Preliminary Floodplain Restoration Plan For a 1-Mile Portion of the Scott River Degraded By Past Gold Dredging

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ABSTRACT

This report describes the development of a preliminary floodplain restoration plan for a 1.3-mile pilot reach within a 4.7-mile portion of the Scott River degraded by large-scale gold dredging operations during the late 1930's and 1940's. The project site is located between the towns of Callahan and Etna in the Scott Valley in western Siskiyou County, California.

The goals of the restoration plan are to establish a more functional floodplain, reduce lateral erosion, restore upland terraces lost to erosion, reduce the likelihood of the river breaking through the tailings to the west side of the valley, provide interim salmon and steelhead enhancement, and provide an example of a cooperative restoration project. The plan takes the approach of getting restoration started soon and fixing geomorphological problems prior to restoring habitat. Methods included site reconnaissance, landowner meetings, GPS surveying, literature review (including historic air photos), restoration design, work plan preparation, and preparation of this report.

The pre-European condition of the pilot reach apparently consisted of a valley-wide floodplain, fine-textured soils, extensive riparian vegetation, numerous beaver dams, year-around flows, and large salmon and steelhead runs. The river condition was changed by beaver trapping, hydraulic and dredge gold mining, and severe floods. Currently, the floodplain is constricted by dredge tailings piles, lateral erosion is substantial, soils consist mostly of cobbles, most riparian vegetation is gone, there are no beaver dams, river flows dry up in the summer, and salmon and steelhead runs are small.

Proposed restoration includes widening the floodplain to at least 500 feet, constructing an interim river channel 45 feet wide and 3 feet deep with a meander length of about 630 feet, using some of the tailings to re-construct 2 river terraces and stockpiling the rest for eventual processing by an on-site gravel company, enhancing an adjacent perennial stream channel to provide interim salmon and steelhead spawning and rearing habitat, and re-planting terraces and streambanks.

The proposed work plan includes project phases and tasks, an implementation timetable, quantities, estimated costs, and funding sources. The total estimated cost for initial restoration of the pilot reach is $1.6 million. Potential federal funding sources include the WRDA Section 206, CWA Section 319(h), Saltonstall-Kennedy, Jobs-In-The-Woods, and Partners For Wildlife grant programs. Potential non-federal funding sources include the Salmon and Steelhead Restoration Account (SB 271), sale of dredge tailings, and pro-bono contributions. The report also addresses restoration of the remaining 3.4 miles of dredge tailings, which would cost an additional $6 million, yielding a total cost of $7.6 million to restore the entire 4.7-mile dredge tailings reach.

Initial restoration of the 1.3-mile pilot reach could be completed in 1 season, and the remaining 3.4 miles could be completed in 3 seasons. Fine-tuning of the entire 4.7-mile reach is proposed following initial floodplain widening, which could be completed in 1 additional season. Restoration of the entire reach would take a total of 5 years, with an additional 5 years of

monitoring and interim maintenance. The primary type of interim maintenance would be river bar removal. If complete funding were available at one time, the timetable could be accelerated.

Biological impacts associated with restoration include the filling of small pockets of existing riparian vegetation totaling about 3 acres to facilitate stockpiling of tailings and construction of a setback levee to protect the west side of the valley. This loss will be mitigated by creation of 2 acres of riparian vegetation, 1 acre of freshwater marsh, and 27 acres of new floodplain, and eventual re-establishment of 70 acres of riparian vegetation within the restored floodplain. About 14 acres of existing riparian vegetation and freshwater marsh will be avoided.

Potential landowner impacts could include increased restrictions on land and water use resulting from restoration of species subject to management under the Endangered Species Act. This will be mitigated by preparing a Memorandum of Understanding between landowners and agencies to provide safe haven projection.

INTRODUCTION

Purpose and Goals

This project was undertaken for the purpose of initiating ecological restoration of a 4.7-mile portion of the Scott River degraded by large-scale gold dredging operations during the late 1930's and 1940's. This portion of river is often referred to as the dredge tailings reach because of numerous large piles of tailings left by dredging activities. The project site is located between the towns of Callahan and Etna in the Scott Valley in western Siskiyou County, California (Figure 1).

The preliminary restoration plan produced by this project is intended to be of sufficient detail to guide grantwriting, field surveys, permit applications, and the approvals process associated with initial restoration efforts along a 1-mile pilot reach of the dredge tailings reach. The plan will be fine-tuned during completion of those next steps prior to being implemented on the ground. Knowledge gained from on-the-ground implementation of this plan along the pilot reach may then be applied to efforts to restore the remaining 3.7 miles of the dredge tailings reach.

The goals of the pilot restoration project consist of the following:

1. Establish a more functional floodplain morphology and provide an interim river channel within the 1-mile pilot reach of river, thereby setting the stage for eventual re-establishment of a more stable river channel morphology, year-round flows, more extensive riparian vegetation, and improved on-site salmon and steelhead habitat.

2. Reduce lateral erosion of dredge tailings piles and eastside river terraces within the pilot reach, thereby protecting adjacent buildings, a major irrigation ditch, and a county road, and reducing sedimentation damage to downstream salmon and steelhead habitat and prime agricultural lands.

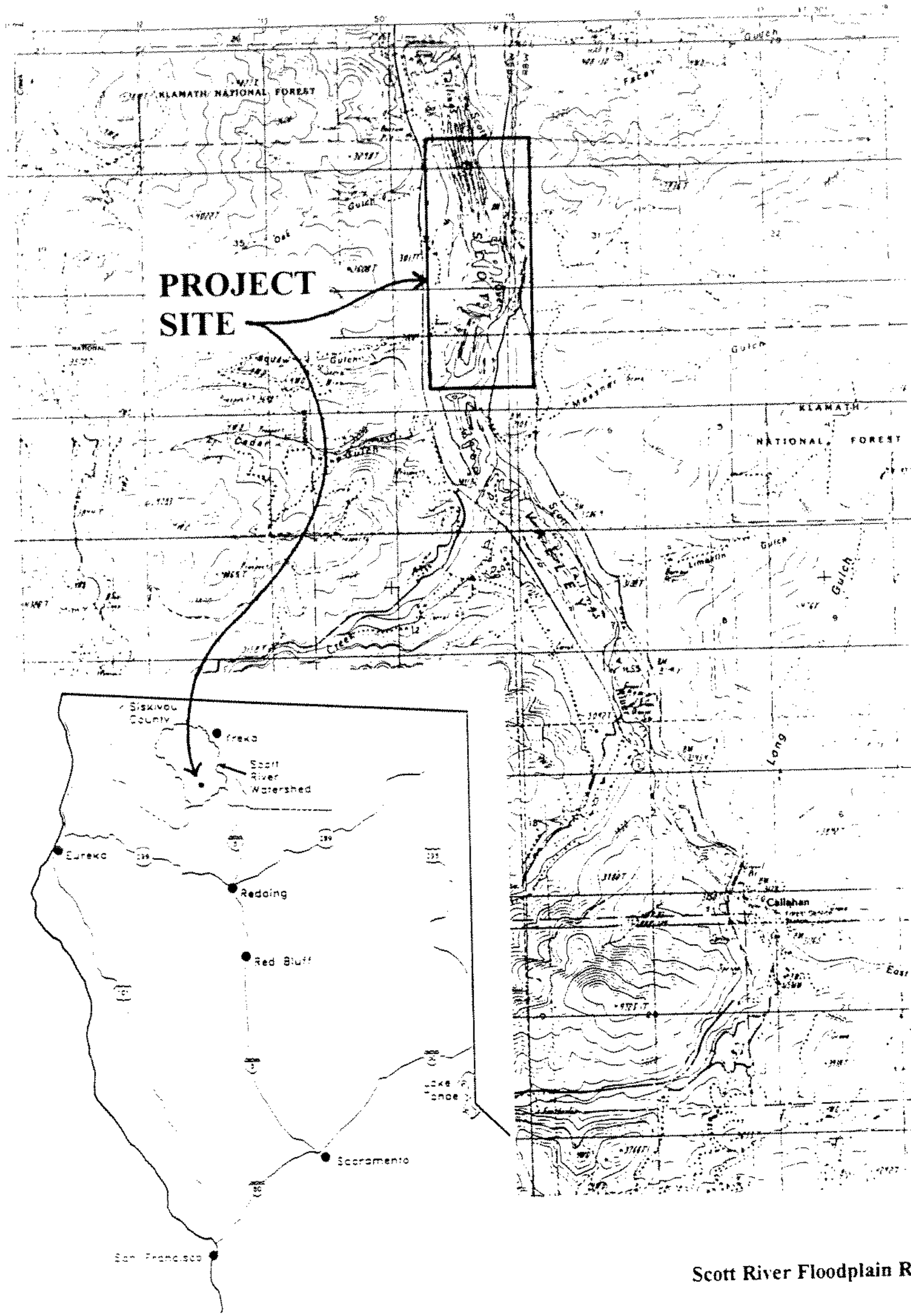
3. Restore eastside river terraces lost due to past erosion within the pilot reach, thereby re-establishing usable private lands and further protecting adjacent improvements.

4. Reduce the likelihood of the river breaking through the tailings to the west side of the valley, thereby protecting riparian habitat, potential fishery habitat, upland river terraces, and a gravel quarry.

5. To the extent feasible, provide interim salmon and steelhead spawning and rearing habitat within and/or adjacent to the pilot reach.

6. Provide a successful example of a major cooperative restoration project between private landowners and government agencies in order to demonstrate the feasibility and mutual benefits of applying this approach to the rest of the dredge tailings reach and other degraded portions of the Scott River and its tributaries.

Figure 1. Project Location and Boundaries.



Approach

The approach taken in this project consists of:

1) Limiting studies to those deemed essential, initiating on-the-ground restoration quickly, and applying lessons learned on the ground to subsequent restoration work.

2) Getting the system to work first, knowing that habitat will follow. More specifically, restoring the floodplain and channel first, and riparian and fishery habitat will recover on their own or can be successfully assisted toward recovery. If done the other way around, habitat restoration projects will be much more likely to fail.

3) Restoring the river system concurrently with repairing high-priority on-site erosion problems (namely, east bank erosion and the risk of the river breaking through the tailings to the west side of the valley), rather than simply installing rip-rap and levees without fixing the system.

4) Taking advantage of opportunities which may exist to provide interim riparian and fishery habitat while the river system is being restored.

5) Incorporating the existing gravel quarry as much as possible into restoration efforts, given the presence of numerous mutual benefits and lack of any significant adverse impacts associated with quarrying in the dredge tailings reach of river.

6) Avoiding conflicts with existing land and water uses; the problems currently facing the dredge tailings reach of river are the result of past land uses.

METHODS

The methods used in preparing this preliminary restoration plan consisted of the following steps:

1) *Project Initiation.* The project was initiated by Larry Alexander, who first contacted the authors in 1997. Mr. Alexander and his wife Peggi own a 60-acre parcel of land which includes about one-half mile of the river, a portion of the dredge tailings, and most of the area where eastside river terraces have been eroded away. He is also the director of the ecosystem management program at College of the Siskiyous. Mr. Alexander has been attempting to initiate restoration of this stretch of river since 1995, but initial funding was not obtained until 1998.

