CHAPTER 4: STEHEKIN AREA IMPLEMENTATION PLAN

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SECTION 1: INTRODUCTION

This Chapter outlines the steps to be taken to address issues relating to the Stehekin area at the northern end of Lake Chelan. The Stehekin area includes a relatively flat area of approximately 300 acres that is periodically inundated by water fluctuations due to reservoir operations, known as "the flats" or "the drawdown zone." It also includes the mouth of the Stehekin River, and the dock, store, and associated buildings known as Stehekin Landing. The issues addressed are of critical interest to the NPS in the relicensing process because of its management responsibility for land in and near the Stehekin area.

Prior to development of the Lake Chelan Project, the drawdown zone included forest, floodplain areas, small homesteads, and a hotel. Historic photos show parts of the area around the Field's Hotel, located at the head of the lake, bordered by a riparian zone. They also show the natural delta with small streams or distributor channels created by the Stehekin River and Little Boulder Creek draining into Lake Chelan. The many large diameter tree stumps still in the drawdown zone provide evidence that Stehekin Flats included forested areas before the lake level was raised. Past Chelan PUD management of the drawdown zone has included the contracted removal of many of the stumps.

The Riparian Zone Investigation prepared for Chelan PUD by Duke Engineering & Services Inc. (DE&S, 2000) identified the riparian zone at the head of Lake Chelan as the largest and most important within the boundaries of the Lake Chelan Project. Productivity, species diversity, and abundance were assessed for birds, small mammals, amphibians, and reptile species. This lakeshore habitat had the highest number of species and the greatest abundance of both birds and small mammals of all the areas studied. The study concluded that "[t]he Stehekin River had the most abundant and stable riparian habitats and was the only site studied with a significant area of emergent wetland."

SECTION 2: GOALS OF THE STEHEKIN MANAGEMENT PLAN

This plan is intended to provide strategies to reduce airborne dust events, monitor changes in the Stehekin River channel topography, restore native riparian vegetation, reduce the invasion of non-native plants, and enhance habitat for native wildlife species that use the drawdown zone, shoreline, and adjacent lands. This plan takes a holistic approach to address several NPS natural resource management goals for the drawdown zone during the period of the New License. To implement this plan, Chelan PUD, NPS, and other interested parties will attempt to:

1. Create and maintain a partnership for the implementation, assessment, and refinement of this plan;
2. Seek additional funding and in-kind partnership support for achieving goals, while minimizing the extent of commitment or burden to any single partner;

3. Reduce the magnitude and duration of fugitive dust events that carry dust into the Stehekin Landing;
4. Protect existing riparian habitat along the shoreline and in the drawdown zone, and enlarge and connect it, where feasible, so that it will function as a multi-storied, diverse, riparian vegetation and wildlife corridor;
5. Reduce the current abundance, distribution, and cover of reed canary grass, and control the spread of other non-native plants along the shoreline; and
6. Monitor native plants and wildlife for species richness, abundance, and distribution, to measure the success of these measures.

SECTION 3: IMPLEMENTATION

3.1 Responsibilities

During the New License term, Chelan PUD will monitor the Stehekin River channel, at a cost not to exceed $90,000. In addition, Chelan PUD will make available $160,000 to the NPS for implementing all other parts of this plan. Actions taken pursuant to this Chapter (other than river channel monitoring), will be coordinated with the Historic Properties and Cultural Resources Management Plan described in Chapter 10 of the Comprehensive Plan so that they do not conflict.

Chelan PUD and the NPS will cooperate in obtaining necessary permits. This plan anticipates the NPS will take the lead in obtaining permits, with assistance from Chelan PUD in the case of permits for work on Chelan PUD land.

This plan calls for the NPS to monitor for changes in species richness, abundance, and distribution throughout the implementation period, to evaluate progress toward objectives. The Riparian Zone Investigation (DE&S, 2000) study will serve as the baseline for purposes of such monitoring.

3.2 Monitoring Program

Progress toward the goals of this plan will be monitored in order to provide a basis for reallocating resources as appropriate. Where possible, standard monitoring protocols will be used to minimize cost and increase the chance of obtaining meaningful, comparable data. Key parts of the monitoring program will be repeated each five years. This plan anticipates monitoring will be carried out by the NPS, with the exception of Stehekin River channel monitoring, which will be carried out by Chelan PUD. A team of relevant personnel from Chelan PUD and the NPS will meet every five years to evaluate the most recent monitoring results. Based on such monitoring results, the team may recommend the reallocation of resources, and such reallocations shall be made, subject to the concurrence of both the NPS and Chelan PUD.

Monitoring will focus on the following questions:

- Are management actions affecting the existing habitat adversely or beneficially?
- Are we protecting existing riparian habitat, or is progressive loss of riparian habitat taking place?
- Are we reducing the magnitude and duration of fugitive dust at Stehekin Landing?
- Are we reducing the area of infestation by non-native canary reed grass?
- Are we increasing the abundance and distribution of native riparian vegetation in areas previously infested with non-native plants?
- Are the revegetated sites connected with protected riparian habitat, and are they sufficient to support greater wildlife species abundance and distribution?

3.3 Partnerships

Goals 1 and 2 of this plan are to establish partnerships and seek additional sources of funding. These goals are particularly important because there is a considerable amount of private land within the Stehekin area, and it will be important to assist those private land owners who wish to undertake steps consistent with this plan. The Chelan County Conservation District has a Resource Conservation and Development Board for riparian restoration, which can assist private property owners with grant money and work crews. The Natural Resource Conservation Service also can provide cost-sharing for private property owners who undertake restoration projects.

The natural resource problems addressed by this plan are unusual and complex. To assure that the best available science is being employed, it may be beneficial to seek outside scientific peer review of aspects of this plan. Contingent on the approval of both the NPS and Chelan PUD, the Society for Ecological Restoration, or some other non-profit, scientific organization, may be contacted to provide such peer review. The cost of such peer review services is not part of Chelan PUD's obligation.

