10	50	62.5	3.1
AGROSTIS SP	G	Agrostis repens	1	2	2	1	2	2	2		2		2	2	2	2	1		5		1	2	16	80	260	13.0
Festuca rubra..	G	Creeping red fescue	2	3	4	2		2	3	2	2	2		3	2	3	3		1	2	3		16	80	410	20.5
FALSE DANDELION	F	Agoseris spp	2	1	1		1	1		1		1	1			2		1	1		1		12	60	55	2.8
TRIFOLIUM repens white	F	Clover	3	2	1	1	1	2	2	1	1	4	1		1	3							13	65	200	10.0
PLANTAGO	F	Plantago lanceolata	2	1	2	1	1	2	3		2	2	3	1	1	2	2	1	1		1	1	18	90	202.5	10.1
Timothy	G	Phleum pratense		2	1	3	3	2		2	1	2	4	2	2		1			1	2	2	15	75	267.5	13.4
Ranunculus	F	Ranunculus acris meadow buttercup		2	1			1	1		2	1	1		1	1	2						10	50	62.5	3.1
speedwell	F	Veronica spp		1																	1		2	10	5.0	.3
Agrostis	G	Agrostis alba redtop			2	1	2	2	2	1			1	2	2	2	2	4	2	5	4	5	16	80	437.5	21.9
Orchardgrass	G	Dactylis glomerata			1			1		2					2				2	2			6	30	65	3.3
TANSY RAGWORT	F	Senecio jacobaea				4				2			1	2			4						5	25	157.5	7.9
Hawkweed	F	Hieracium spp						1															1	5	2.5	.1
Unknown #1	F							1							1					2	2	1	5	25	7	.4
LIVE VEG.																										
LITTER																										
ROCK																										
ER. PT.																										
BR. GR.																										

1 - 0 - 5% (2.5)
2 5 - 25% (15)
3 25 - 50 (37.5)
5 75 - 95 (85)
6 95 - 100 (97.5)

UIR FIELD FORM — PERCENT COVERAGE

ASPECT

ELEVATION

PLANT COMMUNITY TYPE

SLOPE POSITION

% SLOPE

STUDY SITE NO. 02

OBSERVER KEN B

DATE 01/10/71913

XSECT #1 — MICROPLOT NUMBER #2

SPECIES SYMBOL	LF	PHENOLOGY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS Σ F	F	Σ C	% C
DOGTAIL	G	Cynosurus cristatus	2	1			1		1	2	1	3						2	4	4	1	1	12	60	202.5	14.1
TIMOTHY	G	Phleum pratense	2	2	1	2	2	2		1	2		4	4	2	4	4	2	3			2	15	75	390	17.5
ORCHARDGRASS	G	Dactylis glomerata	1			2		3			1	2			2				3				7	35	125	6.3
FALSE DANDELION	F	agoseris spp.	2	2				1	1	2	2	2							2	3	2		10	50	147.5	7.4
PLANTAGO	F	Plantago lanceolata	1	2		2		2	2	1	2	2		2		1	2	1	1	1	1	2	17	85	152.5	7.6
TRIFOLIUM	F	white clover	3	1		1	2	1	2	2	2	2						2	2	1	2	3	14	70	205	10.3
VICIA SPP (VETCH)	F	vicia sativa common vetch	1													1							2	10	5	.3
THISTLE (CANADA)	F	Cirsium arvense Canada thistle	2	1	2			1					4	2		1							7	35	115	5.8
TANSEY RAGWORT	F	Senecio jacobaea						1		1													2	10	5	.3
QUACKGRASS	G	Agropyron repense		3	2	1	2	1	2	2	2	2	2	2	5	2	4	2	1	2		1	18	90	360	18.0
BUTTERCUP	F	Ranunculus acris meadow buttercup		1		1	2			2	1	1								1	1		8	40	45	2.3
AGROSTIS (REDTOP)	G	Agrostis alba redtop			5	2	3	3	2	2		2		2	3	2					1		11	55	290	14.5
RUMEX SPP DOCK	F	Rumex acetosella			1			1												1			3	15	7.5	.4
FESTUCA RUBRA	G	Creeping red fescue				2			4	3				2	1	1	3		1	2	4	3	11	55	277	13.9
UNKNOWN FORB #1	F	IMMATURE PAST LVS ONLY				1	1	1				2		1		1		2	3	1	2		10	50	75	3.8
VELVET-GRASS	G	Holcus lanatus common velvet grass						1			1	1	2				1	1		2	2		8	40	57.5	2.9
LIVE VEG.																										
LITTER																										
ROCK																										
ER. PT.																										
BR. GR.																										

Summary sheet for combining meadow veg data from plots 1 + 2

Species	Macroplot 1 CC	Macroplot 1 FQ	Macroplot 2 CC	Macroplot 2 FQ	Mean value $\bar{x}$ CC	Mean value $\bar{x}$ FQ
grasses						
foxtail	3.1	50	14.1	60	8.6	55
meadow grass	13.0	80	18.0	90	15.5	85
red fescue	20.5	80	13.9	55	17.2	67.5
timothy	13.4	75	19.5	75	16.4	75
velvet grass	3.3	65	6.3	35	4.8	50
velvet-grass	—	—	2.9	40	1.5	20
red top	21.9	80	14.5	55	18.2	67.5
forbs						
plantago	10.1	90	7.6	85	8.9	87.5
meadow thistle	—	—	5.8	35	2.9	17
white clover	10.0	65	10.3	70	10.2	67.5
meadow buttercup	3.1	50	2.3	40	2.7	45
speedwell	.3	10	—	—	.2	5
fancy cinquefoil	7.9	25	.3	10	4.1	17.5
rock	—	—	.4	15	.2	7.5
vetch	—	—	.3	10	.2	5
false dandelion	2.8	60	7.4	50	5.1	55
hawkweed	.1	5	—	—	T	2.5
unknown	.4	25	3.8	50	2.1	37.5

'T' = ~~present but~~ trace or minimum below .1

UIK FIELD FORM — PERCENT COVERAGE

ASPECT

ELEVATION

PLANT COMMUNITY TYPE

STUDY SITE NO. 013

OBSERVER KEM/TM

DATE 07/01/83

SLOPE POSITION

% SLOPE

SPECIES SYMBOL	LF	PHENOLOGY	MICROPLOT NUMBER 1										MICROPLOT NUMBER 2										TOTALS			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Σ F	F	Σ C	% C
JUNCUS	F	Juncus effusus	2		2	5	4	4	5	1		3	3	2	4	3	6	6	6	6	3	3	18	90	1052.5	52.6
SEDGE #1	S		2	1		1							2	1									5	25	32.5	1.9
AGROSTIS	G	agrostis alba	1	5	5	2	3	5	2	5	6	5								2	5	4	13	65	735	37.8
BLACKGRASS	G	Agropyron spicatum	2			1	1	2		1			2	5	2	2	2	2	1				12	60	200	10.0
RANUNCULUS	F	Ranunculus acris meadow buttercup	1													2		1					3	15	20	1.0
POLYGONUM SPP	F			2	2	2	2						2	1	2				1		1		9	45	97.5	4.9
SEDGE #2 LONG-AWNED	S	Scirpus microcarpus small bulrush			2						2												2	10	30	1.5
SPEEDWELL	F	Veronica spp.				1												1	1				3	15	7.5	.4
TIMOTHY	G	Phleum pratense						1													2	2	3	15	32.5	1.6
SEDGE #3	S							1			2												2	10	17.5	.9
UNKNOWN FORB #1	F									1													1	5	2.5	.1
JUNCUS #2	F															1							1	5	2.5	.1
LIVE VEG.																										
LITTER																				2			1	5	2.5	.1
ROCK																										
ER. PT.																										
BR. GR.													2										1	5	2.5	.1

UIK FIELD FORM — PERCENT COVERAGE

STUDY SITE NO. 24 | ASPECT | ELEVATION | PLANT COMMUNITY TYPE | SLOPE POSITION | % SLOPE

OBSERVER KEN B | DATE 07/08/83

SPECIES SYMBOL	LF	PHENOLOGY	XSECT 1 MICROPLOT NUMBER 1	1	2	3	4	5	6	7	8	9	10	NUMBER 2	11	12	13	14	15	16	17	18	19	20	TOTALS Σ F	F	Σ C	% C
JUNCUS	F	Juncus effusus		4	3	6	6	1	2	4	3	3	3		1	1		3	1	2		2		5	17	85	647.5	32.4
AGROSTIS	G	agrostis alba vulgaris		2	3	1		3	3	4	3	3			3	4	3	2	3	3	6	6	4	2	18	90	790	39.5
DUNCKGRASS	G	digitaria sanguinalis		2	2	2	2	2	3	2		2	5			2	2	2	3	2			2	2	16	80	355	17.8
POLYGONUM SPP	F			1					1						3	1	1	1			2	1	2		9	45	82.5	4.1
RANUNCULUS	F	Ranunculus acris meadow buttercup						2	2																2	10	30	1.5
SEDGE #2 LONG-AWNED	S	Scirpus microcarpus	small-fleshy culmed							1													2		2	10	17.5	.9
PLANTAGO SPP	F	plantago lanceolata											2												1	5	15	.8
SPEEDWELL	F	Veronica spp.																			1				1	5	2.5	.1
LIVE VEG.																												
LITTER		WOODY DEBRIS, ARTHROPOD						3			3					3	4	4	3	4	6	4	5	1	11	55	607.5	30.4
ROCK																												
ER. PT.																												
BR. GR.															3										1	5	31.5	.05