2) *Site Reconnaissance and Landowner Input.* Following project initiation, the authors completed a thorough reconnaissance of the project site and met on-site on separate occasions with Larry Alexander and Richard Moore, owner of the adjacent gravel quarry. Mr. Alexander contacted other adjacent landowners to secure their agreement to participate in the project.

3) *GPS Surveying.* Surveying of key features of the project site was completed by John Fryer Land Surveying using global positioning system (GPS) equipment. This type of equipment was chosen because of long survey distances, obstructed views, ease of use of GPS equipment, and recent advances in GPS technology. Six cross sections and one longitudinal section were surveyed, and additional survey points of key features were also recorded. Key features included top of slope, bottom of slope, edge of floodplain, edge of bankfull channel, and bottom of thalweg. A permanent benchmark was installed along East Callahan Road for future tie-in to other surveys. The authors participated on-site in order to identify key features to be surveyed. After completion of the on-site work, the data collected were downloaded into a CAD program, and a plot plan, cross sectional diagrams, and a table of survey points were prepared by the surveyor.

4) *Literature Review.* Relevant reports, studies, historical air photos, maps, and other materials were obtained by the authors and reviewed in order to glean from them all information pertinent to this project.

5) *Restoration Design.* Design of the project began with a consideration of why restoration work should begin at the site tentatively chosen (a 1-mile pilot reach in the middle of the dredge tailings stretch of river) as opposed to another site (for example the upstream end of the tailings). Project design then considered the various choices of how the river could be re-routed through the site to achieve the best balance of natural river processes, restoration costs, and landowner needs and concerns. Project design then progressed to a consideration of what site elements should and could be restored at this juncture, and which should wait for future efforts or be allowed to recover naturally. Site elements considered included the floodplain, river channel, river flows, riparian vegetation, and

upland river terraces. The final step was the preparation of a preliminary restoration site plan. The overall design approach used was to combine field data, historical data, geomorphological techniques, and cost and time constraints to pragmatically achieve the project goals.

6) *Work Plan Preparation.* After completion of the site plan, a work plan was prepared which includes specific tasks (in chronological order), quantities, estimated unit costs and total costs, funding sources, and a rough timetable for implementation.

7) *Final Report Preparation.* The final step in completing the project was the preparation of this final report.

8) *Follow-Up.* The preliminary restoration plan produced by this project will be used for grantwriting, field surveys, permit applications, and CEQA/NEPA approvals associated with restoration of the 1-mile pilot reach of river. A final restoration plan will be produced during the course of completing these steps, and will include further refinement of dimensions, pattern, and profile of the design channel and floodplain. If approved and funded, that plan will then be implemented on the ground.

EVENTS CONTRIBUTING TO DEGRADATION OF RIVER

Pre-European River Condition

Prior to the beginning of alterations to the Scott River by Europeans in the 1800's, the project site apparently consisted of a large floodplain (the entire valley width) with fine-textured soils, extensive riparian vegetation (white alder, black cottonwood, willows, etc.), abundant large woody debris, numerous beaver dams, and a river with relatively stable meandering channels, numerous pools and riffles, year-round flows, and large salmon and steelhead runs (Wells 1881 *in* Siskiyou RCD 1990; Stuart 1925 *in* Klamath Task Force 1991; USDA 1944). Indeed, the first name given to the area was "Beaver Valley." Using present-day geomorphological terms, the prehistoric river channel within the dredge tailings reach was probably a "C" channel.

Historic Events Affecting Project Site

The first recorded alteration to the Scott River occurred during the 1820's and '30's when trappers from the Hudson Bay Company removed large numbers of beaver from the Scott Valley (Wells 1881 *in* Siskiyou RCD 1990). In 1836 alone, over 1,800 beaver were reported trapped. It is speculated that the resultant dramatic reduction in beaver dam construction and maintenance significantly destabilized the river system.

Hydraulic gold mining began in the Scott Valley in 1851, and included the construction of numerous diversion dams, ditches, and flumes to capture and convey the water needed for mining (Wells 1881 *in* Siskiyou RCD 1990). Impacts from this type of mining probably included erosion of hillsides and streambanks and aggradation of coarse sediments within stream channels. A large flood in the winter of 1852-53 wiped out most of the water diversion and conveyance systems. Based on an 1853 map showing a well-defined river channel in the valley, it appears that this flood also wiped out much of the remaining network of beaver dams and riparian vegetation (Metlar 1856 *in* Siskiyou RCD 1990). Additional damaging floods occurred in 1855, 1861, 1864, 1875, and 1880, and the 1861 Flood resulted in the river shifting from the west side to the east side of the valley. Some of the surviving water ditches that were originally constructed for mining were eventually converted to agricultural irrigation ditches.

Construction of the Farmers Ditch, which is the largest active irrigation ditch within the project area, was initially constructed in the 1890's (Alexander, personal communication). For the next 30 years, it was limited to several miles in length, but in the 1920's the Farmers Ditch was extended past McConaughy Gulch to the vicinity of Young's Dam on the Scott River.

From 1934 to 1948, large dredges were used for gold mining directly within the river channel, floodplain, and adjacent upland terraces, leaving the dredge tailings now present along a 4.7-mile reach of river and the lower portion of Wildcat Creek below Callahan (Siskiyou RCD 1990; Averill 1946 *in* Klamath Task Force 1991). These dredges could reach more than 50 feet below the ground surface and resulted in reversing the substrate stratigraphy, leaving cobbles and gravel on top and fines on the bottom (Figures 2, 3, and 4 at end of section). Dredging also broke up previously consolidated substrate material (Moore, personal communication), which, in combination with other factors (see below), resulted in river flows going subsurface during the summer and fall.

As a result of dredging, the river was squeezed against the east side of the valley by extensive piles of dredge tailings, and it appears on historical air photos that a narrow channel may have been constructed in that location to re-route the river during dredging activities (Figure 4). Air photos also reveal that the river subsequently began cutting into the tailings and previously undisturbed eastside river terraces (Figure 5 at end of section). Portions of the riverbed are now situated over substrate which was never disturbed by dredging, and in two locations in the pilot reach, the river has isolated remnant portions of eastside river terrace on the west side of the river. The greatest amount of erosion occurred during the 1964 Flood, when over 8 acres of pasture, a barn full of automobiles, and a portion of the East Callahan Road were lost (Figure 5). Extensive tailings erosion also occurred during this flood, and due to low areas in the distribution of dredge tailings piles, the river came close to breaching the tailings and flooding the west side of the valley. Tailings and upper watershed coarse sediment carried downstream by the 1964 Flood and other flood events have begun to accumulate in the river channel downstream from the tailings reach, thereby impacting an additional 1-1/2 miles of river as well as adjacent prime agricultural land.

Quarrying of the dredge tailings for sand, gravel, and cobble along the pilot reach was started in the 1990's by Richard and Stanley Moore. Quarrying has resulted in the creation of several ponds fed by groundwater, but has not encroached upon the active river channel or floodplain. Two small levees have been constructed in the floodplain, however, to prevent floodwaters from breaking through to the quarry site.

<u>Current River Condition</u>

As a result of the various changes discussed above, the river channel is now mostly a "D" channel through the tailings reach (Figures 6 and 7 at end of section). The river is continuing to achieve a wider floodplain, more meander, and more channel development than were present immediately following dredging, however, and given enough time, it will probably return to being an "C" channel. This evolution is occurring by virtue of continuing lateral erosion of dredge tailings and the eastside river terrace, and as a result, channel braiding and central bar formation are substantial. Also, the tailings themselves are ecologically very sterile (except for isolated ponds and riparian pockets remaining after dredging), they have no utilitarian value other than for gravel quarrying, and they degrade the visual quality of the valley.

Although natural recovery of the river has progressed to some degree, the floodplain and river banks are still largely devoid of riparian vegetation, and the river continues to go dry during the summer and early fall within the project site. Regarding the latter, it has been observed that the river goes subsurface when flows drop below about 30 cfs (DWR 1991). Because of these factors, the salmon and steelhead fishery suffers from the lack of good on-site spawning habitat, the partial blocking of spawners trying to reach the upper watershed, the stranding of juveniles, the lack of good cover and holding areas, the lack of food, and the occurrence of elevated water temperatures due to lack of shade

Conversely, excellent aquatic and riparian conditions have developed on the west side of the valley within the project site where a tree-lined gravel-bottomed stream with abundant aquatic insects has become established. These conditions have apparently resulted from the stable perennial resurgence of river flows passing through the dredge tailings, and from flood protection provided by the tailings functioning like a levee. This stream channel would most certainly be heavily used by salmon and steelhead for spawning and rearing if the stream were accessible, but access is currently blocked at the downstream end of the dredge tailings where the stream goes underground through the tailings before rejoining the river.

Although dye tracing has not been done to confirm the fate of the river's flow once it goes subsurface, a fair amount of circumstantial evidence indicates that the flow stays near the surface of the substrate and that a portion of the flow passes through the tailings and emerges on the west side. This evidence includes an observation made last fall after surface flow had become re-established in the eastside river channel that about half of that flow submerged into the tailings at one location and emerged about a hundred feet away in the gravel quarry where it connected with the westside channel. Also, recent quarry excavation has exposed groundwater flowing in a westerly direction under the tailings. The GPS survey confirmed that the westside stream channel is about 3-4 feet lower in elevation than the eastside river channel, which would help explain this westerly flow. This difference in elevation could to be due to aggradation of bedload material within the eastside channel originating from upstream erosion of tailings piles and coarse sediment input from the upper watershed, or it could simply be an artifact of re-routing of the river during dredging activities.

Further evidence of subsurface river flow patterns includes the observation that when the eastside channel is dry, flowing water can still observed to be present in low areas in the eastside channel where it surfaces and disappears again to form pools. These pools, because of their perennial nature and the presence of cool flowing water, support hundreds of stranded juvenile fish. This phenomenon can be partially attributed to the fact that much of the existing river channel and floodplain within the pilot reach are located over substrate material which has not been disturbed by past dredging. Another factor contributing to the watertable staying high, however, is the effect of substrate stratification caused by dredging in which the cobble layer is perched on top of a sand layer. It has been observed in the gravel quarry that there is very little water movement through the sand layer; most flowing water is perched on top of this layer (Moore, personal communication).

Dredging not only loosened the previously consolidated substrate material under the river, thereby creating a huge French drain, but within the pilot reach the dredge moved back and forth across the valley, leaving the tailings oriented in an east-west direction. This orientation appears to contribute to flows going subsurface on the east side and resurfacing on the west side within this reach of river.

Another contributing factor to the river going dry at the project site is the juxtaposition of the Farmers Ditch diversion immediately upstream from the project site. River flows are perennial at the point of diversion, but during summer months when the river is at its lowest level, the Farmer's Ditch diverts a substantial amount of the flow.