SECTION 4: FUGITIVE DUST MITIGATION AND ABATEMENT

Goal 3 of this plan is to reduce the magnitude and duration of fugitive dust events that carry dust into Stehekin Landing.

4.1 Measurable Objective

Defining a measurable objective for the dust abatement effort has proved problematic. The intent is to substantially reduce the objectionable effects of dust, primarily impaired visibility and discomfort. Because visibility is difficult to measure objectively, and discomfort is largely subjective, Chelan PUD and the NPS simply chose to seek a 50 percent reduction in the magnitude and duration of dust events, in the expectation that such a reduction would create substantial improvements in conditions at Stehekin Landing. The goal of a 50 percent reduction assumes use of the measurements in the existing study report (ARS, 2001) as a baseline. Key data are summarized in section 6, Monitoring and Evaluation, below.

More specifically, the objective is to reduce the duration of dust events and the concentration of total suspended particulates (TSP) measured at Stehekin Landing during dust events by 25 percent within the first 10 years of the New License period, and by an additional 25 percent within the second 10 years of the New License period, and then continue at the 20-year level or better for the remainder of the New License. The concentration of TSP will be represented by the mass particle concentration, in $\mu g/m^3$, collected in the monitoring equipment filter during the dust event. This measure is explained in more detail in section 6. Chelan PUD and the NPS do not know whether this objective is attainable, or how much such a reduction in dust would increase visibility and/or decrease discomfort, but they anticipate that the benefits of such a reduction would be considerable.

4.2 Description of the Resource Problem

Fine sediments that are deposited in Lake Chelan by the Stehekin River cover most of the drawdown zone. The sediments are exposed after the snow melts, which varies from late February to mid-March. They are dried by the air and, except when wetted by rain, remain dry until the lake is refilled in June. Strong down-valley diurnal winds can lift the fine sediments into the air, creating a dust cloud as much as several hundred feet in the air and several miles downlake. Some of this dust is deposited at Stehekin Landing. Dust events usually occur between mid-March and mid-June.

Chelan PUD and the NPS jointly funded an air quality study to determine the timing and duration of dust events, the magnitude (amount and size of particulates), and the chemical composition of dust in the air at Stehekin Landing (ARS, 2001). Dust concentrations were measured for three particle size ranges. These were PM2.5 (smaller than 2.5 microns), PM10 (smaller than 10 microns) and total suspended particulates (TSP). The PM2.5 and PM10 sizes are known as respirable dust and concentration limits are included in EPA standards. EPA standards no longer regulate concentrations of particles larger than PM10, since they are generally no longer considered a health threat. The study determined that dust measured at Stehekin Landing did not exceed any federal air quality standards. The measured concentrations of dust in the PM2.5 and PM10 particle size ranges were below the EPA standards for those ranges. As reflected in the TSP measurements, most of the particles were larger than the PM10 particle size range and so are not regulated.

Although the study showed that the dust does not violate any air quality standards, the NPS considers the dust to be a significant problem, and is concerned about such things as reduced visibility, respiratory irritation from the dust, increased maintenance costs and increased wear and tear on computers and other equipment.

Changes in the annual cycle of water levels and inundation period from the first license to the second license have produced some changes in the drawdown area, and have complicated efforts to understand related natural resource problems. Also, recent observations have shown that normal variations from year to year in the lake level cycle can produce substantial differences in the source area and the dust.

The NPS used photography taken during the fugitive dust events monitored by the air quality study in 2000, together with previous aerial photography and a geographic information system

(GIS), to map the areas in the 300-acre drawdown zone that contribute to the airborne dust. Ninety acres of the drawdown zone appear to be of sufficient elevation to dry out when dewatered during the spring. During 2000 and 2001, only 10 to 30 acres of these 90 acres produced the bulk of airborne particulates. In 2002, the spring lake levels were lower and the source area was observed to have expanded to about 50 acres. Also, observations suggested that the frequency and severity of dust events was greater. This sort of variation should be taken into account in planning dust control efforts.

4.3 Management Actions Considered and Rejected

The Erosion Working Group (EWG) considered several possible approaches to dust control. To be effective, the EWG concluded that an approach must change one of the following factors:

- Stop or deflect wind to protect the soil surface, e.g. by means of windbreaks.
- Prevent or reverse drying of surface soil, e.g. by means of sprinklers or other irrigation.
- Decrease the exposure of the surface particles, e.g. by adding vegetative or other cover.
- Make the soils less susceptible to movement by wind, e.g. alter the grain size or cohesiveness of the surficial soils (gravel cover or dust palliative).

The following methods of dust abatement were considered:

Sprinkler System Irrigation - The use of a sprinkler system over the 50 acre fugitive dust source area was considered a promising option by the EWG. It does not produce a long-term physical, chemical, or biological solution. Its use over a large area may present some technical and logistical problems, and may be relatively expensive. Still, some form of sprinkler system may merit further consideration as part of a pilot program.

Seeding - Like the sprinkler system, seeding the flats with non-invasive cover crops is labor intensive, costly, and does not produce a self-sustaining solution to the dust problem. Seeding the drawdown zone was tested in the 1980s and was unsuccessful. Although cereal rye remains the plant of choice, its effectiveness in this situation was minimal. Given its limited growth by April and May, the cereal rye was unable to hold the fine silt with its root system, or block the wind with its stems and leaves. The grass may not have been planted thickly enough, and planting more cereal rye grass per acre is possible, but it would still not be expected to provide adequate protection because the grass will not grow tall enough within the available time frame.