- summary sheet for combining genus/sedge vegetation data for plots 3 & 4 -

Species	Macroplot 3 CC	Macroplot 3 FQ	Macroplot 4 CC	Macroplot 4 FQ	Mean CC	Mean FQ
grasses						
beaked grass	37.8	65	39.5	90	38.7	77.5
quackgrass	10	60	17.8	80	13.7	70
timothy	1.6	15	—	—	.8	7.5
rushes						
soft rush	52.6	90	32.4	85	42.5	87.5
unknown rush	.1	5	—	—	.05 (T)	2.5
sedges						
wall-fruited beaked sedge	1.5	10	.9	10	1.2	10
unknown sedge	2.8	35	—	—	1.4	17.5
forbs						
St. John's wort	—	—	.8	5	.4	2.5
grass-of-parnassus	1.0	15	1.5	10	1.3	12.5
yellow rattle	.4	15	.1	5	.3	10
unidentified	4.9	45	4.1	45	4.5	45
unknown forb	.1	5	—	—	.05 (T)	2.5

-1-

RANGE INVENTORY - PERCENT COVERAGE

RANGE UNIT/ALLOTMENT	STUDY SITE NO.	HABITAT TYPE	ELEVATION.
	05		

ASPECT	% SLOPE	DATE	OBSERVER
		09 30 93	TIM KEACO

X SECT 1 MICROPLOT NUMBER FF 1 X SECT 2

SPECIES SYMBOL	TBLF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS F	%F	Σ C	%C
QUACK GRASS	G	2	5	2	2	2	3	2	4	5	4	5	2	4	5	4	3	4	3	5	1	20	100	109.5	54.8
MOSS #1	M	4	4	5	5	2	3	3	5	5	5	4	2			4	6	6	6	5	5	18	90	112.5	56.4
GRASS #1	G	1			1			1										1			1	3	15	5	2.5
UNKNOWN GRASS #1	F	1	1		1				2	1	2	1	1	1	1			1	1	1	1	10	50	5.5	2.8
PSEUDOSTEM SP #1	F	1																				2	10	5	3
SEDGE #1	S				1		2					1	1	1	1							4	20	11.5	5.9
EQUISETUM SP	E					2							5	2								2	10	5	2.5
UNKNOWN FORB # 1	F									1								1				2	10	5	3
UNKNOWN FORB # 2	F													1		1						2	10	5	3

VEG.	LITTER	ROCK	ER PT.	BR. GR.
1	2	2	3	1
2	2	3	4	1
3	5	1	1	1
1	1	1	1	1
1				3
1				

1. 0-5 %
5-15 %
15-50 %
50-75 %
75-100 %

RANGE INVENTORY - PERCENT COVERAGE

RANGE UNIT/ALLOTMENT	STUDY SITE NO.	HABITAT TYPE	ELEVATION.
	06		

ASPECT	% SLOPE	DATE	OBSERVER
		093093	

XSECT 1 MICROPLOT NUMBER #2 XSECT 2

SPECIES SYMBOL	TBLF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS # F	% F	# C	% C
RANGE GRASS	6	1	1	1	2			1	1	2	1	2	1	1		2	1	1	1	1	1	18	90	925	4.6
LOSS	M	6	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	5	6	5	6	20	100	1925	95.6
LOSS	F	1	1	1	1	1		1				1		1	1	1	1	1	1	1	1	17	85	425	2.1
UNK FORB #4	F	1		1	1	2	3			1	2	1		1	4	2	2		1	1	1	15	75	1785	9.1
UNK FORB #2	F						1							1								1	5	2	.1
SEDGE #1	S																			2		1	5	2	.1

VEG.
LITTER
ROCK
ER PT.
BR. GR.

Summary sheet for combining the sweetgrass plot community vegetation data for plots 5 and 6

Species	Macroplot 5		Macroplot 6		Mean	
	CC	FQ	CC	FQ	CC	FQ
sweetgrass (grass)	54.8	100	4.6	90	29.7	95
w/f rush (rushes)	2.1	35	—	—	1.1	17.5
[illegible] sedges (sedges)	5.9	20	.1	5	3.0	12.5
Spike-rush (forbs)	.8	10	—	—	.4	5
Stygiarium spp.	2.8	65	2.1	85	2.5	75
Limbarium spp.	.9	30	9.4	85	5.2	57.5
Total	56.4	90	95.6	100	76.0	95

VII-21

ANNEX VII. ENDANGERED SPECIES COORDINATION

1. Biological assessments (BA's) for the Additional Water Storage Project have been prepared on three occasions – originally on July 27, 1992; again on September 6, 1996; and finally, on October 20, 1997. The U.S. Fish and Wildlife Service (FWS) did not concur with the conclusions in the first assessment regarding marbled murrelets and spotted owls (which was "no effect" for both of these species). The FWS requested the Corps to conduct surveys to confirm that these species are not present in the project area. The Corps utilized data from Washington Department of Ecology (DOE) spotted owl surveys, which confirmed that spotted owls are not present in the Charlie Creek drainage adjacent to the project area. Through coordination with the Tacoma Water Division forester, the Corps has determined that the forest age and structure in the project area is not suitable for spotted owl nesting. These findings were included in the 1996 BA.

The Corps invited one of Washington Department of Fish and Wildlife's experts on marbled murrelets to visit the project area in 1993. This person indicated the project area contained only three very small stands of trees that had the potential for nesting by marbled murrelets; and, additionally, that the stands were too isolated from one another, and too far removed from viable habitat, to support nesting murrelets. He recommended, however, that we conduct a single year of murrelet surveys following the protocol developed by the Pacific Seabird Group (normally this requires two years of survey) to confirm that murrelets were not present. Following this advice, the Corps conducted a survey in the summer of 1994, which resulted in no detections of marbled murrelets in the project area. This information was then included in the 1996 BA.

The FWS expressed informal concurrence of the spotted owl and marbled murrelet effect conclusions ("not likely to adversely affect"), but indicated a lack of confidence with the information provided for bald eagles in the 1996 BA. The lack of confidence was a result of "new" downstream flow criteria that agencies had recently recommended. The effect of different flows downstream from HHD on bald eagle food supply and foraging behavior was not addressed in that BA. Effects upstream of the dam were also somewhat in question, particularly with regard to clearing of the timber from the inundation zone of the higher reservoir. The FWS felt that this kind of information will not be available until the project criteria are well established, and the effect on steelhead and salmon can be determined (and therefore the effect on bald eagle prey supply can be assessed). At the time it appeared unlikely that adequate data (or even agency agreement) that would satisfy FWS as to bald eagle effects of the project could be achieved for several years; as a result, the Corps elected to withdraw the 1996 BA. This seemed to be appropriate, as construction of projects must follow completion of BA's (and consultation with FWS) by no more than 180 days; thus, even if consultation could be completed now, consultation would have to be reinitiated just prior to project construction, to assure that any changes in project design or operation, or changes to the endangered species list or the Act itself, would be considered. Thus, it made sense to withdraw the BA and reinitiate consultation

at a time more appropriately timed to project construction, especially considering the unlikely resolution of key issues regarding fish and water management following implementation of the project.

However, higher authority pointed out in the Alternative Formulation Briefing of the project, that to move forward with the Draft Feasibility Report and EIS without a completed BA and FWS concurrence would very likely not be in compliance with the Endangered Species Act. Furthermore, HA pointed out that it is in the Corps' best interest to complete Section 7 consultation at this time, so that reasonable and prudent measures proposed by FWS at this time would not "surprise" us in the future (i.e., if we did not complete coordination during Feasibility). Thus, we re-initiated consultation with the FWS on October 20, 1997. However, FWS still was uncertain about downstream fish survival, and asked to delay a response to the BA until agencies could agree on an operation of the dam that would provide better certainty on fish survival. Common ground was reached in December, 1997, in the description of both with-project and without-project conditions. This allowed completion of the BA, and, more importantly, gave FWS confidence that it could issue a BO without fear of reproach for doing so while lacking key information. Thus, a revised edition of the third version of the BA was provided to the FWS in mid-January, 1998. As of this writing, FWS has not written its BO.

In addition, at least two species of fish – bull trout and the Puget Sound evolutionary significant unit of chinook salmon – may be listed in the next two or three years. In the meantime, data will be gathered that will help us assess the potential effects of the project on these species, should they be listed. Resource agencies will also continue to work to find workable solutions to restoring anadromous fish runs in the Green River.