Current Land and Water Uses

The most prominent land use on the project site is the commercial quarrying of sand, gravel, and cobble from dredge tailings. Quarrying has resulted in the creation of 3 ponds to date, 2 of which have been stocked with trout and are rented on a daily basis for fishing. Livestock grazing occurs on a limited basis along the westside stream channel and on upland river terraces on the west and east sides of the valley. Several residences, a barn, and a shop are also located on these terraces.

The most prominent water-use facility on the project site is the Farmers Ditch, which is a major irrigation ditch providing water for a number of downstream landowners. A small lateral ditch off of the Farmers Ditch irrigates eastside river terraces within the project site. There is also a small water diversion on the westside channel and an accompanying ditch which irrigates a portion of the westside river terrace.

Selected Hydrologic and Geomorphic Information

The watershed above the dredge tailings reach is about 137 square miles in size, and the elevation ranges from 2,500 feet to 8,500 feet above sea level (Siskiyou RCD 1990). Average annual precipitation ranges from about 20 inches in the valley to 60 inches on the higher ridges, and a substantial amount of this precipitation falls as snow. Between 1911 and 1921 (the time period when a gauging station was present near the project site), mean annual discharge was about 100,000 acre feet, with a recorded maximum of 206,000 acre feet and a minimum of 36,000 acre feet (DWR 1960). Annual sediment yield from the upper watershed is 170,000 to 220,000 tons/year, annual sediment yield from the tailings reach is 139,000-239,000 tons/year, and sediment composition within the tailings reach is 51% >4", 43% 1-4", and 6% <1" (Siskiyou RCD 1990). The average valley slope through the tailings reach is about 46 feet/mile or 0.87 percent (USGS 1986).

Figure 2. Gold Dredge Configuration and Operation (*from* Ahnert, 1990, *in* Klamath Task Force, 1991)

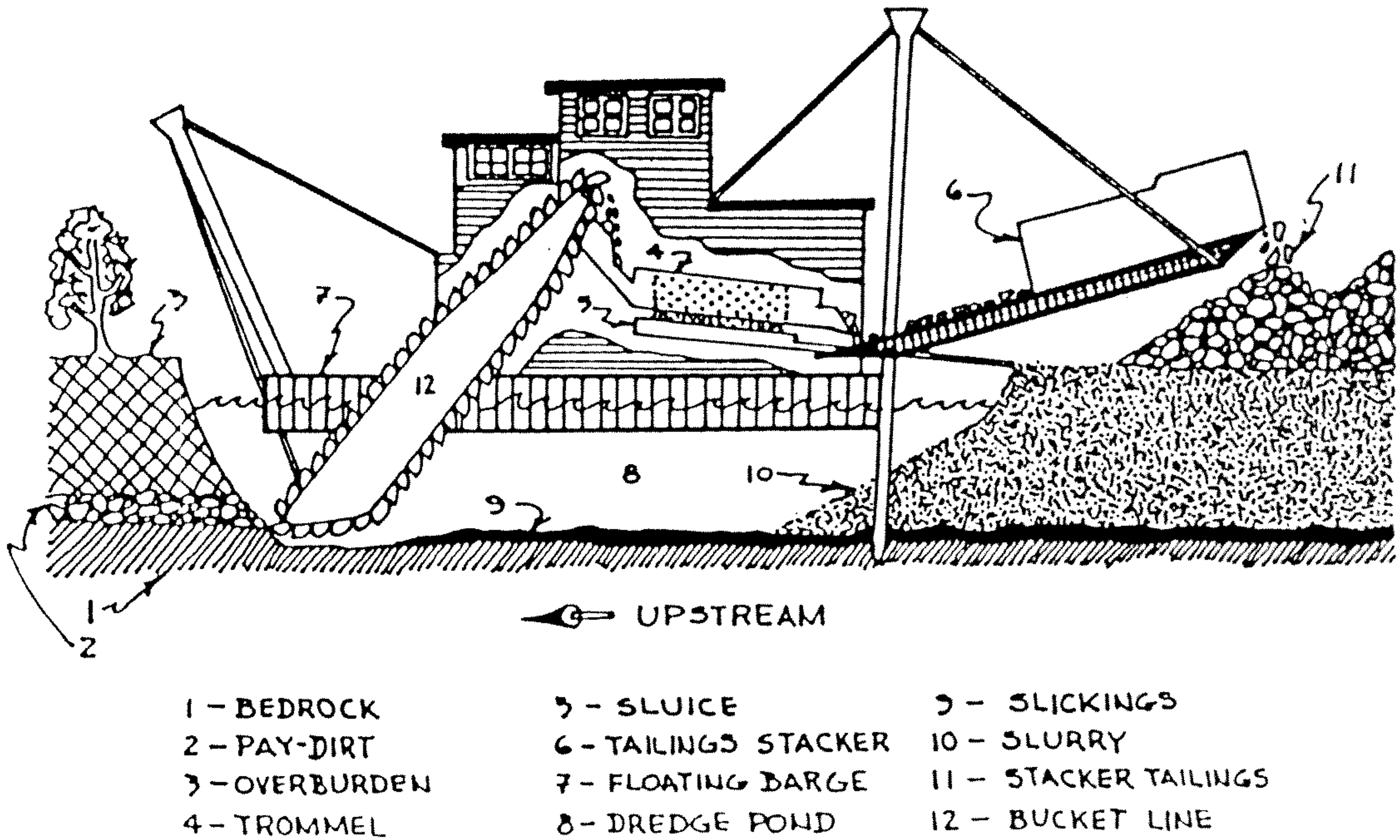
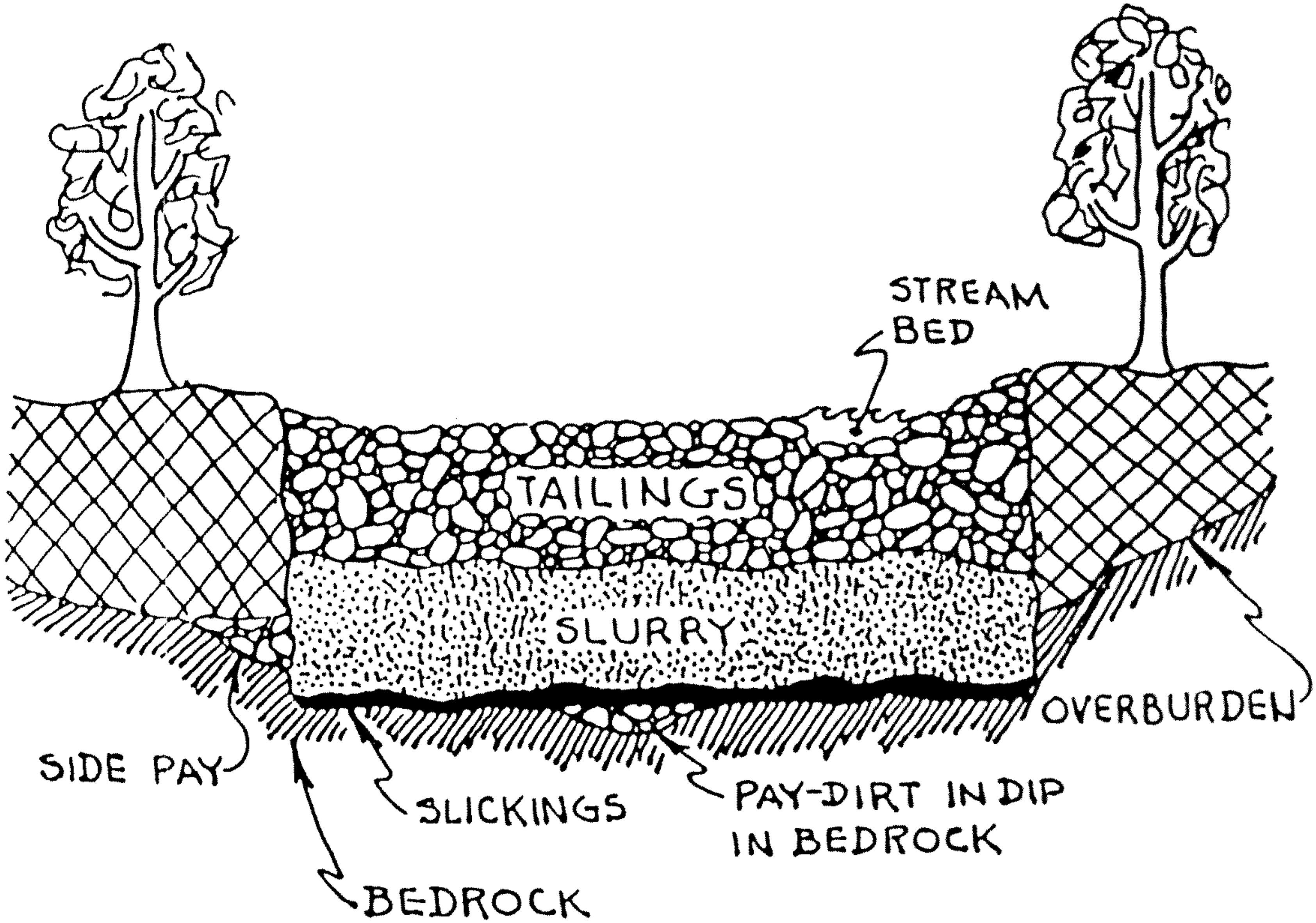


Figure 3. River Corridor Stratigraphy Following Dredging (*from* Ahnert, 1990, *in* Klamath Task Force, 1991).



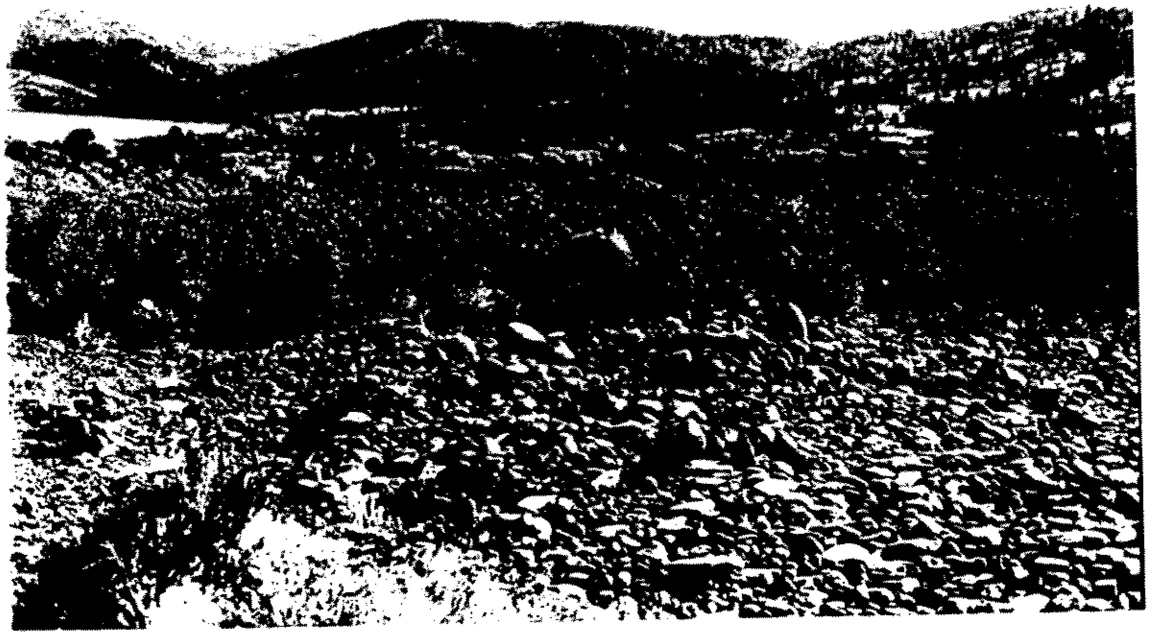


Photo #1 Panorama of tailings looking south across middle of pilot project site.