Dust Palliatives - Chemical dust control solutions are intended for dry surfaces, such as dirt roads during the summer months. They typically contain chemicals that may adversely affect water quality, wildlife, and vegetation. Most are restricted from application within 100 feet of a water body. Many of these solutions contain either sodium chloride or calcium chloride. Some use a soybean-based solution, but the other ingredients are proprietary and of unknown chemical composition. These dust palliatives can pollute surface waters and cause undesired environmental impacts; thus, this method was rejected.

Windbreaks - Fences or other types of windbreaks in the drawdown area were considered by the EWG, but were expected to be unsightly and possibly labor-intensive if the fences were placed and removed at the beginning and end of each spring. In the case of materials left in place from year to year, the potential hazard to boats was considered a problem.

4.4 Management Actions for Problem Resolution

It is unlikely that any single management action will completely solve the problem of fugitive dust. A combination of actions by the NPS (placement of large woody debris with rock anchors, irrigation systems, etc.) may be required to reduce airborne dust from the drawdown zone to the desired degree. The effort to reduce dust in this situation is essentially experimental. It is anticipated that the first several years of plan implementation will include investigation of options and small-scale tests of one or more possible approaches. Alternatives proposed for investigation are described below.

This plan calls for large woody debris (LWD) with rock anchors to be placed in the fugitive dust source areas (about 50 acres) to serve as windbreaks. The LWD will be placed roughly perpendicular to the prevailing wind direction, and either anchored by chains that allow the pieces to float to the surface as the reservoir rises, or anchored directly to the lake bed so that they do not move.

Floating LWD will be placed in rows or rough circles to mimic rafts of driftwood, similar to driftwood accumulations in a shallow, sheltered bay of a lake or reservoir. The surrounding log boom should consist of the largest logs available, two logs wide, to contain free-floating logs inside the boom. The perimeter logs will be chained to rock anchors, with chains long enough to allow the logs to float at the normal maximum water elevation. The floating LWD will function as rafts of driftwood when the reservoir is full. When the reservoir is drawn down in winter, the logs will re-position themselves each year atop the exposed mud flats, ready to capture blowing silt the following spring. It is anticipated that LWD will gradually rot and provide habitat for aquatic insects and fish. Rotting logs will be retained inside the boom, when possible, in hopes of eventually forming a base for grasses and shrubs, and potentially providing some nesting habitat for waterfowl.

Alternatively, LWD may be anchored directly on the lake bottom. This approach could decrease installation and maintenance costs, but should be tested before it is applied on a broad scale. Anchoring LWD to the mud flats or lake bottom has the potential drawback that the LWD could become covered by silt after several years and no longer be effective as wind barriers.

LWD will be placed generally perpendicular to the prevailing wind direction to maximize its effectiveness as a windbreak. The use of LWD and large rock is desirable because they are expected to be less visually intrusive than non-natural materials. They should function as habitat for aquatic wildlife and fish, and the LWD will add nutrients to the system as it decomposes.

LWD will be collected from the head of the lake, where it floats clear of the Stehekin River. The NPS Forest Fuel Reduction Areas in the lower Stehekin valley may be another source of LWD. To the extent feasible, log booms will be arranged and LWD collection and placement will be coordinated so that LWD is collected and placed directly, without the need for intermediate

storage. LWD collection will be coordinated with the erosion control effort, and will not take woody material naturally deposited on the shoreline or within the Stehekin River. Large rock or boulders for anchors will be purchased down-lake and barged to the placement site.

Prior to placement of LWD, temporary windbreaks, such as snow fences, may be placed for one or two years in the area thought to be the primary source of the dust. This will serve as a test of the effectiveness of windbreaks in controlling or preventing the fugitive dust and may also help confirm the location of the source area. The fences should be placed in March and removed in early June. A plan with details of the arrangement, spacing, etc., should be developed prior to plan implementation.

In addition to the above, LWD may be placed by the NPS along the drawdown zone shoreline to reduce erosion while improving native plant survival and wildlife habitat at riparian habitat restoration sites.

If LWD alone does not produce the desired results, other options, such as irrigation, to supplement or replace the placement of LWD can be investigated. One approach might be placement of a fine mist sprinkler system upwind of the fugitive dust source area. The winds that carry the dust could transport the sprinkler mist over a large enough area to wet the fine silts and significantly reduce the amount of dust being lifted into the air.

4.5 Potential Obstacles and Solutions

The NPS should coordinate the collection of LWD with high lake levels. The well-timed collection of driftwood (LWD) will improve efficiency and save thousands of dollars in boat operation and labor. The LWD should be floated from the collection point to dust abatement sites in the drawdown zone while water levels are high. The placement of logs should be coordinated with lake levels in order to move the material into place as efficiently as possible. Some of the work, like the placement of large rock, may require the use of heavy equipment in the drawdown zone during the winter and spring. If so, access for this activity may be difficult.

Placement of LWD in the drawdown zone will require amassing enough LWD to create an effective wind erosion barrier to contain the fugitive dust. Collection of the amount of LWD needed for this and other plans may require several years and can take place during some initial years of testing. It is expected that permitting agencies will require placement of LWD as a condition of permits for erosion control work. To the extent feasible, such required LWD should be placed in the drawdown area to assist in dust control efforts. However, neither Chelan PUD nor the NPS know if there will be enough LWD to apply to the drawdown area after LWD has been applied to other sites as required by permits for work under the NPS Erosion Control Plan (Chapter 2).

The floating rows or circles of logs will appear as log booms interspersed with mats of logs functioning as driftwood. They should be placed strategically within the 50-acre dust source area in the reservoir drawdown zone, east of the Stehekin River channel and Weaver Point. When floating, these rows and circles of logs will be buoyed as a group hazard to navigation, to warn boaters of the danger. The buoys will be cabled to move with the rise and fall of the

reservoir, and could also warn of submerged hazards during lower water levels per U.S. Coast Guard standards.