ANNEX VIII. COST ANALYSIS TABLES

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	INS/BOND	B&O TAX	TOTAL COST	UNIT COST
04.12.08.02 Site Work		205,433	16,435	8,875	13,845	3,669	1,241	249,497	
TOTAL FEEDER WELLS	5.00 EA	205,433	16,435	8,875	13,845	3,669	1,241	249,497	49899.49
04.12.10 HORIZONTAL DRAINS FOR EXISTING									
04.12.10.02 Site Work		315,500	25,240	13,630	21,262	5,634	1,906	383,173	
TOTAL HORIZONTAL DRAINS FOR EXISTING	4500.00 LF	315,500	25,240	13,630	21,262	5,634	1,906	383,173	85.15
04.12.12 PRESSURE GAGE									
04.12.12.02 Site Work		1,635	131	71	110	29	10	1,986	
TOTAL PRESSURE GAGE	1.00 EA	1,635	131	71	110	29	10	1,986	1985.77
04.12.14 RE-PERFORATE FEEDER WELLS									
04.12.14.02 Site Work		17,120	1,370	740	1,154	306	103	20,792	
TOTAL RE-PERFORATE FEEDER WELLS	10.00 EA	17,120	1,370	740	1,154	306	103	20,792	2079.25
04.12.16 ROCK BLANKET									
04.12.16.02 Site Work		2,048,988	163,919	88,516	138,085	36,593	12,381	2,488,481	
TOTAL ROCK BLANKET	69000.00 CY	2,048,988	163,919	88,516	138,085	36,593	12,381	2,488,481	36.06
TOTAL SEEPAGE CONTROL		5,726,329	458,109	247,378	385,909	102,266	34,600	6,954,591	
TOTAL DAMS		29,451,676	2,736,029	1,287,508	2,008,513	532,256	180,080	36,196,062	
06 FISH AND WILDLIFE FACILITIES									
06.03 Wildlife Facilities & Sanctuary									
06.03.9A Wildlife Habitat									
06.03.9A.01 Wildlife Habitat Mitigation		895,912	74,002	29,097	54,946	15,809	5,349	1,075,116	
06.03.9A.03 Wildlife Habitat Restoration		1,369,508	113,121	44,479	83,991	24,166	8,176	1,643,443	
TOTAL Wildlife Habitat		2,265,420	187,124	73,576	138,937	39,976	13,525	2,718,558	
06.03.9B Fish Habitat									

OWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
LDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Phase 1: Mitigation Sites

1	Meadow (BPA ROW)	$66,000
2	Meadow (BPA ROW)	280,000
5	Meadow (BPA ROW)	49,000
6	Meadow (PSPL ROW)	43,000
7	Meadow (PSPL ROW)	43,000
8	Meadow/Forest (PSPL ROW)	52,000
9	Forest/Herbicide/Harvest, south side	12,300
10	Forest/Herbicide/Harvest, south side	21,100
12	Forest/Herbicide/Harvest, north side	11,200
13	Forest/Herbicide/Harvest, north side	9,500
14	Pasture (BPA ROW)	44,200
15	Forest, north side	21,000
17	Forested, south side	10,500
17	Swamp	14,000
18	Forest, north side	48,300
19&20	Forest, north side	48,300
22	Reservoir Sedge Plantings	37,300
23	Reservoir Sedge Plantings	102,100
24	Reservoir Sedge Plantings	67,100
25	Reservoir Sedge Plantings	37,300
26	Create Subimpoundment	118,600
27	Forest, 50 Acres	102,500
	Total Mitigation, Phase 1	$1,238,300

Phase 1: Restoration Sites (see detailed MCACES estimate)

Forest, 50 acres
Page Mill Pond
Tributary Streams
Sedge Meadows

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Phase 2: Mitigation Sites

	Mature Managed Forest, 150 acres	$210,000
3	Meadow (BPA ROW)	86,500
4	Meadow (BPA ROW)	32,800
11	(design unavailable)	
14	Forest, north side	21,000
17	Pasture	57,700
22	Subimpoundment	214,100
24	Subimpoundment	326,000
	Total, Phase 2	$738,100

Mitigation Site No. 1
Meadow Creation

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove timber	18	ACR	$100	$1,800	$125	$2,250	$0	$0	$4,050	$225	Small, Decid. Assume non-merchantable.
Remove stumps	18	ACR	125	2,250	160	2,880	0	0	5,130	285	
Scarify	18	ACR	30	540	30	540	0	0	1,080	60	
Apply lime	18	ACR	30	540	0	0	10	180	720	40	
Disk & seed	18	ACR	30	540	30	540	25	450	1,530	85	
Plant forage trees & shrubs	324	EA	25	8,100	5	1,620	25	8,100	17,820	55	
Plant screening trees	85	EA	20	1,700	5	425	15	1,275	3,400	40	Conifer or pacific yew
Fencing, cyclone	1100	LF	6	6,600	0	0	4	4,400	11,000	10	Protect trees
Fertilize	18	ACR	30	540	0	0	20	360	900	50	
Remove fence	1100	LF	1	1,100	1	1,100	0	0	2,200	2	
Subtotal									$47,830	$2,657	
OH&P 20%									9,566		
Subtotal									$57,396	$3,189	
Contingency 15%									8,609		
Total									$66,005		
Total, Rounded									$66,000	$3,667	

Mitigation Site No. 2

Meadow Creation

45 Acres, good soil compatibility, no road required, no pre-treatment, 0-8% slopes, existing vegetation class G/FDY (sparse), over 1/4 mile from reservoir and McDonald field, 22.5 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove timber	45	ACR	$100	$4,500	$125	$5,625	$0	$0	$10,125	$225	Small, Decid. Assume non-merchantable.
Remove stumps	45	ACR	125	5,625	160	7,200	0	0	12,825	285	
Scarify	45	ACR	30	1,350	30	1,350	0	0	2,700	60	
Apply lime	45	ACR	30	1,350	0	0	10	450	1,800	40	
Disk & seed	45	ACR	30	1,350	30	1,350	25	1,125	3,825	85	
Plant forage trees & shrubs	2025	EA	25	50,625	5	10,125	20	40,500	101,250	50	
Plant screening trees	170	EA	20	3,400	5	850	15	2,550	6,800	40	Conifer or pacific yew
Fencing, cyclone	5100	LF	6	30,600	0	0	4	20,400	51,000	10	Protect trees
Fertilize	45	ACR	30	1,350	0	0	20	900	2,250	50	
Remove fence	5100	LF	1	5,100	1	5,100	0	0	10,200	2	
Subtotal									$202,775	$4,506	
OH&P 20%									40,555		
Subtotal									$243,330	$5,407	
Contingenc 15%									36,500		
Total									$279,830		
Total, Rounded									$280,000	$6,222	

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 3
Meadow Creation
15 Acres, good soil compatibility, no road required, no pre-treatment, 0-15% slopes, existing vegation class G/FDY (sparse), over 1/4 mile from reservoir and McDonald field, 7.4 habitat units gained

			Labor		Equipment		Material				
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Unit Price	Comments
TREATMENTS											
Remove Timber	15	ACR	$100	$1,500	$125	$1,875	$0	$0	$3,375	$225	
Remove Stumps	15	ACR	125	1875	160	2400	0	0	4,275	285	
Scarify	15	ACR	30	450	30	450	0	0	900	60	
Apply Lime	15	ACR	30	450	0	0	10	150	600	40	
Disk & Seed	15	ACR	30	450	30	450	25	375	1,275	85	
Plant forage trees & shrub	15	ACR	200	3000	35	525	200	3000	6,525	435	
Plant screening trees	500	EA	20	10000	0	0	15	7500	17,500	35	
Fencing, cyclone	2500	LF	6	15000	0	0	4	10000	25,000	10	
Fertilize	15	ACR	30	450	0	0	20	300	750	50	
Remove fence	2500	LF	1	2500	0	0	0	0	2,500	1	
							Subtotal		$62,700		
							OH&P 20%		12,540		
							Subtotal		$75,240		
							Contingency 15%		11,286		
							Total		$86,526		
							Total, Rounded		$86,500		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1996 Price Level

Mitigation Site No. 4
Meadow Creation
14 Acres, good soil compatibility, no road required, no pre-treatment, 0-30% slopes, existing vegation class G/FDY (sparse), over 1/4 mile from reservoir and McDonald field, 7 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove Timber	14	ACR	$100	$1,400	$125	$1,750	$0	$0	$3,150	$225	
Remove Stumps	14	ACR	125	1750	160	2240	0	0	3,990	285	
Scarify	14	ACR	30	420	30	420	0	0	840	60	
Apply Lime	14	ACR	30	420	0	0	10	140	560	40	
Disk & Seed	14	ACR	30	420	30	420	25	350	1,190	85	
Plant forage trees & shrubs	14	ACR	200	2800	35	490	200	2800	6,090	435	
Plant screening trees	50	EA	20	1000	0	0	15	750	1,750	35	
Fencing, cyclone	500	LF	6	3000	0	0	4	2000	5,000	10	
Fertilize	14	ACR	30	420	0	0	20	280	700	50	
Remove fence	500	LF	1	500	0	0	0	0	500	1	
Subtotal									$23,770		
OH&P 20%									4,754		
Subtotal									$28,524		
Contingency 15%									4,279		
Total									$32,803		
Total, Rounded									$32,800		