Photo #2. Panorama of tailings looking north beyond limit of pilot project site

Photo #3   South Reach eroded east bank

Photo #4   South Reach undermined buildings

Photo #5 North Reach eroded east bank

Photo #6 North Reach eroded east bank with people shown for scale.

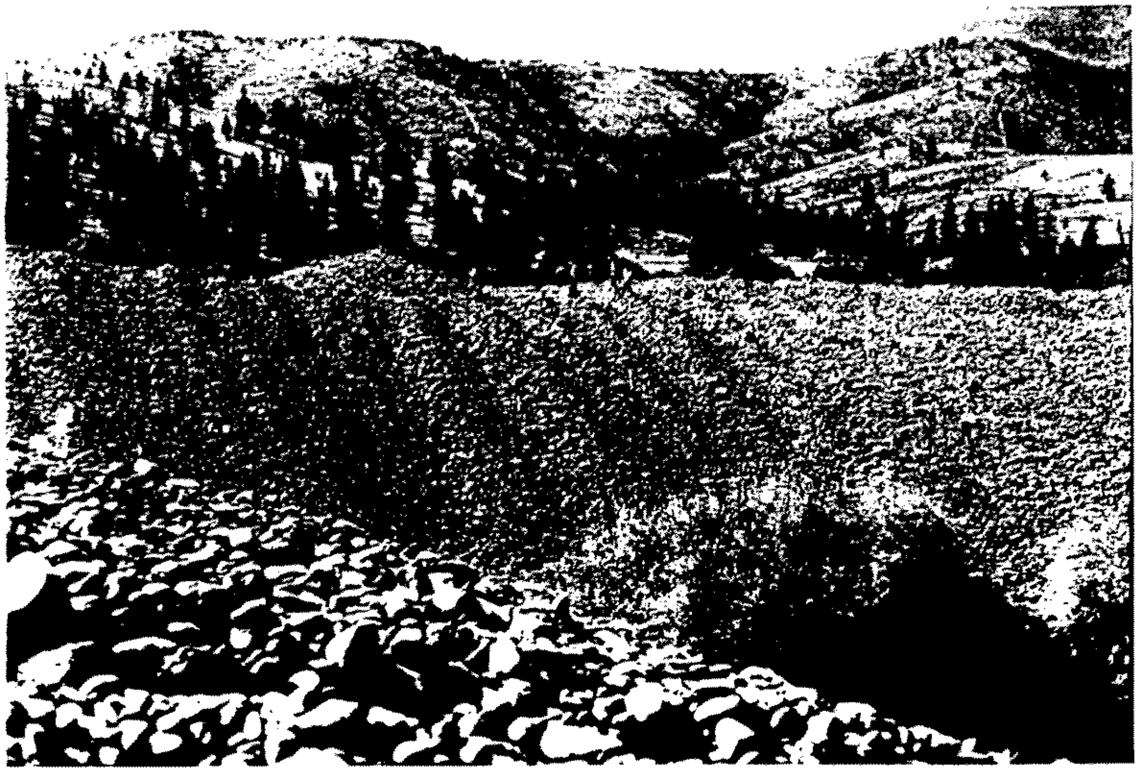


Photo #7. Largest tailings piles with people shown for scale, looking west.

Photo #8. Westside stream channel, showing potential for spawning habitat

Photo #9 Pond across from Alexander Residence, with people standing in remnant pre-dredging river channel

Photo #10 Remnant soil and river bed in vicinity of pond across from Alexander Residence

SITE SELECTION

Alternatives Considered

The pilot reach addressed in this preliminary restoration plan was used as a starting point for project development simply because this was the reach proposed by the landowner who initiated the project, other landowners along this reach also supported the project, and this reach had serious problems that warranted attention.

Even though this was the starting point, however, consideration was also given to how much river should be tackled in one construction season, whether or not it would be better to begin restoration at the upstream end of the dredge tailings, and whether or not initiating restoration of any portion of the dredge tailings would be of high enough priority to obtain funding relative to other restoration needs in the Scott River watershed. A no-action alternative was also considered. These alternatives are addressed in more detail in opposite order below.

No Action Alternative

As is apparent from the extent and pattern of lateral erosion of eastside terraces and dredge tailings, the Scott River is slowly re-establishing an adequate floodplain width and channel meander. If no actions are taken to speed up or re-direct this process, the river will eventually recover on its own. This process will take much longer under this alternative, however, and further impacts from lateral erosion and downstream deposition will continue to be substantial.

Dredge Tailings Reach vs Elsewhere In Watershed

The Scott River watershed has numerous high-priority restoration needs, including riverbank restoration in the valley reach below the dredge tailings, stream channel restoration on the East Fork and other tributaries, logging road stabilization and decommissioning throughout the watershed (especially in decomposed granite areas), and water quality and quantity improvements in many areas. These and other needs in the watershed warrant action as opportunities allow. To date, however, efforts to take action have been hampered to varying degrees by actual or perceived conflicts between proposed restoration actions and existing land and water uses, disagreements over which restoration actions should be taken, and difficulty in getting the support of all affected landowners.

The dredge tailings reach, conversely, does not appear to have any unresolvable conflicts between restoration and existing land and water uses, it is fairly clear what restoration actions need to be taken (at least in a broad sense), and the initial landowners involved have been supportive. The Scott River Flow Augmentation Study prepared by the Department of Water Resources in 1991 states in its Action Plan, "At the present time only the reach of the river from Callahan to approximately Fay Lane is suitable for reconstruction."

Also, the dredge tailings reach is geographically located at a critical point in the movement of salmon and steelhead to and from the upper watershed, and it is also located just upstream from the most productive and extensive agricultural lands in the watershed. This reach is so degraded that there is also very little risk of restoration efforts making the situation worse, and a very good likelihood of making the situation substantially better.

More specifically, restoration of the dredge tailings reach would reduce river terrace erosion, thereby protecting the East Callahan Road, the Farmers Ditch, various buildings near the river, and remaining usable pasture lands. It would also re-establish pasture lands lost to previous erosion, and would reduce downstream damage to the river channel and adjacent prime agricultural lands resulting from aggradation of coarse sediment originating from the tailings reach and the upper watershed. Also, the presence of gravel quarrying operations and the existence of a market for quarry products provides an opportunity to reduce restoration costs by incorporating quarry operations into restoration efforts. For these reasons, private landowners stand to benefit greatly, and at the same time, they have nothing to lose by participating.

Over time, restoration could also result in re-establishment of year-round river flows, more stable channel morphology, and much more extensive riparian vegetation, all of which would greatly benefit dwindling salmon and steelhead stocks. This would be of great interest to regulatory agencies and the general public due to the current high priority of restoring these stocks in the Klamath River Basin. Restoration could also include opportunities for public education and public-private cooperation, which are also of high priority. Lastly, public and private interests would benefit from improvement of the visual quality of the river corridor by removal of the tailings piles.

Middle vs Top of Dredge Tailings Reach

The sheer magnitude and associated high cost of restoring the dredge tailings reach suggest that a multi-year effort will be required, and during this time period substantial lateral dredge tailings erosion will continue to occur where floodplain width is inadequate. For these reasons, restoration efforts should ideally be started at the upstream end of the tailings reach and should progress in a downstream direction. Otherwise, large amounts of coarse sediment could enter a restored reach from upstream tailings erosion, settle out due to reduced hydraulic energy associated with floodplain restoration, and thereby compromise floodplain and/or river channel function. In the worst case, a major central point bar would form and direct erosive hydraulic forces laterally toward recently-restored river terraces.

On the other hand, the mid-reach area has the most immediate problems (eastside terrace erosion threatening several buildings, the Farmers Ditch, and the East Callahan Road, tailings erosion threatening to breach the quarry berm and switch the river back to the west side, and river flows seasonally going subsurface). Also, interim river bar removal can be incorporated into quarry activities, thereby preserving the integrity of the restored reach while also serving as a convenient way to transport upstream tailings to the quarry, and the quarry is centrally located to stockpile tailings removed from the mid-reach floodplain. In addition, if full dredge tailings restoration is approved and funded, it would only be several years at the most before the portion of the tailings reach above the pilot reach would also be restored, and interim annual sediment removal would be necessary in restored areas regardless of where restoration were started. The latter would be the case not only because of continued bedload shifting within the dredge tailings reach as it evolved toward eventual equilibrium, but also because of continued substantial inflow of coarse sediment from the as-yet unstabilized upper watershed (which could over-shadow coarse sediment production from erosion within the tailings reach). Lastly, the mid-reach is where landowner approvals have already been obtained and where initial funding appears to be most likely.

For these reasons, starting in the mid-reach appears to be the most pragmatic alternative. If, however, landowner approvals and project funding could be obtained to restore the entire dredge tailings reach, this aspect of project design should be reconsidered. It might be possible to simultaneously start floodplain widening at the upstream end, reinforce the existing mid-reach levee keeping the river from shifting westward, and temporarily armor eastside terraces in the mid-reach area. It could also be possible to complete the entire 4.7-mile dredge tailings reach in 1 season if all approvals and funding could be obtained at one time and enough heavy equipment and operators were available, but it is unlikely that everything would fall into place so quickly. Also, this scenario would preclude the opportunity to first complete work on a pilot reach in order to subsequently apply lessons learned to the remaining dredge tailings reach.

Length Of Pilot Reach

Factors in determining the length of the pilot reach include landowner approvals, funding availability, the location of relatively stable upstream and downstream endpoints, the amount of work that can realistically be completed in one season by a local contracting firm, and limits on how much should be done during the initial "pilot" phase so that the remaining tailings reach will benefit from knowledge gained from the pilot reach. The 1.3-mile pilot reach currently proposed has landowner approvals and stable endpoints, work could be completed in 1 season, and it constitutes only about 25 percent of the total tailings reach. The estimated cost for restoring this reach is about $1.6 million, however, which could be difficult to raise. If this proves to be the case, there is a relatively stable floodplain area in the middle of the pilot reach which could allow for breaking this reach into two sub-reaches.

DETERMINATION OF RIVER ROUTING

Alternatives Considered

River routing alternatives within the pilot reach include the presumed historic westside routing, a mid-valley routing shown on the assessor's map and 1944 air photos, or the existing routing on the east side of the valley (Figure 8 at end of section). These alternatives are discussed in more detail below.