If an irrigation system is determined to be necessary to supplement or replace the LWD placement, the two systems should be constructed to optimize the effectiveness of both systems and details of the design completed before construction.

4.6 Timing of Management Actions

Actions during years 1-10 of the New License:

- Map the flats during the drawdown period, and determine the precise boundaries of the primary source of fugitive dust. Measure the land area that is affected by strong winds during the spring months of March through mid-May.
- Consult with WDFW and file a Joint Aquatic Resource Permits Application (JARPA) to obtain necessary state and federal permits.
- Install temporary snow fences to test the effectiveness of blocking or deflecting wind.
- Collect free-floating logs near the mouth of the Stehekin River and place them in a containment boom until they can be floated above submerged flats and set in place.
- Place large rock to anchor LWD in the dust source area. Buoy chains and large rock to aid in later attachment of LWD, and to alert boaters to the navigational hazard. Connect LWD to rock when a sufficient amount is collected.
- Install a small mist sprinkler system and irrigate a portion of a primary dust area as a test, and evaluate the effectiveness.
- Evaluate effectiveness of above actions after the first five years.

Actions during the remaining years of the New License:

- Every five years, evaluate the success of LWD placement - supplement LWD in areas that are experiencing wind erosion.
- Every 15 years, inspect LWD material, replace rotting logs or rusted/worn chains, and replace warning buoys.
- Assess the efficiency of the mist sprinkler irrigation, if present, for dust abatement.
- If necessary and cost-effective, continue irrigation for the duration of New License.

4.7 Cost Estimate

- A three-person crew (salaries and equipment) to move LWD and large rock into place, connect logs together, anchor to large rock with chain, and anchor some LWD to the reservoir bottom. ($60,000)
- Purchase rock for LWD anchors and contract for a barge to place rock. ($27,000)
- Special drill bits to make the connections for LWD and rock. ($8,000)
- Purchase hardware for connections. ($5,000)
- JARPA for project completion; National Historic Preservation Act (NHPA) consultation with the State Historic Preservation Officer (SHPO).
- Irrigation supplies and setup (if irrigation is used) - may include well drilling, pumps, pipe, system burial, labor, and seasonal operator costs. Parts maintenance and replacement cost.

Item	Cost per year	3-year install*
Crew salaries and equipment	$20,000	$60,000
Purchase large rock	$5,000	$15,000
Place LWD and rock	$4,000	$12,000
Misc. tools and supplies	$12,000	$26,000
Irrigation system	not included	not included

* 3-Years to install the log booms, LWD rafts, and anchored LWD after a sufficient amount has naturally accumulated at the head of Lake Chelan or is augmented from other sources. The LWD accumulation may take 10 years.

The total estimated cost for dust abatement is $113,000; however, this estimate does not reflect the probable overlap between LWD placement for dust control and placement required by permits for erosion control work. This overlap in efforts could result in a substantial reduction in costs under this plan. Costs for contingency plans are not included. It is anticipated that small-scale testing and pilot programs, as discussed in section 4.4, will avoid the possibility of spending the entire estimated amount to fully implement the LWD plan and then discovering that it does not allow the objective to be reached.

Chelan PUD will make available $100,000 for use in this effort. Any funds remaining after the stated dust control objective is reached will be available for other work under this plan. Chelan PUD will provide an additional, $45,000 for use in dust abatement or monitoring efforts, as needed. The cost of labor and materials contributed by Chelan PUD to implementation of this work will be reimbursed from these funds.

SECTION 5: SHORELINE RIPARIAN ZONE REVEGETATION AND WILDLIFE HABITAT

5.1 Objectives

Goal 4 of this plan is to protect existing riparian habitat along the shoreline and in the inundation zone, and to enlarge and connect it where feasible, so that it will function as a multi-storied, diverse, riparian vegetation and wildlife corridor.

- Goal 4a: Protect existing shoreline riparian vegetation to prevent a decrease in total acreage, and to maintain plant species diversity, forest structure, and connectivity.
- Goal 4b: Improve the species richness, function of wildlife habitat, and diversity of forest structure within existing riparian vegetation.
- Goal 4c: Reduce shoreline riparian habitat fragmentation, and improve fish and wildlife habitat by enlarging and connecting existing riparian vegetation.
- Goal 4d: Improve riparian wildlife habitat for vertebrate and invertebrate species.

Goal 5 of this plan is to reduce the current abundance, distribution, and cover of reed canary grass and control the spread of other non-native plants along the shoreline.

- Goal 5a: Reduce the cover of reed canary grass from the perimeter of areas of native riparian vegetation, and plant native vegetation to achieve 50 percent native plant cover along the drawdown zone shoreline within the first 25 years of the New License.
- Goal 5b: Reduce the total shoreline area currently covered by non-native plant species by 50 percent within the first 25 years of the New License, and avoid new invasions.

Only goals 5a and 5b appear measurable. It is unknown whether any of the above goals are attainable.

5.2 Description of the Resource Problem

Native Riparian Plants - The present shoreline of the drawdown zone includes deltas and islands that were cleared for the reservoir in the late 1920s, but were not completely inundated. Today, these deltas and islands are vegetated with native riparian plants and reed canary grass. A more detailed description can be found in the Riparian Zone Investigation study report (DE&S, 2000).

Since these low-lying areas are not submerged and have some native plants, they are prime areas for revegetation. The success of native riparian plant rehabilitation efforts is expected to depend to a great extent on the influence of the lake level on ground water levels. Also, at the highest lake levels, small channels that penetrate these low-lying areas are flooded. This appears to have a negative effect on stability and retention of the surface soils. The species diversity (richness) of native vegetation along the drawdown zone shoreline is believed to have decreased since the mid-1970s, based on evaluation of aerial photography. Proposed changes to Project operations are expected to decrease the period of inundation and encourage more plant growth in some parts of the drawdown zone, as compared with the existing baseline conditions. This will be a beneficial effect of operation under the New License, though its magnitude is presently unknown.