Mitigation Site No. 5

Meadow Creation

18 Acres, good soil compatibility, road required, no pre-treatment, 0-15% slopes, existing vegetation class G/FM/FC (dense), within 1/4 of reservoir and McDonald field, 8.1 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Mobilize	1	JOB							$5,000		
Access Road	667	SY	$2.50	$1,668	$2.75	$1,834	$1.75	$1,167	4,669	$7.00	
Remove timber	18	ACR	0	0	0	0	0	0	0	0	Assume merchantable.
Remove stumps	18	ACR	125	2,250	160	2,880	0	0	5,130	285	
Scarify	18	ACR	30	540	30	540	0	0	1,080	60	
Apply lime	18	ACR	30	540	0	0	10	180	720	40	
Disk & seed	18	ACR	30	540	30	540	25	450	1,530	85	
Plant forage trees & shrubs	324	EA	25	8,100	5	1,620	20	6,480	16,200	50	
Fertilize	18	ACR	30	540	1	18	20	360	918	51	
Subtotal									$35,247	$1,958	
OH&P 20%									7,049		
Subtotal									$42,296	$2,350	
Contingency 15%									6,344		
Total									$48,641		
Total, Rounded									$49,000	$2,722	

Mitigation Site No. 6
Meadow Creation
11 Acres, good soil compatibility, road required, no pre-treatment, 0-15% slopes, existing vegetation class G/FDY/FD, within 1/4 of reservoir and McDonald field, 5.83 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove timber	11	ACR	$100	$1,100	$125	$1,375	$0	$0	$2,475	$225	Small, Decid. Non-merchantable.
Remove stumps	11	ACR	125	1,375	160	1,760	0	0	3,135	285	
Scarify	11	ACR	30	330	30	330	0	0	660	60	
Apply lime	11	ACR	30	330	0	0	10	110	440	40	
Disk & seed	11	ACR	30	330	30	330	25	275	935	85	
Plant forage trees & shrubs	121	EA	25	3,025	5	605	20	2,420	6,050	50	
Plant screening trees	85	EA	20	1,700	5	425	15	1,275	3,400	40	Conifer or pacific yew
Fencing, cyclone	1100	LF	6	6,600	0	0	4	4,400	11,000	10	Protect trees
Fertilize	11	ACR	30	330	0	0	20	220	550	50	
Remove fence	1100	LF	1	1,100	1	1,100	0	0	2,200	2	
Subtotal									$30,845	$2,804	
OH&P 20%									6,169		
Subtotal									$37,014	$3,365	
Contingency 15%									5,552		
Total									$42,566		
Total, Rounded									$43,000	$3,909	

Mitigation Site No. 7
Meadow Creation
11 Acres, good soil compatibility, road required, no pre-treatment, 0-15% slopes, existing vegetation class G/FDY/FD1, within 1/4 of reservoir and McDonald field, 6.16 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove timber	11	ACR	$100	$1,100	$125	$1,375	$0	$0	$2,475	$225	Small, Decid. Non-merchantable.
Remove stumps	11	ACR	125	1,375	160	1,760	0	0	3,135	285	
Scarify	11	ACR	30	330	30	330	0	0	660	60	
Apply lime	11	ACR	30	330	0	0	10	110	440	40	
Disk & seed	11	ACR	30	330	30	330	25	275	935	85	
Plant forage trees & shrubs	121	EA	25	3,025	5	605	20	2,420	6,050	50	
Plant screening trees	85	EA	20	1,700	5	425	15	1,275	3,400	40	Conifer or pacific yew
Fencing, cyclone	1100	LF	6	6,600	0	0	4	4,400	11,000	10	Protect trees
Fertilize	11	ACR	30	330	0	0	20	220	550	50	
Remove fence	1100	LF	1	1,100	1	1,100	0	0	2,200	2	
Subtotal									$30,845	$2,804	
OH&P 20%									6,169		
Subtotal									$37,014	$3,365	
Contingency 15%									5,552		
Total									$42,566		
Total, Rounded									$43,000	$3,909	

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Mitigation Site No. 8
Meadow Creation/Managed Forest
14 Acres, good soil compatibility, road required, no pre-treatment, 0-30% slopes, existing vegetation class G/FDY, within 1/4 of reservoir and McDonald field, 6.65 habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove timber	14	ACR	$100	$1,400	$125	$1,750	$0	$0	$3,150	$225	Small, Decid. Non-merchantable.
Remove stumps	14	ACR	125	1,750	160	2,240	0	0	3,990	285	
Scarify	14	ACR	30	420	30	420	0	0	840	60	
Apply lime	14	ACR	30	420	0	0	10	140	560	40	
Disk & seed	14	ACR	30	420	30	420	25	350	1,190	85	
Plant forage trees & shrubs	196	EA	25	4,900	5	980	20	3,920	9,800	50	
Plant screening trees	85	EA	20	1,700	5	425	15	1,275	3,400	40	Conifer or pacific yew
Fencing, cyclone	1100	LF	6	6,600	0	0	4	4,400	11,000	10	Protect trees
Fertilize	14	ACR	30	420	0	0	20	280	700	50	
Nests	8	EA	40	320	10	80	30	240	640	80	
Remove fence	1100	LF	1	1,100	1	1,100	0	0	2,200	2	
Subtotal									$37,470	$2,676	
OH&P 20%									7,494		
Subtotal									$44,964	$3,212	
Contingency 15%									6,745		
Total									$51,709		
Total, Rounded									52,000	$3,714	

HOWARD ISON DAM ADDITIONAL WATER STORAGE PROJECT - FEAS TY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 9
Manage as mature forest
10 Acres, no road required, 0-30% slopes, existing vegation class FD1/FM,
within 1/4 mile from reservoir on south side, ___habitat units gained

			Labor		Equipment		Material				
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Unit Price	Comments
TREATMENTS											
Remove Timber	0	ACR	$100	$0	$125	$0	$0	$0	$0	$225	Assume merchantable
Remove Stumps	1	ACR	125	125	160	160	0	0	285	285	This and the next three items
Scarify	1	ACR	30	30	30	30	0	0	60	60	are done for grass planting
Apply Lime	1	ACR	30	30	0	0	10	10	40	40	under alder stands
Disk & Seed	1	ACR	30	30	30	30	25	25	85	85	
Plant forage trees & shru	2.5	ACR	200	500	35	87.5	200	500	1,088	435	Accomplished over 1/4 of site
Fertilize	10	ACR	30	300	0	0	20	200	500	50	
Place Nest boxes on site	10	ACR	260	2600	0	0	0	0	2,600		
Subtotal									$4,658		
OH&P 20%									932		
Subtotal									$8,189		
Contingency 15%									1,228		
Total									$9,417		
Total, rounded									$9,400		
Herbicide Trees	2.5	ACR	250	625	250	625	50	125	1,375		
Subtotal									1,375		
OH&P 100%									688		
Subtotal									2,063		
Contingency 15%									309		
Total									2,372		
Total, rounded									2,400		
Harvest Selected Alder	1	ACR	100	100	125	125	0	0	225		
Subtotal									225		
OH&P 100%									225		
Subtotal									450		
Contingency 15%									68		
Total									518		
Total, rounded									500		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 10
10 Acres, road required, 0-30% slopes, existing vegation class FD1/FM,
within 1/4 mile from reservoir on south side, ____habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Road Access, with RR crossing	0.1	MI	35,000	3500	35,000	3500	15,000	1500	8500		
Remove Timber	0	ACR	$100	$0	$125	$0	$0	$0	0	$225	Assume merchantable
Remove Stumps	1	ACR	125	125	160	160	0	0	285	285	This and the next three items
Scarify	1	ACR	30	30	30	30	0	0	60	60	are done for grass planting
Apply Lime	1	ACR	30	30	0	0	10	10	40	40	under alder stands
Disk & Seed	1	ACR	30	30	30	30	25	25	85	85	
Plant forage trees & shrubs	2.5	ACR	200	500	35	87.5	200	500	1,088	435	Accomplished over 1/4 of site
Fertilize	10	ACR	30	300	0	0	20	200	500	50	
Place Nest boxes on site	10	ACR	260	2600	0	0	0	0	2600		
Subtotal									$13,158		
OH&P 20%									2,632		
Subtotal									$15,789		
Contingency 15%									2,368		
Total									$18,157		
Total, Rounded									$18,200	1820	
Herbicide Trees	2.5	ACR	250	625	250	625	50	125	1,375		
Subtotal									1,375		
OH&P 100%									688		
Subtotal									2,063		
Contingency 15%									309		
Total									2,372		
Total, rounded									2,400		
Harvest Selected Alders	1	ACR	100	100	125	125	0	0	225		
Subtotal									225		
OH&P 100%									225		
Subtotal									450		
Contingency 15%									68		
Total									518		
Total, rounded									500		

HOWARD ...SON DAM ADDITIONAL WATER STORAGE PROJECT - FEAS ...ITY STUDY
WILDLIFE ... ...IGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 12
Manage as mature forest
12 Acres, no road required, 0-30% slopes, existing vegation class FD/FDY,
within 1/4 mile from reservoir on south side, ____habitat units gained