Westside Routing Alternative

The attractiveness of this alternative is that the river apparently followed this routing prior to the 1861 Flood, and more important, this routing is currently the low-point of the system (being about 3-4 feet lower in elevation than the eastside channel). Since flows are perennial along this routing, it has the appearance of being the best way to restore fish passage in the short run.

Aside from these aspects, however, there are a number of potential problems with this alternative. The existing westside channel is only about 30 feet wide and 1 foot deep, which is not wide or deep enough to satisfy bankfull channel width and depth requirements, and it does not have adequate sinuosity. Much of the riparian vegetation would need to be removed on the east bank of this channel during widening and re-routing, and remaining vegetation would be subject to severe damage during floods. Subsequent sediment deposition could result in the loss of the perennial flows which made this routing so attractive in the first place. Also, westside river terrace erosion could occur, water diversions would become more difficult to maintain, and the aesthetic values of the existing stream would be lost, all of which would likely result in lack of westside landowner support for this alternative.

In addition, eastside terrace restoration would be more expensive to undertake, and eastside landowners may not want to lose riverfront land ownership. It would also be difficult to tie back into the eastside channel without staying on the west side all the way to the downstream end of the tailings, in which case the increased project length could be more than what could logically be completed in one season. This alternative would also require complete relocation of the quarry. In short, this alternative would very likely transfer to the west side of the valley many of the problems that currently exist on the east side.

Mid-Valley Routing Alternative

This alternative would follow the routing shown on assessor's maps and the 1944 air photos, which apparently reflects the river's routing after the 1861 Flood but prior to gold dredging. The only argument in favor of this alternative, however, is that the river had once followed this routing.

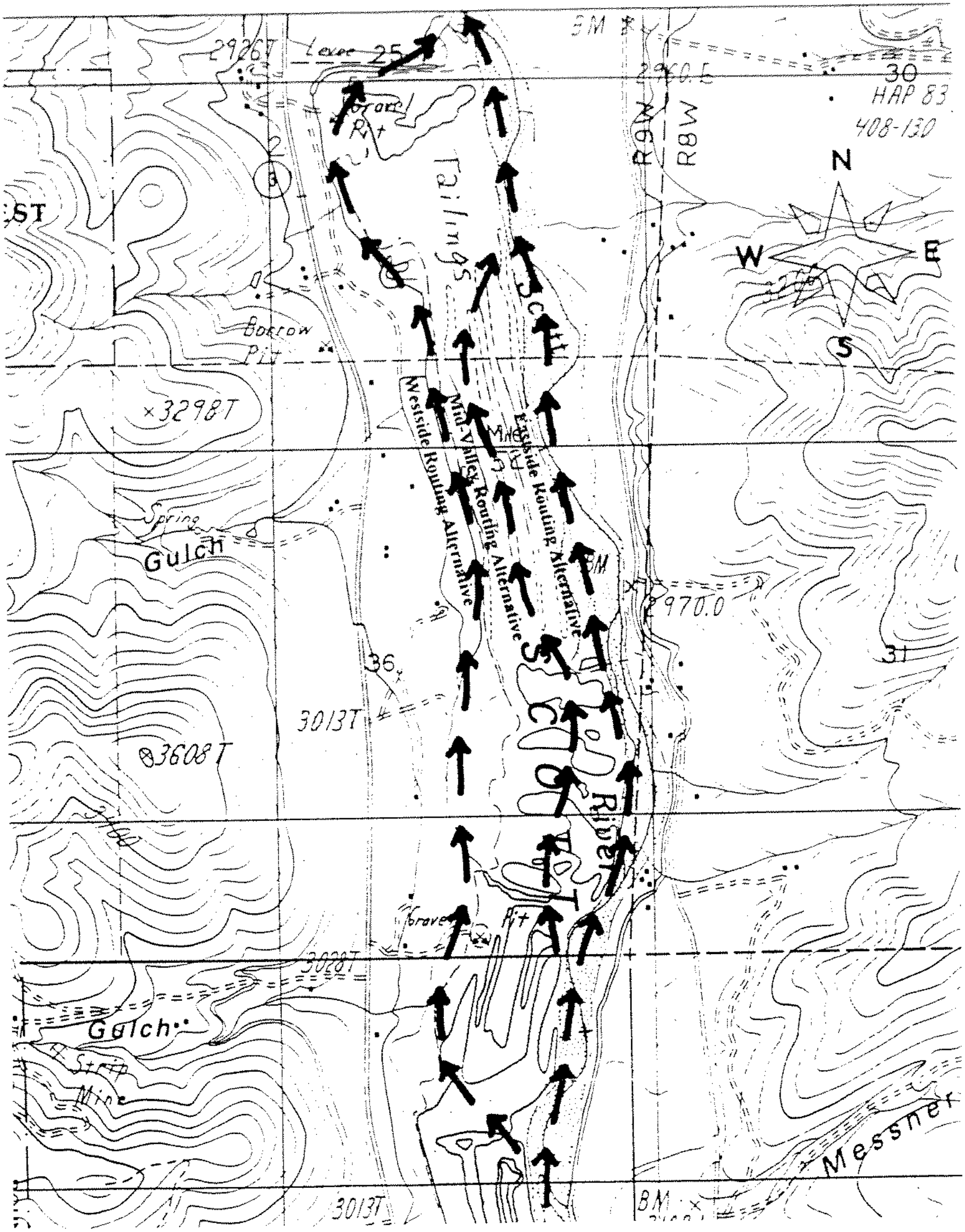
The biggest problem with this alternative is that far more dredge tailings would need to be moved in order to achieve adequate floodplain width than would be the case with the other alternatives. The substantially higher cost of restoration would therefore make this alternative unacceptable. In addition, more landowners would be involved, and their disposition on restoration is not yet known.

Eastside Routing Alternative

This routing is the preferred alternative. It provides the best opportunity to fix existing erosion of eastside terraces and protect existing buildings, East Callahan Road, and the Farmers Ditch, while also avoiding damage to westside terraces and riparian vegetation. It involves moving much less tailings material than the mid-valley alternative. It involves the fewest number of landowners and has the least impact on the quarry, and all of the landowners involved, including the quarry owner, support the project. It has the best upstream and downstream tie-in points in terms of existing stable floodplain areas with an intervening pilot reach of a length which can reasonably be restored within one season. Although the river did not follow this routing immediately prior to dredging or the 1861 Flood, this should not matter since the river has been all over the valley floor at some point in the past (as is evidenced by the valley-wide distribution of rounded river rock in the substrate).

Given the disparity between short-term fishery needs and the longer-term process of geomorphological restoration, the westside routing alternative is more tempting at first glance than the eastside routing alternative because of the prospect of immediate perennial flows. As a compromise, westside channel fishery enhancement could be included with eastside river restoration (pending westside landowner approvals), thereby achieving substantial short-term fishery benefits at a very low cost while also avoiding the pitfalls of the westside routing alternative. Eastside river restoration could in turn focus on immediate floodplain widening and erosion repair and could then shift to the much longer timeframe needed for the river to re-establish floodplain and channel stability, fill interstitial spaces in dredged substrate, re-achieve perennial flows, re-establish extensive riparian vegetation, and ultimately once again provide good fishery habitat

Figure 8   River Routing Alternatives Considered Within Pilot Reach



SELECTION AND DESIGN OF RESTORATION TREATMENTS

Restoration Treatments Considered

Restoration treatments considered include floodplain widening and grading, channel reconstruction, upland terrace reconstruction, subsurface modifications, and re-vegetation.

As mentioned in the Introduction, the approach being taken in this project is to restore the geomorphological components of the system first and then focus on habitat. Since habitat problems have been identified as key limiting factors affecting salmon and steelhead populations in the Scott River watershed, resource agencies have traditionally tended to focus on actions to directly improve habitat. In the dredge tailings reach, the habitat-related limiting factors of greatest concern are lack of perennial flows and lack of sufficient riparian vegetation. Installation of substrate dams (to force groundwater to the surface) has been considered as a means to restore perennial flows, and extensive replanting has been considered to restore riparian vegetation. Since neither of these alternatives restore the geomorphological components of the system, however, it was concluded that their likelihood of success would be low. They would, in effect, constitute the treatment of symptoms rather than the underlying causes of habitat problems.

Floodplain and channel restoration, on the other hand, would constitute the treatment of underlying causes by directly reversing the geomorphological changes associated with dredging. By restoring the hydrologic connection between floodplain and channel, the natural function of the floodplain to dissipate the energy of high flows can be re-established. Only after this natural function is restored can improvements to habitat be expected to survive flood flow forces. For this reason, the natural floodplain/channel connection is the focus of this preliminary restoration plan. This is consistent with the Action Plan of the Scott River Flow Augmentation Study, which states, "Where possible, a more natural geomorphic form should be restored to the river [to] thereby help the river convert back to its once highly productive state."

It is important to note, however, that the recommendations in this preliminary restoration plan do not strictly adhere to re-creating the pristine state of the river channel prior to disturbance by European influences. The degraded condition of the watershed and the enormous volume of dredge tailings prevent a design that would precisely mimic historic conditions. The plan does, however, take significant steps toward that objective, and by doing so, allows for the natural hydraulic interaction of channel and floodplain to shape the morphology of the system.

Regarding subsurface substrate stratigraphy, it was concluded that restoration of this component of the system would be too costly and time-consuming to include as a direct component of the current restoration plan. The significant implications of substrate stratigraphy are that it has a bearing on retention of surface flows during low river flows and on riverbed stability during peak flows. Once the floodplain is restored, fine sediment should begin to fill interstitial spaces in the substrate and gradually re-establish perennial surface flows. Regarding riverbed stability, however, there is a concern that downcutting could occur if the sand (slurry) layer is exposed to peak flow conditions. Since sand has a high market value, this problem can be mitigated by allowing the quarry owner to remove any sand found too close to the surface during restoration activities. Also, to the extent that quarry operations already include the mining of the sand layer wherever possible, this on-going practice will help to restore a more natural substrate stratigraphy over time.

Floodplain Design

This preliminary restoration plan is based primarily on the observation that the river's floodplain is too narrow. Until an adequate floodplain is re-established (either naturally or through intervention), the system will continue to be unstable, particularly with respect to lateral erosion and channel morphology, and opportunities for aquatic and riparian habitat recovery will be limited.

The valley floor of the pilot reach averages about 1,500 feet in width, which would have been the historic floodplain width prior to dredging operations, by definition of a river valley. River valleys can be wider than what is necessary simply for stable floodplain function, however, since valleys are a product of tectonic as well as erosional processes. This could well be the case in the main part of Scott Valley, but the portion of Scott Valley where the dredge tailings reach is situated is the narrowest part of the valley, it has the steepest gradient, and it is essentially an alluvial fan comprising a transition area between tributary canyons and the main valley. This is precisely why gold dredging was done in this location. Given the apparent constricted nature of this reach, historic floodplain width probably constitutes the ideal width necessary to fully restore the dynamic equilibrium which existed along this reach prior to degradation.