Non-native plants are invading disturbed and undisturbed lands along the shoreline of the reservoir, and threaten the structure and function or ecological integrity of native plant communities. Disturbed lands along the shoreline provide a conduit for invasive non-native plants.

Cereal rye and reed canary grass (Phalaris arundinacea) were planted in the drawdown zone during the 1980s to reduce the problem of windborne dust. These attempts were not successful and the reed canary grass spread to the wetlands at the head of the lake, across the Stehekin road, and into the Little Boulder Creek floodplain. It has advanced to inland riparian areas and onto shoreline private property. In the shoreline deltas and islands where the land was cleared for the reservoir, but not inundated, reed canary grass has become the predominate plant cover. Now, it is invading along the Stehekin River, Little Boulder Creek, and other small tributaries that feed the lake in the drawdown zone.

A variety of native grasses, sedges, shrubs, willows, and trees are necessary to create a diverse, multi-stored riparian habitat. Propagation and planting of native vegetation is needed to restore or improve the species richness, structure, and function of the shoreline riparian areas. Assuming that an assortment of selected native plant species can out-compete reed canary grass,

such planting will assist in controlling this exotic grass. It will also improve the habitat for wildlife species using the riparian zone. Based on photographs taken during spring dust events and GIS modeling, it appears that the revegetation of the shoreline will have little or no effect on wind speed on the flats.

Native Riparian Wildlife - NPS Management Policies and The Natural Resources Management Guidelines (NPS-77) provide management policies pertaining to native animal management.

NPS-75, "Natural Resources Inventory and Monitoring Guidelines," directs park units to inventory and monitor natural resources as a proactive protection measure. In 1998, Congress passed the National Parks Omnibus Management Act mandating a "program of inventory and monitoring of National Park system resources to establish baseline information and to provide information on the long-term trends in the condition of National Park system resources."

The Riparian Zone Investigation (DE&S, 2000) describes the Stehekin River area as being the most extensive, diverse, and structurally developed of any of the nine areas studied on Lake Chelan. According to the study, the Stehekin River has the highest mammal, bird, and amphibian species diversity, and the highest mammal and bird species abundance of the nine areas. It is also the only location where a zone of emergent vegetation was found.

The Project will continue to inundate the drawdown zone, although for significantly less of the year than occurs under the second license. Inundation causes areas in the drawdown zone to remain unsuitable as wildlife habitat for much of the annual cycle. During spring and early summer, rising water levels flood the nests of breeding waterfowl. The current water level cycle continues to inhibit the development or repair of riparian habitat by making water unavailable when needed and available at the wrong times. This effect will be present to a significantly lesser degree under the New License.

5.3 Management Actions for Problem Resolution

The areas of the reed canary grass infestation will be mapped using GIS/GPS technology. A preliminary examination of a GIS-generated map using aerial photography shows about 10 acres of private land and 12 acres of public land along the shoreline infested with reed canary grass. It also shows 12 acres of private land and seven acres of public land with some native riparian vegetation. About four of the seven acres of public land were initially cleared for the reservoir, but have never been completely inundated and offer a prime site to begin riparian rehabilitation. The amount of similar private land is unknown.

Efforts to rehabilitate native riparian vegetation on the deltas and islands at the head of Lake Chelan are expected to be aided by some initial earthwork (regrading) to fill small channels and stop water from entering these lands at the highest water levels. This is expected to improve the conditions for riparian plant survival and growth, increase the number of species for which these sites are suited, and deepen adjacent channels. This regrading will be planned for winter and spring during times of low water levels. The rehabilitation work should be combined with efforts to reduce the distribution of reed canary grass. Grass should be removed from within and adjacent to existing stands of native riparian vegetation to encourage the native riparian area to enlarge and improve its structure and function.

The objective is to eventually connect isolated stands or islands of riparian vegetation to mimic a natural condition and provide a wildlife riparian habitat corridor. Control techniques for removing reed canary grass between riparian stands should include pulling, seedhead cutting, and mowing operations. It is expected that native riparian plants such as willow, red alder, black cottonwood, big-leaf maple, red osier dogwood, western red cedar, and various sedges can be propagated at the NPS native plant nursery and planted to assist in these efforts. To be most effective this work should be coordinated with erosion control efforts.

The objective is to recreate, where feasible, a multi-storied, multi-species native riparian vegetation corridor along the lakeshore at the head of Lake Chelan. To be most effective species of native trees and shrubs (from local genetic stock) should be propagated locally to preserve their genetic integrity, and then planted at designated locations, thereby improving, expanding, and connecting existing riparian vegetation. Deciduous plants are preferred because they provide forage and cover for wildlife.

Young native plants are usually developed sufficiently to transplant after they are two years old. One or more control techniques should be used upon the reed canary grass before the nursery plants are transplanted along the perimeter of, or within areas of, existing riparian vegetation. Care and maintenance of the young native plants will be necessary for at least two years. This should consist primarily of watering, weeding, fertilizing, and protecting from voles and deer damage until the young native plants become well established. Eventually, the shrubs and trees will shade-out the reed canary grass in their immediate vicinity.

This work should be performed on adjacent private lands wherever there is a willing owner. The Natural Resource Conservation Service, with the support of Chelan PUD and the NPS, may be able to obtain one or more grants to assist private property owners with labor, transplanting and maintenance expenses.

If herbicides are used, they should be non-residual and applied very selectively to control reed canary grass at the head of the lake to insure that no harm occurs to aquatic biota and water quality. Most herbicide brands that can be used near water state that they cannot be used within a half mile of potable water sources. Several valley residents live at the head of the lake, and residual herbicide use could affect residential water sources.