			Labor		Equipment		Material				
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Unit Price	Comments
TREATMENTS											
Remove Timber	0	ACR	$100	$0	$125	$0	$0	$0	$0	$225	Assume merchantable
Remove Stumps	1	ACR	125	125	160	160	0	0	285	285	This and the next three items
Scarify	1	ACR	30	30	30	30	0	0	60	60	are done for grass planting
Apply Lime	1	ACR	30	30	0	0	10	10	40	40	under alder stands
Disk & Seed	1	ACR	30	30	30	30	25	25	85	85	
Plant forage trees & shrubs	3	ACR	200	600	35	105	200	600	1,305	435	Accomplished over 1/4 of site
Fertilize	1	ACR	30	30	0	0	20	20	50	50	
Place Nest Boxes on site	12	ACR	260	3120	0	0	0	0	3,120		
Subtotal									$4,945		
OH&P 20%									989		
Subtotal									$5,934		
Contingency 15%									890		
Total									$6,824		
Total, rounded									$6,800		
Herbicide Trees	3	ACR	250	750	250	750	50	150	$1,650		
Subtotal									$1,650		
OH&P 100%									825		
Subtotal									$2,475		
Contingency 15%									371		
Total									$2,846		
Total, rounded									$2,800		
Harvest Selected Alders	3	ACR	100	300	125	375	0	0	$675		
Subtotal									$675		
OH&P 100%									675		
Subtotal									$1,350		
Contingency 15%									203		
Total									$1,553		
Total, rounded									$1,600		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 13
Manage as mature forest
10 Acres, no road required, 0-30% slopes, existing vegation class FD/FM,
within 1/4 mile from reservoir and MacDonald field, ____habitat units gained

			Labor		Equipment		Material			Unit	
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Price	Comments
TREATMENTS											
Remove Timber	0	ACR	$100	$0	$125	$0	$0	$0	$0	$225	Assume merchantable
Remove Stumps	1	ACR	125	125	160	160	0	0	285	285	This and the next three items
Scarify	1	ACR	30	30	30	30	0	0	60	60	are done for grass planting
Apply Lime	1	ACR	30	30	0	0	10	10	40	40	under alder stands
Disk & Seed	1	ACR	30	30	30	30	25	25	85	85	
Plant forage trees & shrubs	2.5	ACR	200	500	35	87.5	200	500	1,088	435	Accomplished over 1/4 of site
Fertilize	1	ACR	30	30	0	0	20	20	50	50	
Place Nest Boxes on site	10	ACR	260	2600	0	0	0	0	2600		
Subtotal									$4,208		
OH&P 20%									842		
Subtotal									$5,049		
Contingency 15%									757		
Total									$5,806		
Total, rounded									$5,800		
Herbicide Trees	2.5	ACR	250	625	250	625	50	125	$1,375		Accomplished over 1/4 of site
Subtotal									$1,375		
OH&P 100%									688		
Subtotal									$2,063		
Contingency 15%									309		
Total									$2,372		
Total, rounded									$2,400		
Harvest Selected Alders	2.5	ACR	100	250	125	312.5	0	0	$563		Accomplished over 1/4 of site
Subtotal									$563		
OH&P 100%									563		
Subtotal									$1,125		
Contingency 15%									169		
Total									$1,294		
Total, rounded									$1,300		

HOWARD [illegible]NSON DAM ADDITIONAL WATER STORAGE PROJECT - FEAS[illegible]TY STUDY
WILDLIFE [illegible]IGATION/RESTORATION SITES
October 1997 Price Level
Mitigation Site No. 14 - Manage as mature forest and elk grazing pasture
20 Acres, 5 acres of pasture, 15 acres of managed forest, road required, 0-30% slopes, existing vegation class existing vegetation class FC/FM, over 1/4 mile from reservoir and McDonald field,___ habitat units gained

			Labor		Equipment		Material				
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Unit Price	Comments
Pasture Creation											
TREATMENTS											
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$10,000	$2,500	$20,000	$80,000	
Remove Timber	5	ACR	$0	$0	$0	$0	$0	$0	$0	$0	Assume Merchantable
Remove Stumps	5	ACR	125	625	160	800	0	0	1425	285	
Scarify	5	ACR	30	150	30	150	0	0	300	60	
Apply Lime	5	ACR	30	150	0	0	10	50	200	40	
Disk & Seed	5	ACR	30	150	30	150	25	125	425	85	
Plant forage trees & shrubs	5	ACR	200	1000	35	175	200	1000	2175	435	
Plant screening trees	50	EA	20	1000	0	0	15	750	1750	35	
Fencing, cyclone	500	LF	6	3000	0	0	4	2000	5000	10	
Fertilize	5	ACR	30	150	0	0	20	100	250	50	
Remove fence	500	LF	1	500	0	0	0	0	500	1	
Subtotal									$32,025		
OH&P 20%									6405		
Subtotal									$38,430		
Contingency 15%									5764.5		
Total									$44,195		
Total, Rounded									$44,200		
Manged Forest											
TREATMENTS											
Remove Selected Timber	15	ACR	$0	$0	$0	$0	$0	$0	$0	$0	Assume Merchantable
Top-girdle Trees@4/acre	15	ACR	$140	$2,100	$10	$150	$0	$0	$2,250	$150	
Place Large Woody Debris	15	ACR	50	750	100	1500	0	0	2250	150	
Apply Lime	15	ACR	30	450	0	0	10	150	600	40	
Plant forage trees & shrubs	15	ACR	200	3000	35	525	200	3000	6525	435	
Fertilize	15	ACR	30	450	0	0	20	300	750	50	
Place Nest boxes on site	10	ACR	160	1600	0	0	100	1000	2600		
Subtotal									$14,975		
OH&P 20%									2995		
Subtotal									$17,970		
Contingency 15%									2695.5		
Total									$20,666		
Total, Rounded									$21,000		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 15
Manage as mature forest
15 Acres, no road required, 0-70% slopes, existing vegetation class FM,
over 1/4 mile from reservoir and MacDonald field, ____habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Remove Selected Timber	15	ACR	$0	$0	$0	$0	$0	$0	$0		Assume Merchantable
Top-girdle Trees@4/acre	15	ACR	$140	$2,100	$10	$150	$0	$0	2,250		
Place Large Woody Debris	15	ACR	50	750	100	1500	0	0	2,250		
Apply Lime	15	ACR	30	450	0	0	10	150	600		
Plant forage trees & shrubs	15	ACR	200	3000	35	525	200	3000	6,525		
Fertilize	15	ACR	30	450	0	0	20	300	750		
Place Nest Boxes on site	10	ACR	260	2600	0	0	0	0	2,600		Labor cost includes materials cost
Subtotal									$14,975		
OH&P 20%									2,995		
Subtotal									$17,970		
Contingency 15%									2,696		
Total									$20,965		
Total, rounded									$21,000		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 17
Manage existing elk grazing pasture, with pocket wetlands, and mature forest
10 Acres, 2 acres of pasture, 7 acres of managed forest, 1 acre of wetlands, road required, 0-15% slopes, existing vegation class existing vegetation class FD/FDy/G, within 1/4 mile from south side of reservoir,___ habitat units gained

			Labor		Equipment		Material				
Description	Quantity	Unit	Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal	Total	Unit Price	Comments
TREATMENTS											
Pasture Creation											
Access Road	0.5	MI	$35,000	$17,500	$35,000	$17,500	$10,000	$5,000	$40,000	$80,000	
Remove Timber	2	ACR	$0	$0	$0	$0	$0	$0	0	$0	Assume Merchantable
Remove Stumps	2	ACR	125	250	160	320	0	0	570	285	
Scarify	2	ACR	30	60	30	60	0	0	120	60	
Apply Lime	2	ACR	30	60	0	0	10	20	80	40	
Disk & Seed	2	ACR	30	60	30	60	25	50	170	85	
Plant forage trees & shrubs	2	ACR	200	400	35	70	200	400	870	435	
Plant screening trees	0	EA	20	0	0	0	15	0	0	35	
Fencing, cyclone	0	LF	6	0	0	0	4	0	0	10	
Fertilize	0	ACR	30	0	0	0	20	0	0	50	
Remove fence	0	LF	1	0	0	0	0	0	0	1	
Subtotal									$41,810		
OH&P 20%									8,362		
Subtotal									$50,172		
Contingency 15%									7,526		
Total									$57,698		
Total, Rounded									$57,700		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 17

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
Manged Forest											
TREATMENTS											
Remove Selected Timber	7	ACR	$0	$0	$0	$0	$0	$0	$0	$0	Assume Merchantable
Top-girdle Trees@4/acre	7	ACR	$140	$980	$10	$70	$0	$0	1,050	150	
Place Large Woody Debris	7	ACR	50	350	100	700	0	0	1,050	150	
Apply Lime	7	ACR	30	210	0	0	10	70	280	40	
Plant forage trees & shrubs	7	ACR	200	1400	35	245	200	1400	3,045	435	
Fertilize	7	ACR	30	210	0	0	20	140	350	50	
Place Nest boxes on site	7	ACR	160	1120	0	0	100	700	1,820		
Subtotal									$7,595		
OH&P 20%									1,519		
Subtotal									$9,114		
Contingency 15%									1,367		
Total									$10,481		
Total, rounded									$10,500		

Create Pocket Wetlands											
Excavate channels and ponds	24	HR	120	2880	0	0	0	0	$2,880		Equipment Rental
Dispose of excavated material	1000	CY	7	7000	0	0	0	0	7,000		Equipment Rental
Place Nest boxes on site	1	ACR	160	160	0	0	100	100	260		
Subtotal									$10,140		
OH&P 20%									2,028		
Subtotal									$12,168		
Contingency 15%									1,825		
Total									$13,993		
Total, rounded									$14,000		