Lateral erosion has been and continues to be substantial along the edges of the narrower floodplain creating by dredging operations. The average floodplain width along the pilot reach in 1958 was 190 feet (based on air photos), and the average width in 1998 was 353 feet (based on the GPS survey). Based on these data, lateral erosion has resulted in an average floodplain widening of 163 feet over a 40-year period, or about 4 feet per year. During the 1964 Flood alone, the floodplain widened over 250 feet in 2 locations within the pilot reach (due mainly to eastside river terrace erosion). Although some lateral erosion has been caused by lateral deflection of hydraulic forces due to central river bar formation, the overall degree and pattern of lateral erosion within the tailings reach is not indicative of a system having an adequate floodplain width.

The minimum observed floodplain width which has resulted in relative stability within the dredge tailings reach is about 500 feet. This width occurs at the upstream and downstream endpoints of the pilot reach, which is why these locations were chosen as endpoints. At these locations lateral erosion is minimal and riparian vegetation has begun to become established, although central point bars and braided channel conditions still exist.

For preliminary design purposes, the alternatives available for floodplain restoration consist of restoring the pilot reach floodplain to its full valley width (1,500 feet), its currently observed relatively stable width (500 feet), or a width somewhere in between these values. The alternatives could also include incrementally widening the floodplain over a number of years. Given the tremendous quantity of tailings to be moved and the associated high cost, coupled with empirical observations on the minimum width needed to achieve relative stability in the short-run, the recommended alternative is to initially widen the floodplain to 500 feet, and then to gradually widen it further to the extent that refined calculations indicate and opportunities and funding allow. Given that central point bar formation has already been observed to be a problem, it is also recommended that interim annual river bar removal be included in restoration efforts.

Regarding the elevation of the widened floodplain relative to that of the existing floodplain, some degree of lowering of elevation might be warranted to help restore year-round surface flows. This is based on observations that perennial surface flows are maintained in the westside channel by being only 3-4 feet lower in elevation than the eastside channel, and that flowing pools of surface water persist in low-lying areas along the eastside channel when that channel has otherwise dried up. Design alternatives include lowering the entire elevation of the new floodplain and channel throughout the pilot reach or simply lowering floodplain elevation only in those areas where central deposition bars have developed within the existing floodplain.

By lowering the entire floodplain elevation of the pilot reach, however, downcutting could be triggered at the upstream end which could further destabilize upstream areas, and aggradation could be triggered within the pilot reach which could compromise efforts to re-establish year-round flows. These problems could be reduced or avoided by starting restoration at the upstream end of the dredge tailings reach, but the feasibility of starting at the upstream end is uncertain at this point in time. If restoration is initiated at the pilot reach, its floodplain could simply be widened at this juncture and then lowered at a later date after upstream floodplain widening and lowering have been completed, but this would require re-constructing the river channel within the pilot reach a second time which would be costly and excessively disruptive.

As a compromise, if floodplain restoration is initiated at the pilot reach, the floodplain elevation could be lowered only in those areas where there is evidence of aggradation. Extensive central deposition bar development has occurred along the pilot reach, most notably where the existing floodplain is the widest (which would be expected). Based on a preliminary longitudinal profile prepared during the GPS survey, the floodplain elevation is significantly higher in these areas. The longitudinal profile of the new floodplain should be a straight line (i.e., the floodplain should be an inclined plane without humps), and this could be achieved by shaving off existing deposition bars. Since interim river bar removal will need to be done regardless of the finish elevation, aggradation following floodplain leveling could hopefully be effectively managed. Given the importance of restoring year-round river flows as soon as possible, it is recommended that some lowering of elevation be included in initial floodplain restoration. Before a decision can be made as to the location and extent of this lowering, however, a more extensive longitudinal profile should be prepared which covers the entire dredge tailings reach.

Regarding cross-sectional floodplain slope, the recommended design is to construct a level cross-section over most of the floodplain width (consistent with creating an inclined plane). In order to reduce the likelihood of lateral erosion, however, the edges of the floodplain should have a slight (2-5 percent) transition slope near the edges .

Since isolated ponds and pockets of riparian vegetation having ecological and geomorphological value are scattered through the dredge tailings, it is also recommended that the edge of the new floodplain be routed to incorporate these features where possible. Also, since the tailings piles are oriented parallel to the floodplain edge in the northern (downstream) portion of the pilot reach, it is further recommended that the floodplain edge be oriented to correspond with troughs in the tailings piles in order to reduce excavation.

Channel Design

River channel design alternatives consist of leaving the existing channel intact, constructing a floodplain without a channel (i.e., leaving it up to natural events to re-establish a channel), constructing a rudimentary but functional channel and letting natural events do the fine-tuning, or constructing a very thoroughly designed replica of how the original channel appears to have been configured.

Since the existing primary river channel passes directly against the active cutbanks of both locations in the pilot reach where the eastside river terrace is severely eroded, restoration of these eroded areas will preclude the option of leaving the existing channel intact. Also, because the existing channel has evolved within an inadequately-sized floodplain, it will not have the proper channel geometry once the floodplain is widened. If floodplain restoration is undertaken without interim channel construction, there will not be sufficient hydraulic energy to keep coarse sediment moving. As a result, large central deposition bars will most likely form, causing channel braiding and possible lateral erosion of the restored river terraces. On the other hand, to over-build the river channel could also be a waste of restoration efforts since high bedload movement would inevitably result in channel changes even if the channel were successful in transporting much of the coarse sediment through the restored reach. Since only a portion of the dredge tailings reach can be restored in a given season, bedload movement will continue to be substantial from lateral erosion as well as from input from the upper watershed. Based on the above, the preferred alternative is to construct a rudimentary river channel in association with floodplain restoration along the pilot reach, coupled with interim river bar removal while restoration work continues on the remainder of the dredge tailings reach. Subsequent fine-tuning of the river channel can be done after completion of initial floodplain widening along the entire dredge tailings reach.

Specific channel geometry design parameters to be considered include bankfull width and depth, meander wavelength and amplitude, and sinuosity. Related parameters include longitudinal channel slope, roughness of the channel bottom, and bankfull discharge. Bankfull conditions occur when the flows in a functioning river channel are right at the point of spilling onto the floodplain. At this point, hydraulic energy and associated sediment transport ability are at their highest levels, and over time a dynamic equilibrium is achieved which defines the geometry of the river channel. For these reasons, bankfull conditions are the most important in terms of channel design.

For purposes of this preliminary restoration plan, values for channel geometry design parameters were approximated by using a combination of on-site measurements, comparisons to other watersheds, and mathematical modeling. Based on on-site measurements, the longitudinal channel slope of the interim channel will be about 0.65 percent and the channel bottom roughness (Manning's "n") will be about 0.031. Comparisons of over 400 watersheds in the western United States indicate that for a watershed size of 137 square miles (the size of the Scott River watershed above the dredge tailings reach), the bankfull discharge should be in the neighborhood of 1,000 cubic feet per second (Leopold 1994). By plugging these values into a mathematical model, the calculated bankfull channel width is about 45 feet and mean channel depth (in riffle areas) is about 3 feet. The model also yields a calculated bankfull flow velocity of about 7.6 feet per second, which is high but probably necessary to move coarse sediment through the system. These preliminary values will probably change to some extent when the design is fine-tuned.

Meander wavelength can be approximated by using the empirical relationship that meander length is equal to about ten to fourteen times the bankfull channel width. A channel width of 45 feet would therefore yield a meander length of about 450 to 630 feet. Since the interim channel will still be carrying a high sediment load, the higher meander length of 630 feet would be more likely to be stable. Wavelength amplitude can be approximated by using the empirical relationship that amplitude is equal to about 2.7 times the bankfull channel width, or in this case about 122 feet. Again due to a high sediment load, this amplitude would probably be too high to be stable, since the resultant channel slope would be too gentle. An amplitude of about 75 feet would yield a channel slope of 0.65 percent, which, as used in the calculations above for channel width and depth, would appear to work for the system being modeled.

The above meander wavelength and amplitude would result in a channel length of 7,400 feet meandering through a pilot reach with a straight-line valley length of 6,600 feet. The ratio of these distances yields a sinuosity of 1.12 to 1. This value is low for this channel type, but given the anticipated high sediment load to be transported, a tighter sinuosity could result in channel failure. Sinuosity can increase over time due to an increase in wavelength amplitude. This in turn can result from natural processes involving gradual erosion at the outside edge of river bends and deposition at the inside edge, or wavelength amplitude can be increased as part of future restorative actions. Regardless of cause, however, this increase must coincide with a decrease in the amount of coarse sediment to be transported through the system; otherwise, the channel could fail.

Regarding the cross-sectional shape of the interim channel, it is recommended that its shape reflects that which is observed in nature, where the outside bank of a river bend is steep and the inside bank is gentle. Coarse on-site material should be used to armor the outside of river bends (to keep sinuosity from increasing too rapidly), and channel depth should be greatest at these locations (about 6 feet deep--for geomorphological as well as fish habitat reasons). Regarding overall meander pattern, it is recommended that the pattern be natural-appearing and also take advantage of the opportunity to intercept isolated existing ponds and pockets of riparian vegetation. This will provide some additional interim pool and riparian habitat, and the riparian vegetation will also provide shade and additional interim channel armoring.

The dredge tailings reach is so degraded that measurements of existing channel geometry parameters were deemed for the most part to not be useful. For this reason and the preliminary nature of the current project, the design recommendations given above rely heavily on empirical relationships derived from other river systems and will need to be fine-tuned prior to project implementation. Fine-tuning should involve the use of historic air photos, maps, gauging station data, reference reach measurements, substrate measurements, and other information. The most likely reference reach would be the 1.5-mile reach between the downstream end of the dredge tailings and Fay Lane Bridge, but this reach is also fairly degraded.

The challenge in fine-tuning the project design will be to find a balance point between aggradation and downcutting: a balance point at which the river will simultaneously move coarse sediment through the system and dissipate excessive hydraulic energy. Interim river bar management and on-the-ground channel fine-tuning will undoubtedly be necessary, but overall, the system should be significantly more stable following initial floodplain and channel restoration than is currently the situation.

Westside Channel Fishery Enhancement

The currently isolated perennial stream on the west side of the dredge tailings could provide an excellent opportunity to achieve immediate fishery benefits while longer-term river recovery is initiated on the east side of the tailings. This 1.5-mile stream is fed in a spring-like manner by river water passing through the tailings. It has stable cold flows, good pool/riffle development, a gravel bottom, extensive riparian vegetation, and what appears to be a healthy and diverse aquatic invertebrate population. From an anadromous fishery point of view, the only limiting factor is the presence of a downstream fish barrier in the form of tailings piles where flows go subsurface once again before re-joining with the river.

To make the most of this stream, not only must the downstream tailings be removed, but 2 water diversions should be modified and upstream opportunities for lengthening and re-routing of the stream should be pursued. Regarding the latter, another 1,800 lineal feet of spawning and rearing habitat could easily be created by extending the channel further into the tailings and re-routing a portion of the stream within the gravel quarry. It is recommended that contingent upon landowner approvals, this channel be incorporated into the project design for enhancement of salmon and steelhead spawning and rearing habitat. To facilitate landowner approvals, it is further recommended that a Memorandum of Understanding be prepared in which affected landowners agree to allow fishery enhancement to be done on their land in exchange for an agreement from applicable regulatory agencies to provide these landowners with safe haven protection under the Endangered Species Act.