The NPS anticipates using an integrated pest management approach to contain and control invasive non-native plants within Lake Chelan National Recreation Area (Lake Chelan NRA). New invasions of non-native plants will be controlled quickly and aggressively to assure success, reduce environmental impacts, and keep future costs at a minimum.

5.4 Potential Obstacles and Solutions

Measuring success in reducing the amount of reed canary grass is anticipated to require monitoring throughout the New License period. The complete control of reed canary grass is unattainable. The strategy in this plan is intended to control reed canary grass, and thereby improve and expand the structure and function of native riparian habitat. Continual vigilance and control measures are necessary to assure that previous gains are maintained.

It is anticipated that use of heavy equipment in the drawdown zone to excavate soil and place it onto the deltas and islands as an initial step for rehabilitating the native riparian plant community may require consultation with the SHPO on the recommended action and the appropriate permits from several agencies, including the U.S. Army Corps of Engineers, WDWF, and possibly the Washington Department of Ecology. The proposed revegetation work at other locations along the shoreline will require little, if any, soil disturbance and will be above the high water level, and will, therefore require fewer permits.

5.5 Timing of Management Actions

Actions during years 1-10 of the New License:

- Refine the GIS map of the drawdown zone to refine existing estimates of reed canary grass infestation and existing native riparian vegetation.
- Prioritize and select native riparian vegetation areas for future maintenance and improvement.
- Test the efficacy of the proposed management actions at selected sites.
- Collect and propagate selected native plants, particularly shrub and tree species as appropriate.
- Perform regrading of selected sites.
- Concentrate initially on planting native shrub and tree species because they may be competitive against reed canary grass infestation.
- Work from existing native riparian vegetation areas outward to enlarge their perimeter and area.
- Contain the reed canary grass by mowing, trimming seedheads, and pulling along the perimeter of existing native riparian vegetation. Chemical herbicides may not be used at the head of the lake.
- Work with private landowners to control reed canary grass and plant native herbaceous species, shrubs, and trees on their shoreline property.

Actions during the remaining years of the New License:

- Practice vigilant containment of reed canary grass for the remainder of New License.
- Continue annual planting of native plants to reach the 50 percent ground cover in goal 5a.
- Plant native riparian plants on sediment islands where LWD has been anchored in shallow water for permanent windbreaks and more erosion control of the flats area.

5.6 Cost Estimates

As defined in the Wildlife Habitat Plan (Chapter 9), Chelan PUD will provide funding on an annual basis for the riparian zone revegetation work outlined in this Chapter. Chelan PUD and the NPS anticipate that for the first several years of the New License period, funding needed for the riparian revegetation work will be greater than the stream of funds provided under the Wildlife Habitat Plan. The need for funds for this work is then expected to taper off to a smaller annual expenditure. Chelan PUD and the NPS also anticipate that the $160,000 provided for tasks related to dust control will not be needed immediately for dust control. To address the cash flow problem related to riparian restoration work, the NPS will be allowed to "borrow" funds

from the $160,000 provided for other tasks in this Chapter and "repay" those funds later from the annual stream of funds defined in Chapter 9. The total cost of riparian zone revegetation to be paid by Chelan PUD shall not exceed the funds defined in Chapter 9.

Task	Timing / Interval	Unit cost	Total cost
Collect native plant material	First 5 years	100,000 cuttings or seeds @ 5 cents/each	$5,000
Propagate native riparian plants	First 7 years for public lands	20,000 plants total 7 yrs @ $5,700/yr	$39,900
Regrading of deltas and islands	First 5 years	Lump sum estimate, incl. permits	$20,000
Contain reed canary grass & other exotics	10 yrs (3-12), ¼ acre /day/GS-4 employee	(10yrs)x(8 wks/yr)x(2 people) x ($450/wk)	$72,000
Plant nursery stock	7 yrs, 150 plants/day /GS-4 employee	(7 yrs)x(2 wks/yr)x(2 people) x ($450/wk)	$12,600
Maintain rehab. sites	Years 1-12, 4 wks/yr	Included with exotic Plant containment	Included with exotic plant containment
Work with NRCS & private propt. owners	7 years, start in year 8	NRCS grant to assist property owners	NRCS grant
Project crew leader and tech. supervision	Crew leader, 10 yrs, 10 wks/yr	Crew leader @ 10 wks/yr @ $750/wk	$75,000
	Plant ecologist, yrs 1, 2, 3, 5, 10, and 20	Plant ecologist @ 4 wks/yr @ $1,200/wk	$28,800
TOTAL EST.			$253,300

Assumptions: Crews work four 10-hour days per week, 8 day per 2-week pay period; there are two seasonal crew members for exotic plant control; the crew leader will be a GS-7 term appt. biological technician assisting the Stehekin resource manager (35% benefits); 20 acres of public lands along the shoreline require exotic plant control and planting native riparian vegetation; a similar 20 acres of private lands will be funded by NRCS grants other sources, and is not included in this budget; out-plant 1,000 shrubs and trees per acre; plant ecologist provides technical oversight; and the maintenance crew is two employees.

SECTION 6: MONITORING AND EVALUATION

6.1 Objectives

This plan anticipates monitoring will be performed by NPS as appropriate to document progress in meeting goals 3 through 6 described in section 2.

In addition, Chelan PUD will perform monitoring for the purpose of providing information about ongoing changes at the mouth of the Stehekin River.

- Chelan PUD will monitor topographical changes in the lower Stehekin River channel during the period of the New License, as defined below.
- NPS plans to monitor the concentration of TSP blown into Stehekin Landing once every five years until the measurable objective is met.

- NPS plans to monitor environmental effects of LWD placed in the drawdown zone.
- NPS plans to monitor the species richness, abundance, and distribution of native riparian vegetation and invasive non-native plants at the head of Lake Chelan.
- NPS plans to monitor the species richness and abundance of native vertebrate wildlife using riparian habitats at the head of Lake Chelan, using the methods from the DE&S study (2000).
- NPS plans to measure wildlife community patterns (total functional diversity, functional richness, and functional redundancy) and functional responses of communities (resilience, resistance, and attenuation).