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HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 18
Manage as mature forest
15 Acres, road required, 0-70% slopes, existing vegetation class FM/FD/FC,
within 1/4 mile of reservoir and MacDonald field, ____habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$10,000	$2,500	$20,000	$80,000	
Remove Selected Timber	15	ACR	$0	$0	$0	$0	$0	$0	0		Assume Merchantable
Top-girdle Trees@4/acre	15	ACR	$140	$2,100	$10	$150	$0	$0	2,250	150	
Place Large Woody Debris	15	ACR	50	750	100	1500	0	0	2,250	150	
Apply Lime	15	ACR	30	450	0	0	10	150	600	40	
Plant forage trees & shrubs	15	ACR	200	3000	35	525	200	3000	6,525	435	
Fertilize	15	ACR	30	450	0	0	20	300	750	50	
Place Nest Boxes on site	10	ACR	260	2600	0	0	0	0	2,600	260	Labor cost includes materials cost
Subtotal									$34,975		
OH&P 20%									6,995		
Subtotal									$41,970		
Contingency 15%									6,296		
Total									$48,266		
Total, rounded									$48,300		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 19 and 20
Manage as mature forest
15 Acres, road required, 0-70% slopes, existing vegetation class FM/FD/FC,
over 1/4 mile from reservoir, within 1/4 mile of MacDonald field, ____habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$10,000	$2,500	$20,000	$80,000	
Remove Selected Timber	15	ACR	0	0	0	0	0	0	0		Assume Merchantable
Top-girdle Trees@4/acre	15	ACR	140	2,100	10	150	0	0	2,250		
Place Large Woody Debris	15	ACR	50	750	100	1,500	0	0	2,250		
Apply Lime	15	ACR	30	450	0	0	10	150	600		
Plant forage trees & shrubs	15	ACR	200	3,000	35	525	200	3,000	6,525		
Fertilize	15	ACR	30	450	0	0	20	300	750		
Place Nest Boxes on site	10	ACR	260	2,600	0	0	0	0	2,600		Labor cost includes materials cost
Subtotal									$34,975		
OH&P 20%									6,995		
Subtotal									$41,970		
Contingency 15%									6,296		
Total									$48,266		
Total									$48,300		

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HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 22
Wetland creation
8 Acres--5 planted to sedges, 3 created by subimpoundment, no road required, no pre-treatment, 0-15% slopes, existing vegation class FM/FD/SS, adjacent to reservoir, over 1/4 mile from McDonald field, ___habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Plant Sedges*	5	AC	5400	27000	0	0	0	0	27,000		*Labor cost includes
Subtotal									$27,000		cost of plants
OH&P 20%									5400		
Subtotal									$32,400		
Contingency 15%									4860		
Total									$37,260		
Total, rounded									$37,300		
Create Subimpoundment											
Engineering Design	15	DAY	$600	9000	0	0	0	0	9,000		
Permitting	4	DAY	$500	2000	0	0	0	0	2,000		
Berm Construction--matieral hauling	15,000	CY	$7	105000	0	0	0	0	105,000		Equipment rental
Berm Construction--shaping matieral	24	HR	$120	2880	0	0	0	0	2,880		Equipment rental
Outlet control structure	1	UNIT	$30,000	30000	0	0	0	0	30,000		
Spillway	1	UNIT	$5,000	5000	0	0	0	0	5,000		
Place Large Woody Debris	3	ACR	50	150	100	300	0	0	450		
Place Nest boxes on site	3	ACR	160	480	0	0	100	300	780		
Subtotal									$155,110		
OH&P 20%									31,022		
Subtotal									$186,132		
Contingency 15%									27,920		
									$214,052		
Total									$214,100		

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HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 23
Wetland creation
10 Acres planted to sedges, road required, no pre-treatment, 0-15% slopes, existing vegation classes FM/FD/SS/ML, adjacent to reservoir, over 1/4 mile from McDonald field, ___habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$10,000	$2,500	$20,000	$80,000	
Subtotal									$20,000		
OH&P 20%									4,000		
Subtotal									$24,000		
Contingency 15%									3,600		
Total									$27,600		
Plant Sedges*	10	AC	5400	54000	0	0	0	0	54000		*Labor cost includes
Subtotal									$54,000		cost of plants
OH&P 20%									10,800		
Subtotal									$64,800		
Contingency 15%									9,720		
Total									$74,520		
									$102,100		

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HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 24
Wetland creation
15 Acres--9 planted to sedges, 6 created by subimpoundment, no road required, no pre-treatment, 0-15% slopes, existing vegation class FM/FD/SS/EM, adjacent to reservoir, at McDonald field, ___habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Plant Sedges*	9	AC	5400	48600	0	0	0	0	48,600		*Labor cost includes
Subtotal									$48,600		cost of plants
OH&P 20%									9,720		
Subtotal									$58,320		
Contingency 15%									8,748		
Total									$67,068		
Total, rounded									$67,100		
Create Subimpoundment											
Engineering Design	15	DAY	$600	9,000	0	0	0	0	9,000		
Permitting	4	DAY	$500	2,000	0	0	0	0	2,000		
Berm Construction--materal hauling	26,000	CY	$7	182,000	0	0	0	0	182,000		Equipment rental
Berm Construction--shaping materal	48	HR	$120	5,760	0	0	0	0	5,760		Equipment rental
Outlet control structure	1	UNIT	$30,000	30,000	0	0	0	0	30,000		
Spillway	1	UNIT	$5,000	5,000	0	0	0	0	5,000		
Place Large Woody Debris	6	ACR	50	300	100	600	0	0	900		
Place Nest boxes on site	6	ACR	160	960	0	0	100	600	1,560		
Subtotal									$236,220		
OH&P 20%									47,244		
Subtotal									$283,464		
Contingency 15%									42,520		
Total									325,984		
Total, rounded									$326,000		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 25
Wetland creation
5 Acres planted to sedges, no road required, no pre-treatment, 0-15% slopes, existing vegation class EM, adjacent to reservoir, at McDonald field, ___habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Plant Sedges*	5	AC	5,400	27,000	0	0	0	0	27,000		*Labor cost includes
Subtotal									$27,000		cost of plants
OH&P 20%									5,400		
Subtotal									$32,400		
Contingency 15%									4,860		
Total									$37,260		
Total									$37,300		

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 26
Wetland creation
5 Acres of subimpoundment, no road required, no pre-treatment, 0-15% slopes, existing vegation class FD,FD1, adjacent to reservoir, 1/2 mile from McDonald field, ___habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal		
TREATMENT										
Create Subimpoundment										
Engineering Design	15	DAY	600	9,000	0	0	0	0	9,000	
Permitting	4	DAY	500	2,000	0	0	0	0	2,000	
Berm Construction--matieral hauling	5000	CY	7	35,000	0	0	0	0	35,000	Equipment rental
Berm Construction--shaping matieral	24	HR	120	2,880	0	0	0	0	2,880	Equipment rental
Outlet control structure	1	UNIT	30,000	30,000	0	0	0	0	30,000	
Spillway	1	UNIT	5,000	5,000	0	0	0	0	5,000	
Place Large Woody Debris	5	ACR	50	250	100	500	0	0	750	
Place Nest boxes on site	5	ACR	160	800	0	0	100	500	1,300	
Subtotal									$85,930	
OH&P 20%									17186	
Subtotal									$103,116	
Contingency 15%									15,467	
Total									$118,583	
Total									$118,600	

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Mitigation Site No. 27
Manage as mature forest
100 Acres, road required, 0-70% slopes, existing vegetation class FM/FD/FC,
some within 1/4 mile from reservoir, some within 1/4 mile of MacDonald field, ____habitat units gained

Description	Quantity	Unit	Labor		Equipment		Material		Total	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal		
TREATMENTS										
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$10,000	$2,500	$20,000	
Remove Selected Timber	100	ACR	$0	$0	$0	$0	$0	$0	$0	Assume Merchantable
Top-girdle Trees@4/acre	100	ACR	$140	$14,000	$10	$1,000	$0	$0	$15,000	
Place Large Woody Debris	100	ACR	50	5000	100	10000	0	0	15000	
Apply Lime	100	ACR	30	3000	0	0	10	1000	4000	
Plant forage trees & shrubs	100	ACR	200	20000	35	3500	200	20000	43500	
Fertilize	100	ACR	30	3000	0	0	20	2000	5000	
Place Nest Boxes on site	100	ACR	260	26000	0	0	0	0	26000	Labor cost includes materials cost
Subtotal									$128,500	
OH&P 20%									25700	
Subtotal									$154,200	
Contingency 15%									23130	
Total									$177,330	
Total									$177,300	

HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Description	Quantity	Unit	Labor		Equipment		Material		Total	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal		
TREATMENTS										
Access Road	0.25	MI	$35,000	$8,750	$35,000	$8,750	$80,000	$20,000	$20,000	
Remove Selected Timber	50	ACR	$0	$0	$0	$0	$0	$0	$0	Assume Merchantable
Top-girdle Trees@4/acre	50	ACR	$140	$7,000	$10	$500	$0	$0	$7,500	
Place Large Woody Debris	50	ACR	50	2500	100	5000	0	0	7500	
Apply Lime	50	ACR	30	1500	0	0	10	500	2000	
Plant forage trees & shrubs	50	ACR	200	10000	35	1750	200	10000	21750	
Fertilize	50	ACR	30	1500	0	0	20	1000	2500	
Place Nest Boxes on site	50	ACR	260	13000	0	0	0	0	13000	Labor cost includes materials cost
Subtotal									$74,250	
OH&P 20%									14850	
Subtotal									$89,100	
Contingency 15%									13365	
Total									$102,465	
Total									$102,500	