Upland Terrace Restoration

Based on the 1958 air photos, the eastside river terrace upstream from the Alexander residence extended up to 250 feet further westward and had a slope of about 7 percent at the time of the photos (Figure 5). Similarly, the terrace downstream from the Alexander residence extended up to 300 feet further westward and had a slope of about 11 percent at the time of the photos. According to the Soil Survey of Siskiyou County, these terraces are comprised of Duzel gravelly loam (SCS 1983).

Alternatives for terrace restoration include letting the riverbank recover naturally over time (i.e., no action), installing rip-rap at the base of the eroded banks, excavating back the steep slopes to lessen their steepness, using imported material to re-construct the terraces, or using dredge tailings for re-construction.

Taking no action at this point in time would eventually result in bank stabilization, but the Farmers Ditch would most certainly be washed out and would need to be re-routed. East Callahan Road might be washed out, and several buildings could be lost. In addition, more usable land would be lost and more sediment would be transported downstream. It would seem that given what is at stake, taking no action is not an acceptable alternative. Excavating back the steep banks would differ from the no action alternative only in making the cut banks more attractive and reducing to a small extent the amount of sediment entering the river.

Installing rip-rap could be an effective alternative as long as the floodplain is restored, the river channel is moved westward, and interim river bar management is undertaken. No additional usable land would be created, however, and an opportunity to dispose of dredge tailings would be lost. If rip-rapping were done without river restoration, it would be destined to fail given the hydraulics involved. Rip-rap projects completed in the 1960's at the upstream-most eastside terrace of the pilot reach and several years ago near Fay Lane both failed.

To create additional usable land while also protecting existing improvements would require the importation of a substantial amount of fill material. Based on the 1958 air photos, about 88,000 cubic yards have been lost from the upstream terrace over the last 40 years, and about 107,000 cubic yards have been lost from the downstream terrace over the same time period. Importing these quantities of material over any distance at all would be very expensive, and to import material from further away than the project site would be cost prohibitive.

The most cost-effective way to restore these terraces would be to use dredge tailings. This would also be the most cost-effective way to dispose of tailings removed during floodplain widening. In fact, if it weren't for the latter, terrace restoration beyond simply stabilizing the existing banks would not be worthwhile since the expense would greatly exceed the value of usable land created.

Use of tailings to restore eastside river terraces would involve gradually re-building the terraces in layers (lifts) until the desired topography were achieved. To stop at this point, however, would have achieved the disposal of a substantial amount of tailings but would not have created very usable land due to the gravelly composition of the tailings. The re-constructed terraces could be capped by pushing adjacent terrace soil out over the tailings, by excavating ponds nearby to provide capping material, and by salvaging 2 pockets of river terrace material now isolated on the west side of the existing floodplain. All of these methods are recommended in concert to restore the terraces to some semblance of their historic condition. Fines removed from sediment basins on French Creek and fines produced by quarry operations might also be of value in capping the terraces while also providing a means of disposing of those materials.

The tailings under the topsoil cap will initially be quite porous, but the soil layer will have reasonable water holding capacity and the interstitial spaces of the underlying tailings should gradually fill-in over time. The tailings will also be fairly erodible at the toe of the slope, but the floodplain can be shaped to slope upward before reaching the terrace and riparian vegetation can be planted at the terrace edge. Regarding the latter, terrace reconstruction coupled with the porous nature of the tailings and water leakage from adjacent irrigation ditches should result in a significant amount of seepage at the base of the terraces, thereby providing the water needed by riparian vegetation.

Re-Vegetation

Re-vegetation of the re-constructed floodplain and river channel could range from no replanting at all to extensive riparian planting. Given the restoration approach proposed by this project of incrementally restoring the foundational parameters necessary for achieving a stable system in the future, it would not be worthwhile to invest much effort in replanting the floodplain and river channel after initial reconstruction. Significant substrate re-arrangement will be expected on an annual basis from a combination of natural events, river bar removal, and eventual fine-tuning of the floodplain and channel after the entire dredge tailings reach has been initially re-constructed. Also, initial restoration may not bring the water table close enough to the surface to facilitate re-establishment of riparian vegetation, and the soil texture may not be fine enough to satisfy the substrate conditions preferred by many riparian species.

The only replanting that would be worthwhile in the reconstructed floodplain area would be the opportunistic replanting of willow and cottonwood poles and rootwads along the new river channel that are salvaged during floodplain widening. The rootwads and poles would be large and deep enough to have some chance of reaching groundwater and resisting floods. Mortality of these plantings would still be expected to be high, however.

Regarding the re-constructed river terraces, seeding and strawing would be essential to control erosion of the topsoil cap. Use of native seeds would be better for wildlife purposes (particularly birds and wintering deer) and would suffice for livestock as long the terraces were not intensively grazed. If intensive grazing is desired by the landowners involved, then appropriate pasture species should be planted. Water is available at both terrace locations for interim and/or on-going irrigation as needed. If any grazing is planned, a sod layer should be established prior to any grazing and riparian fencing should be installed with a reasonable setback from the edge of the floodplain to allow riparian plant species to become established. Regarding riparian species, extensive planting of cuttings (including willow, hawthorn, and cottonwood) would be very desirable at the base of the re-constructed terraces since hydraulic forces should be less, the water table should be higher, and the soil texture should be better at these locations than elsewhere in the re-constructed floodplain.

The portion of the westside channel created for fisheries enhancement and the ponds created as a source of river terrace soil should be replanted with nursery stock and cuttings of riparian species (including willow, hawthorn, white alder, and cottonwood), and with seeds of various herbaceous riparian species

Role of Quarry

The presence of an active gravel quarry within the project site provides several opportunities which could greatly benefit restoration efforts. The quarry would be a good location to stockpile large amounts of tailings removed during floodplain widening, and the income derived from selling these tailings to the quarry could be used to cover some of the restoration costs. If the sand layer underlying the tailings proves to be too close to the surface at any location following floodplain and/or channel excavation, the sand can also be sold to the quarry to cover the cost of its removal. (Note: if a layer of cobble is not maintained over the sand layer, increased channel and/or floodplain erosion could occur. On the other hand, since most subsurface water flow is perched above the sand layer, the more porous cobble layer should be kept to the minimum thickness necessary for armoring.)

The quarry could also provide interim river bar removal services in exchange for mineral rights to the material removed. Similarly, a "vortex gravel sampler" could be installed which would automatically intercept moving bedload in the river channel and transport it to the quarry using vortex currents created in the delivery culvert. Quarrying of remaining tailings along the western edge of the restored floodplain could also be encouraged, thereby resulting in further widening of the floodplain over time until the historic valley-wide floodplain width is achieved. Quarry operations could also be coordinated with extension of the westside spawning channel (including being the source of spawning gravel for the extended channel), and could be one of the sources of fines for river terrace capping.

By dovetailing quarry operations with restoration needs, a mutually beneficial relationship could be developed which, if properly structured, would not have any negative impacts on either the quarry operator or the public interest. A similar symbiosis, albeit on a smaller scale, currently exists on the Applegate River in Oregon, where Copeland Sand and Gravel Company has been authorized to remove gravel bars to slow down channel aggradation and enhance coho salmon habitat (Copeland, personal communication).

PROJECT WORK PLAN AND FUNDING

Summary

The recommended design components discussed in the previous section were incorporated into a preliminary site plan and cross-sections, and a work plan and list of funding sources were prepared to facilitate project implementation (Figures 9 and 10 and Tables 1 and 2 at end of section). The work plan includes project phases and tasks, an implementation timetable, quantities, and estimated costs. Project phases consist of Funding, Surveys/Permits/Approvals, Contractor Recruitment, Concurrent Studies, Excavation, Re-Vegetation, Monitoring, and Administration/Education. These phases are discussed below in chronological order of implementation.

Funding

The first phase in implementing this Preliminary restoration plan will be the securing of funding. The Surveys/Permits/Approvals Phase and the Contractor Recruitment Phase, which are scheduled for completion in 1999, are proposed to be funded through the Jobs-In-The-Woods Program administered by U.S. Fish and Wildlife Service. An application for this funding has been submitted by Tom Hesseldenz and Associates (THA) and is currently pending. In addition, an application for SB 271 funding through the California Department of Fish and Game was submitted by SHN Consulting Engineers, and if obtained, would fund the Concurrent Studies Phase to be initiated in 1999.

Applications for funding for phases to be initiated in the year 2000 must also be submitted in 1999 in order for these phases to proceed on schedule. Grantwriting services will be provided on a pro bono basis by THA as part of the match required by the Partners For Wildlife Program which funded completion of this Preliminary restoration plan. At a minimum, funding will be pursued for restoration of the 1-mile pilot reach of the dredge tailings. Funding may be pursued for restoration of the entire 4.7-mile dredge tailings reach, however, in those cases where funding sources are receptive and the grantwriting burden is not substantially increased. A Partners For Wildlife grant has already been obtained by one of the affected landowners (Larry Alexander), and a request for partial funding for the year 2000 was included in the Jobs-In-The-Woods grant application already submitted by THA. Additional funding sources to be pursued include:

WRDA Section 206 Program (U.S. Army Corps of Engineers)
Saltonstall-Kennedy Grant Program (National Marine Fisheries Service).
Klamath Restoration Program (U.S. Fish and Wildlife Service)
Northwest Salmon Initiative (U.S. Fish and Wildlife Service)
CWA Section 319(h) NPS Grant Program (State Water Resources Control Board)
Salmon and Steelhead Trout Restoration Account--SB 271 (Ca. Dept. of Fish and Game)

In addition to grant programs, other methods of covering restoration costs will also be pursued. These include:

Partners For Wildlife Program in-kind match requirement (Larry Alexander)
Northern Calif. Ecosystem Training Center (NorCET)--donated and discounted services
Donation of privately-owned tailings to project, with subsequent sale to local quarry

Surveys, Permits, and Approvals

This phase will consist of securing final landowner and local agency support, conducting field surveys, fine-tuning the project design, applying for permits, and satisfying CEQA and NEPA requirements necessary for project approval.

Final landowner support will be pursued through a Memorandum of Understanding between applicable landowners and regulatory agencies. Initial landowner support has been obtained for eastside river channel restoration within the 1-mile pilot reach, but additional landowners will need to provide their support if westside channel fishery enhancement is included in the project. Pending successful landowner support, the support of the Scott River CRMP, Siskiyou RCD, and County Board of Supervisors will be sought.

Field surveys will include an aerial survey (digital orthophoto), cultural survey, contaminants survey, land and water-use survey, ecological survey (including a wetland delineation), selected hydrologic and geomorphic measurements, and baseline monitoring (GPS transects, photos, and vegetation). The project design will then be fine-tuned, based on landowner and local agency input, field data collected, continued literature review, and results of an independent design review of this Preliminary restoration plan to be provided by SHN Consulting Engineers.