Of the objectives listed above, only the first two are measurable as defined.

6.2 Description of the Resource Problem

Resource problems related to dust and native and non-native riparian plants are explained in sections 4.2 and 5.2, respectively. Explanations of resource problems related to other items to be monitored are provided in section 6.3, below.

6.3 Management Actions for Problem Resolution

Monitoring Stehekin River Channel - Chelan PUD will perform monitoring of topographical changes in the lower Stehekin River channel during the period of the New License. This monitoring will include the following:

- Up to five re-surveys of up to seven cross-sections will be performed by a licensed professional surveyor under contract to Chelan PUD. The surveying will be done at times of low flow, probably October. Surveying will follow flood events selected jointly by the NPS and Chelan PUD. Sections to be monitored are 1H, 2, 4, 5, 11, 13, and 18, from Evaluation of the Backwater Hydraulic Profile of the Lower Stehekin River (Chelan PUD, 2001).
- Chelan PUD engineers will prepare two-dimensional hydraulic models, including existing measurements and updated survey results.
- Chelan PUD staff will make arrangements for aerial photographs of the Stehekin River mouth and flats. Photographs will be taken at five to 10 year intervals during times of low lake level.
- Copies of all results will be provided to the NPS.

The purpose of the monitoring program is to provide topographical and photographic data, and computer model results to aid in documenting any long-term trends of change in the river channel. The program is expected to complement other data collection by the NPS. It is not expected to provide an understanding of all significant processes at work in the lower Stehekin River, or to allow for separation of effects of the lake level from effects of other significant influences known to be active in the area as noted in the existing analysis (Chelan PUD, 2001).

Monitoring Airborne Dust - The NPS plans to perform periodic monitoring of airborne dust at Stehekin Landing. The indicator to be used to determine the extent of success of dust abatement work is the product of the duration of dust events and the mass concentration of TSP. The NPS plans to conduct TSP monitoring on the roof of the cabana at Stehekin Landing, where the air

quality monitoring equipment was located in 2000. A remote weather station should be placed with the TSP sampler to document weather conditions associated with dust events, including wind speed and direction, temperature, and humidity. The Particle and Visibility Monitoring Data Analysis Report (ARS, 2001) will serve as the baseline for comparing levels of TSP. Key data from that report are summarized in the table, below.

This plan anticipates monitoring will occur once every five years from mid-March to mid-June, using a high volume TSP sampler or other equipment that provides comparable results. The objective is to reduce the airborne dust by 25 percent in the first 10 years, and an additional 25 percent in the second 10 years, as explained under the Fugitive Dust section of this Chapter. The percent reduction achieved is calculated by comparison of a year's average product (TSP times duration) measured during dust events with the comparable number based on measurements from the 2000 monitoring period stated in the report noted above (ARS, 2001). The minimum and maximum durations and mass concentrations will also be analyzed for significant changes.

Dust Event Date (day)	Approx. Duration (hours)	TSP Mass conc. ($\mu g/m^3$)	Product: (TSP x Duration)	Lake Elevation (feet)
03/28/00	6.50	376.9	2450	1088.1
04/19/00	4.25	332.2	1412	1088.4
04/22/00	7.75	132.5	1027	1088.8
05/03/00	4.25	68.5	291	1089.6
05/05/00	8.25	69.6	574	1089.7
05/10/00	4.50	44.9	202	1090.0
05/16/00	8.75	52.4	459	1090.1
05/17/00	11.50	82.0	943	1090.4
05/21/00	7.25	93.9	681	1091.0
05/22/00	5.00	36.9	185	1091.4
Averages	6.80	129.0	822	1089.8

References: Table 4-2, Event Particulate Data, page 4-4; Table 4-3, Particulate Data Recovery and Mass Concentration Statistics, page 4-5; and Table 5-2, Summary of Parameters for Event Sampling Days, page 5-11; Stehekin, Washington, March 15 to June 12, 2000.

The NPS and Chelan PUD understand that the monitoring may be influenced by random variations between years in weather, lake level cycle, and possibly other factors. Also, a certain degree of judgment will have to be exercised to decide whether developing conditions merit monitoring as a dust event, and to determine its starting and ending times. Annual variations and the small amount of subjectivity required are unavoidable, and should be considered in evaluating results.

Monitoring LWD - The NPS plans to assess the environmental effects of placing LWD in the drawdown zone, once every 10 years for the duration of the New License period.

Monitoring Native and Non-Native Plants - The NPS plans to monitor the success of efforts to establish native riparian plants and remove non-native plants. The Riparian Zone Investigation by DE&S will serve as the baseline, and as a guide for methods of monitoring vascular native and non-native plants. The data collected should describe the riparian plants currently present per site, including species composition, basal area of trees, shrubs, forbs and grass densities, and cover. The native riparian plants used for the rehabilitation effort should be monitored biannually. Mortality, plant condition, percent of browse, and signs of disease should be documented.

The effectiveness of removal of reed canary grass and other non-natives should also be monitored as part of this plan. The monitoring should document the areas of successful removal and the extent of the non-natives in the Project area. Monitoring should consist of measurement of areal extent. Reed canary grass shows up well in aerial photos, especially when it has changed to autumn gold. Currently, the infestation is one continuous area with several satellite patches adjacent to the large patch.