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HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT - FEASIBILITY STUDY
WILDLIFE MITIGATION/RESTORATION SITES
October 1997 Price Level

Sedge Plantings (coir mats)

Description	Quantity	Unit	Labor		Equipment		Material		Total	Unit Price	Comments
			Unit Price	Subtotal	Unit Price	Subtotal	Unit Price	Subtotal			
TREATMENTS											
Plant Sedges*	5	AC	5,400	27,000	0	0	0	0	27,000		*Labor cost includes
Subtotal									$27,000		cost of plants
OH&P 20%									5,400		
Subtotal									$32,400		
Contingency 15%									4,860		
Total									$37,260		
Total									$37,300		

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ANNEX X. MAPS

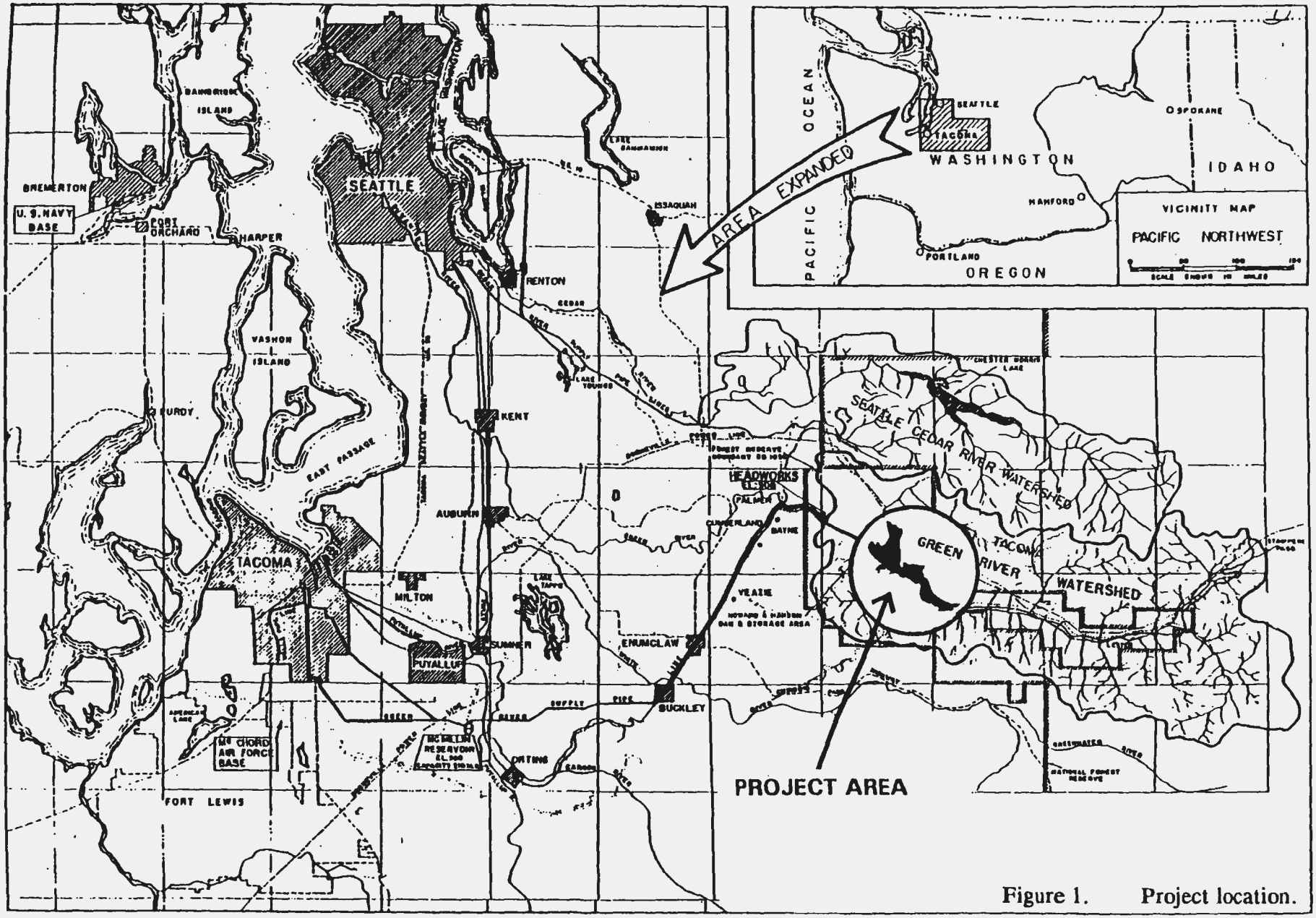
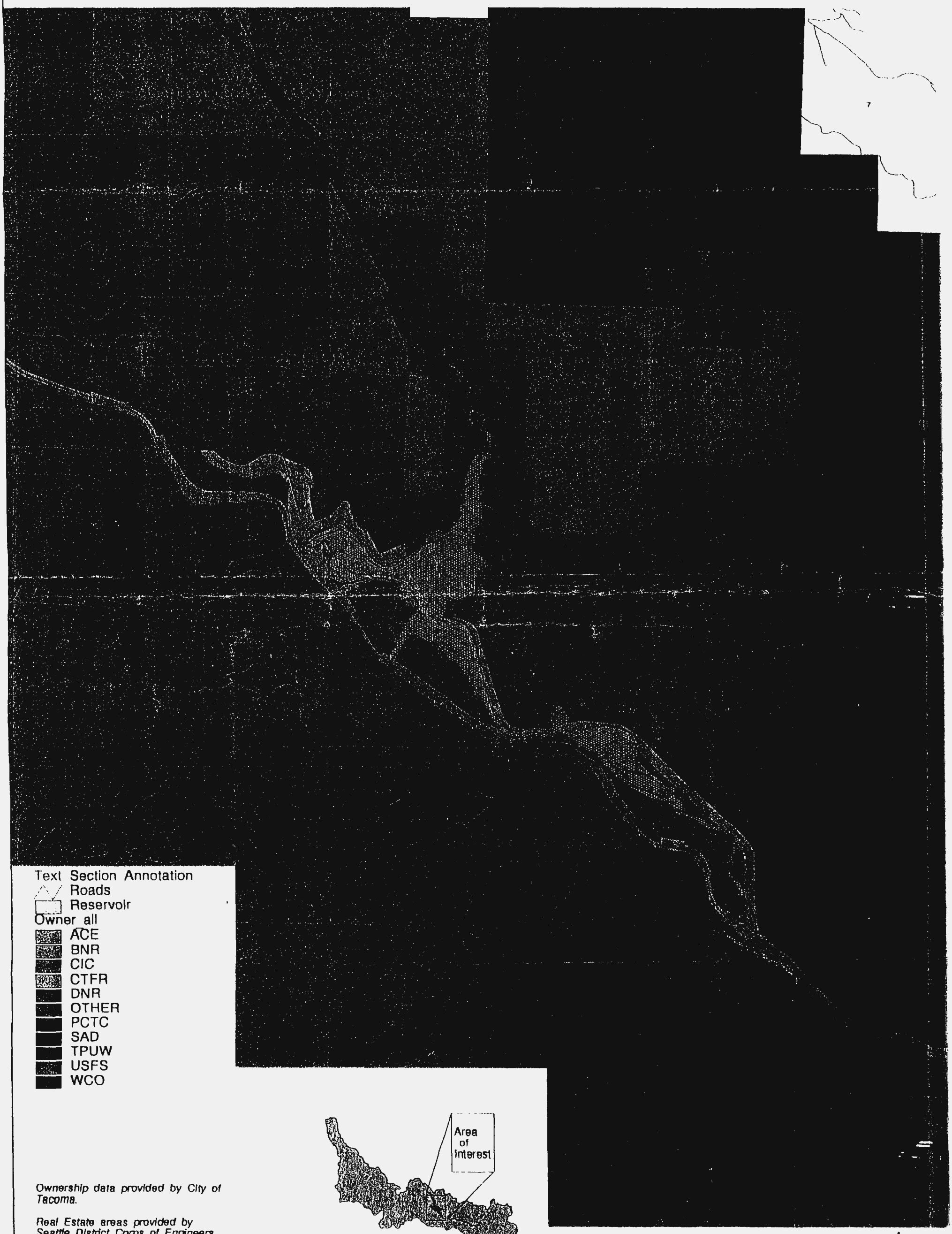


Figure 1. Project location.