Monitoring Native Raptors - The riparian vegetation and wildlife habitat portions of this plan and the Fisheries Management Plan may affect Osprey (Pandion hahaetus) and Bald Eagle (Haliaeetus leucocephalis) recovery at the head of Lake Chelan. Specific NPS concerns are the existence today of only one nesting pair per species. The cause of their decline is unknown, but regionally declines have been attributable to high contaminant levels from pesticides and herbicides, and changes in their prey base. These raptors may serve as key indicators of the overall ecological 'health' or condition of Lake Chelan and its tributaries. For this reason, the NPS plans to monitor the demography (nest site occupancy and productivity) of osprey and bald eagles, and also explore the possibility of taking occasional blood samples to coincide with the existing monitoring of contaminants in osprey along the Columbia River and in British Columbia.

Osprey historically nested within the Stehekin Valley, but no pairs are known to have nested there since 1985. In 1999, an osprey pair successfully raised young at a nest near Castle Creek along the west shore of Lake Chelan, within the Lake Chelan NRA. The causes of the disappearance of nesting osprey in the Stehekin Valley are unknown.

Bald Eagles are not known to have attempted nesting in Lake Chelan NRA since its designation as a park unit in 1968; however, in 2001, a pair of eagles produced one eaglet within the Stehekin Valley near Weaver Point, and it fledged successfully.

Monitoring Native Riparian Wildlife: The Riparian Zone Investigation (DE&S, 2000) will serve as the baseline, and as a guide for methods used to monitor vertebrate species (breeding bird, small mammal, bat, amphibian, and reptile). Ninety-two species of birds were documented, ten species were considered Priority Species by the Washington Department of Fish and Wildlife, and three species were Federal Species of Concern. Of the nine tributaries sampled, the Stehekin River had the most waterbird species and best riparian habitat for breeding birds.

6.4 Timing of Management Actions

The NPS plans to monitor wildlife populations at riparian habitat restoration sites for two consecutive years at Years 10-11, 20-21, and 40-41 of the New License. The NPS plans to monitor osprey and bald eagle demography annually for the life of the New License.

6.5 Cost Estimates

- Monitor Stehekin River channel. $90,000
- Monitor fugitive dust at Stehekin Landing. $15,000
- Monitor environmental effects of Large Woody Debris. $50,000
- Provide sufficient riparian resource baseline information. $10,000
- Monitor native riparian vegetation and non-native plants. $15,000
- Monitor wildlife in drawdown zone (richness and abundance). $90,000

Chelan PUD will monitor the Stehekin River channel, as described, for a cost not to exceed $90,000, and will provide to the NPS $3,000 each five years of the New License term for fugitive dust monitoring, until control efforts are successful, as described above. Funding for other monitoring tasks will be provided as outlined in the Wildlife Habitat Plan (Chapter 9).

Monitoring Task	Timing / Interval	Unit Cost	Total Cost
Stehekin River Sedimentation	Approx. each 10 years as specified in plan	n/a	$90,000
Airborne Dust	At 5 year intervals, 25-year minimum*	$3,000	$15,000
Effects of LWD	10-year interval	$10,000	$50,000
Collect baseline data	Year one	$10,000	$10,000
Native Riparian Vegetation	Annually for 3 years, then 5-year interval	$2,000 + $1,000	$15,000
Exotic Plants	5-year interval	$2,000	Included above.
Osprey & Bald Eagles	Annually	$1,000	$50,000
Riparian Wildlife	Years 10, 11, 20, 21, 40, and 41	$15,000	$90,000
TOTAL			$320,000

*If the objective is not met in the first 25 years, monitoring may continue.

SECTION 7: RESPONSIBILITIES

This plan describes Chelan PUD and NPS management activities related to the Stehekin area. As described in this Chapter, Chelan PUD is responsible only for funding and/or implementing specific items under this plan. An itemization of Chelan PUD's responsibilities follows:

- Chelan PUD shall make available $160,000 to address dust control, and monitoring and related efforts planned to be implemented by the NPS. The $160,000 includes:

- The $100,000 commitment for dust abatement (section 4.7);
- The $45,000 to be provided on an as needed basis for additional dust abatement or monitoring efforts (section 4.7);
- The $15,000 for monitoring and evaluation of dust abatement efforts (section 6.5)

- Chelan PUD will monitor the Stehekin River channel for a cost not to exceed $90,000 (section 6.5)

Chelan PUD's commitments for riparian revegetation are referenced in section 5.6, but funds are provided as defined in Chapter 9 of the Comprehensive Plan.

SECTION 8: CONCLUSIONS

The Stehekin Area Implementation Plan contained in this Chapter integrates airborne dust abatement, riparian vegetation rehabilitation, non-native plant control, and riparian wildlife habitat rehabilitation. There is a monitoring component to help assess the efficacy of these management actions, and to evaluate whether the desired future condition is being reached within the time frame and funds allotted.

Portions of this plan anticipated to be carried out by NPS may be changed as necessary by NPS in consultation with Chelan PUD, as a result of monitoring program review, recommendations, and refinements. Portions of this plan anticipated to be carried out by Chelan PUD may be changed as necessary by Chelan PUD in consultation with NPS, as a result of monitoring program review, recommendations, and refinements. Any modification of License Article 4 shall require the approval of the NPS and Chelan PUD.

SECTION 9: LITERATURE CITED

Air Resource Specialists, Inc., (ARS). 2001. Particle and visibility monitoring data analysis report, Stehekin, Washington. Prepared by ARS, Fort Collins, Colorado. Prepared for Chelan PUD and the U.S. Department of the Interior, National Park Service. January 10, 2001. 192 pp.

Chelan PUD. 2001. Evaluation of the backwater hydraulic profile of the lower Stehekin River - final. Lake Chelan Hydroelectric Project No. 637. Chelan PUD, Wenatchee, Washington. January 15, 2001. 166 pp.

Duke Engineering and Services (DE&S). 2000. Riparian zone investigation – final, Lake Chelan Hydroelectric Project No. 637. Prepared by DE&S, Bellingham, Washington. September 26, 2000. 230 pp.