Ownership - Howard Hanson



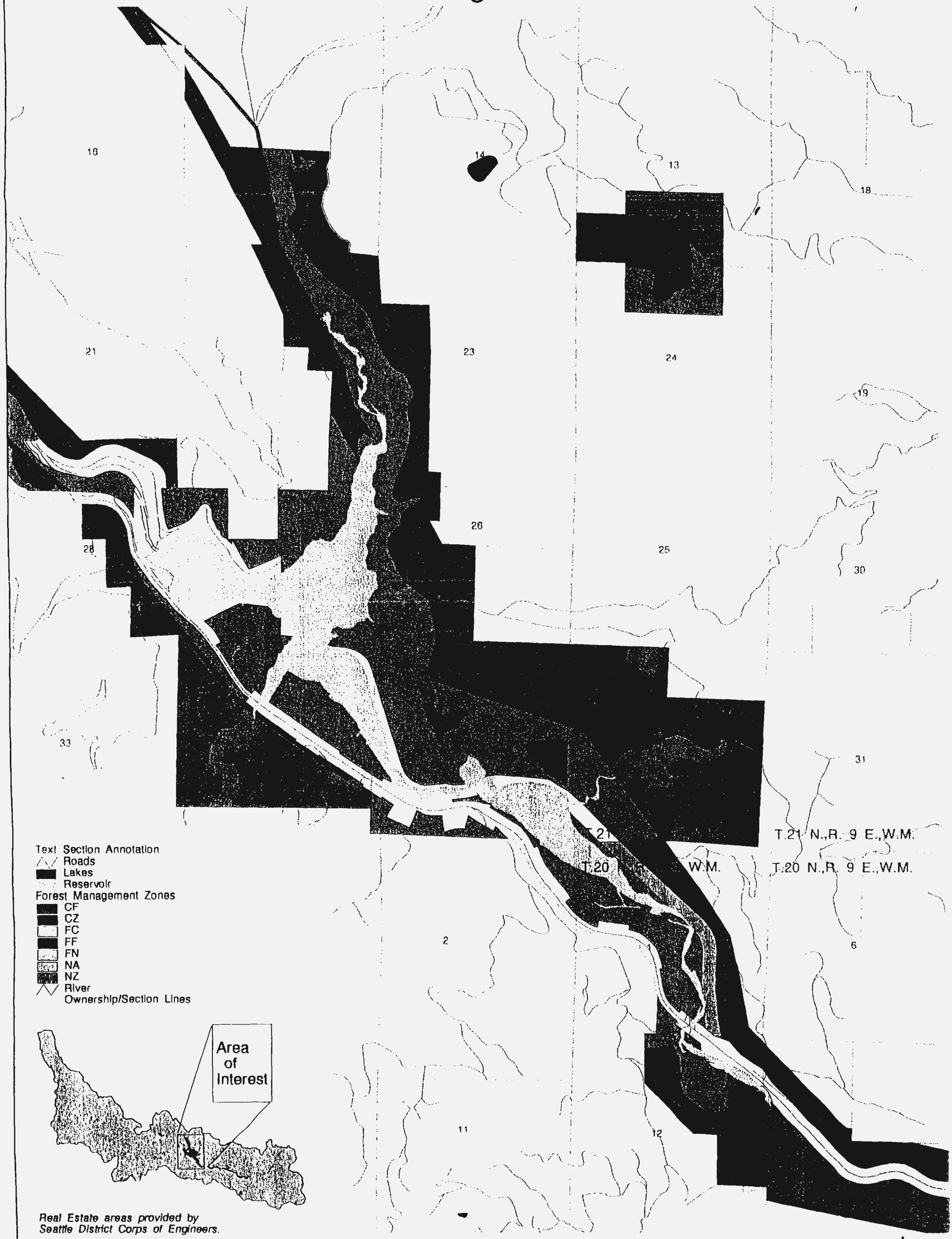
Ownership data provided by City of Tacoma.

Real Estate areas provided by Seattle District Corps of Engineers.

Howard Hanson Dam - Figure 2

Corps of Engineers, Seattle District

Forest Management Zones



Text Section Annotation
Roads
Lakes
Reservoir
Forest Management Zones
CF
CZ
FC
FF
FN
NA
NZ
River
Ownership/Section Lines

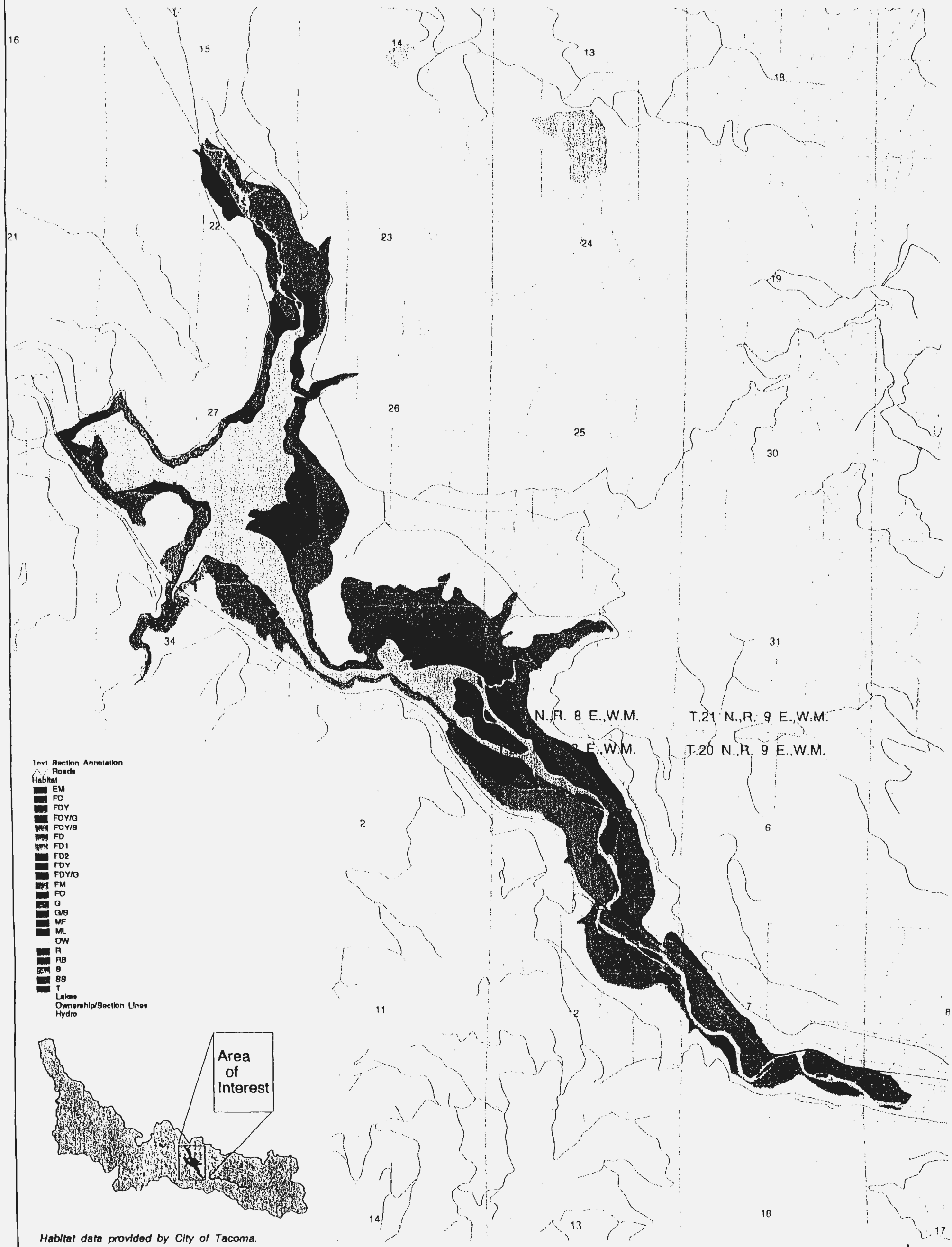
Real Estate areas provided by Seattle District Corps of Engineers.

Transportation data supplied by Wash. State Dept of Natural Resources (DNR).

Howard Hanson Dam - Figure 3

Corps of Engineers, Seattle District

Habitat - Howard Hanson



Habitat data provided by City of Tacoma.

Transportation data supplied by Wash. State Dept of Natural Resources (DNR).

Howard Hanson Dam - Figure 4

Corps of Engineers, Seattle District

17-4

Wildlife Sites and Forest Planning Sites

FP-01

FP-02

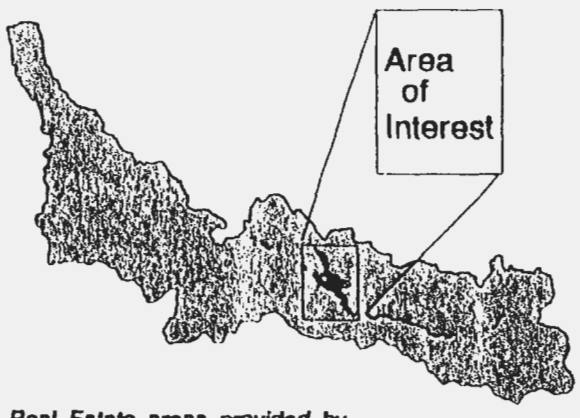
T.21 N.,R. 8 E.,W.M.

T.21 N.,R. 9 E.,W.M.

T.20 N.,R. 8 E.,W.M.

T.20 N.,R. 9 E.,W.M.

Text Section Annotation
Access Roads
Wildlife Sites
Forest Planning Sites
Roads
Lakes
Reservoir
River
Ownership/Section Lines



Real Estate areas provided by Seattle District Corps of Engineers.

Transportation data supplied by Wash. State Dept of Natural Resources (DNR).

Howard Hanson Dam - Figure 5

Corps of Engineers, Seattle District