Once all of the necessary data have been collected and the project design has been fine-tuned, a combined Initial Study (CEQA) and Environmental Assessment (NEPA) will be prepared and submitted to Siskiyou County Planning Department along with a use permit application. A mitigated negative declaration under CEQA will be proposed, and the CEQA/NEPA process will serve as a vehicle for public input. At the same time, applications will be submitted to the applicable regulatory agencies for endangered species consultation, a wetland permit, water quality certification, a streambed alteration agreement, and revisions for the existing gravel quarry's reclamation plan, NPDES permit, and use permit.

Contractor Recruitment

During this phase of the project, construction documents will be prepared, the excavation portion of the project will be put out to bid, and an excavation contractor will be hired. Pending funding, the re-vegetation portion of the project will be done by NorCET as part of the Jobs-In-The-Woods Program. Construction documents will include a revised site plan (based on the outcome of the approvals process), a grading plan, detail drawings, specifications, and a project manual.

Concurrent Studies

If SHN Consulting Engineers is successful in obtaining funding through the state's Salmon and Steelhead Trout Restoration Account, that company will conduct additional field studies, research historical records, and evaluate the success of restoration efforts on the pilot reach in order to prepare a restoration plan for the remainder of the dredge tailings reach. SHN's proposal includes floodplain and channel restoration, but also puts substantial emphasis on short-term restoration of perennial flows, possibly through the use of substrate dams. Related to that emphasis, SHN's proposal includes some subsurface field studies (such as test pits, drilling, and piezometer installation) which have not been proposed in this Preliminary restoration plan for the pilot reach. (It was concluded that for purposes of this plan, adequate subsurface information could be derived from existing quarry operations, historical data, and direct field observations on river flow behavior.)

If SHN fails to get funding, some of the work to be done under the project phases discussed above for the pilot reach could be expanded to include the entire dredge tailings reach without substantial additional cost. Work to be done on fine-tuning the pilot reach design will require studying the entire dredge tailings reach anyway, and CEQA/NEPA may require that the entire reach be addressed in the approvals process regardless of geographic limitations of the pilot project. Landowner negotiations would take a little longer, but the same M.O.U. could be used. The same funding sources would be approached and the same permits would be required. In other words, there would be an economy of scale associated with many of these tasks.

If the scope of the project were to be increased, those tasks which would increase substantially in cost would be completion of expanded field studies and the preparation of expanded construction documents, since their costs are directly related to the geographic size of the project. Subsurface field studies proposed by SHN relating to achieving perennial flows would not need to be undertaken, however, unless requested by the regulatory agencies, in which case additional funding would be required for those studies as well.

Excavation

All excavation and re-vegetation work is proposed to be completed in the year 2000 if needed permits, approvals, and funding can be obtained. The work plan is broken down in such a way that if only partial funding is obtained, the southern half of the pilot reach can be completed first. The "South Reach" was given higher priority due to more immediate threats to buildings, the Farmers Ditch, the East Callahan Road and the quarry. Also, excavation would not be started until after spring runoff (May) and would be completed prior to the beginning of the flood season (November). This yields about a 6-month construction season, and during most of this time, the riverbed will be dry in the pilot reach. When low flows are present, temporary culverts can be used to facilitate restoration work.

The Excavation Phase will utilize dozers, excavators, scrapers, dump trucks, and other large earthmoving equipment, reminiscent of a major highway or dam construction project. Specific tasks will consist of:

- Laying out the earthwork to be done
- Salvaging woody vegetation in areas to be filled
- Constructing and maintaining temporary haul routes and culverts
- Excavating test pits to determine sand depth
- Widening the floodplain and excavating the new river channel
- Armoring outside bends of the new channel using large-sized spoils
- Hauling spoils to stockpile areas and setback levee and terrace reconstruction sites
- Rough grading reconstructed terraces
- Hauling soil to terraces from remnant floodplain pockets and new ponds
- Spreading remnant soil over terraces
- Finish-grading the new channel, floodplain, terraces, and ponds.

Pending landowner approval, excavation will also include westside channel extension, which will consist of laying out the channel routing, excavating the channel, lining the channel with spawning gravel, opening the existing channel at its downstream end (to allow fish passage), and modifying existing water diversions along the channel (to enhance fish passage).

Re-Vegetation

Re-vegetation will consist of: planting salvaged poles and rootwads of riparian trees along the new river channel (using an excavator to reach the water table and anchor the poles and rootwads to reduce wash-out); planting salvaged cuttings along the base of reconstructed terraces, along the extended westside channel, and around the new ponds; planting native nursery stock along the extended westside channel and around the new ponds; sowing commercially-grown native wildflower and grass seed on reconstructed terraces, along the extended westside channel banks, and around the new ponds; tractor-harrowing and hand-raking of seeded areas; and spreading of straw over seeded areas.

Monitoring

Five years of monitoring will be performed following completion of excavation and re-vegetation, in order to satisfy the requirements of various regulatory permits as well as glean information from the restoration efforts undertaken to apply to future restoration. In addition, baseline data will be collected during the Surveys/Permits/Approvals Phase. Monitoring will include annual aerial surveys (yielding digital orthophoto maps with a 1-foot contour interval), GPS transects along permanent transect lines, on-the-ground photographs from pre-established photo-points, vegetative monitoring at permanent plots, and redd counts along the westside channel. Annual reports will be prepared which summarize the various monitoring data collected.

Administration and Education

This phase will extend over the full timeframe of the project. The administrative portion of this phase will include invoice preparation, bill paying, budget tracking, and quarterly and final report preparation. The educational portion will include phone conversations and meetings with landowners and agencies, public presentations, media releases, field trips, training of displaced timber workers employed on the project, and involvement of local schools and volunteers in re-vegetation and monitoring activities.

Table 1. Scott River Preliminary Floodplain Restoration Project
PILOT REACH WORK PLAN AND COST ESTIMATE

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
DESIGN (1998-99):								
Perform site reconnaissance.	2 trips					830	1,671	2,501
Perform topographic survey.	1 trip					634	3,600	4,234
Prepare base sheet and cross-sections.	2 sheets					65	825	890
Prepare preliminary site plan.	1 plan					1,544	700	2,244
Meet with landowners and agencies.	3 meetings					1,643	345	1,988
Prepare final site plan, etc. (Figs. 9, 10).	2 sheets					514		514
Prepare work plan, etc. (Tables 1, 2).	1 document					1,869		1,869
Prepare final report (this Plan).	1 report					520	240	760
Subtotal						**7,619**	**7,381**	**15,000**
FUNDING (1998-99):								
Apply for JITW funding (USFWS).	1 application					3,000		3,000
Apply for Section 206 funding (ACOE).	1 application					2,000		2,000
Apply for 319(h) funding (WQCB).	1 application					2,000		2,000
Apply for S-K funding (NMFS).	1 application					2,000		2,000
Apply for NW Salmon Initiative funding.	1 application					2,000		2,000
Apply for Klamath Restoration funding.	1 application					2,000		2,000

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Apply for SB 271 funding (DFG).	1 application					2,000		2,000
Subtotal						**15,000**		**15,000**
SURVEYS/PERMITS (1998-99):								
Prepare landowner/agency MOU.	5 mtgs; 1 doc					2,503		2,503
Seek CRMP/RCD/Supes support.	3 meetings					875		875
Perform toxics survey (w/ USFWS).	1 survey					276		276
Perform cultural survey (w/ USFWS).	1 survey					276		276
Conduct land/water use study	1 study					520		520
Perform ecological survey/wetland delin.	1 survey					1,073	1,440	2,513
Prepare orthophoto survey.	1 survey					260	5,000	5,260
Perform baseline GPS/photo monitor'g.	15 transects					553	2,600	3,153
Perform baseline veg. monitoring.	14 transects					520	360	880
Perform hydrologic/geomorphic survey.	1 survey					260	1,800	2,060
Research historic records/literature.	1 study					260	1,800	2,060
Obtain independent design review	1 review. SHN					260	3,000	3,260
Fine-tune project design.	1 re-design					1,040	1,440	2,480
Prepare revised quarry reclamation plan.	1 plan					1,040		1,040
Prepare Initial Study/EA.	1 document					3,000	360	3,360
Apply for project use permit (Sisk. Co.)	1 application				2,000	260		2,260
Apply for Sec. 7,10 ESA permit (FWS)	1 application					520		520

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Apply for wetland permit (ACOE/DFG).	1 application					520		520
Apply for water quality cert. (WQCB).	1 application				500	520		1,020
Apply for quarry NPDES pmt (WQCB).	1 application				500	520		1,020
Apply for 1603 permit (DFG).	1 application				1,191	520		1,711
Apply for rev. reclam. plan (Sisk. Co.).	1 application				1,325	520	520	2,365
Apply for quarry use permit (Sisk. Co.).	1 application				1,000	520		1,520
Subtotal					**6,516**	**16,616**	**18,320**	**41,452**
CONTRACTOR RECRUIT (1998-99):								
Prepare construction site plan.	1 plan					1,040		1,040
Prepare site plan/planting details, specs.	1 set docs					520		520
Prepare grading plan, sections, specs.	1 set docs					260	2,080	2,340
Prepare/circulate bid documents.	1 set docs					1,040	1,040	2,080
Conduct walk-thru; select contractors	1 meeting					553		553
Prepare and execute contracts.	2 contracts					520		520
Subtotal						**3,933**	**3,120**	**7,053**
CONCURRENT STUDIES (1999-2000):								
Perform studies to augment design.	1 project: SHN						136,784	136,784
Subtotal							**136,784**	**136,784**
SOUTH REACH EXCAVATION (2000):								
Lay out edges of cuts, fill, new channel.	74 gradestakes					553	3,600	4,153

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Lay out haul routes, staging areas, etc.	1 day					553		553
Remove/save woody veg from fill areas.	80 hours			2,000		276		2,276
Construct/maintain haul routes/culverts.	6,200 lf		5,000		800	276		6,076
Excavate test pits for sand depth.	14 pits		875			276		1,151
Push tailings into area south of quarry.	100,296 cy	$0.45/cy	45,133			2,433	2,130	49,696
Push tailings into quarry area.	53,126 cy	$0.45/cy	23,907			1,106	1,106	26,119
Push tailings into area north of quarry.	56,500 cy	$0.45/cy	25,425			1,106	1,106	27,637
Load and haul tailings to quarry.	543,629 cy	$0.85/cy	462,085			9,290	8,627	480,002
Load and haul tailings to terrace recon.	70,988 cy	$0.85/cy	60,340			1,217	1,217	62,774
Rough grade reconstructed terrace	5.6 acres		1,500			276		1,776
Load/haul remnant soil to terrace.	11,156 cy	$2.00/cy	22,312			553		22,865
Load/haul remnant soil to stockpiles.	5,094 cy	$2.50/cy	12,735			276		13,011
Spread soil, finish grade terrace	5.6 acres		1,500			276		1,776
Armor outside bends of new channel.	977 cy	$1.25/cy	1,221			276	276	1,773
Finish grade new channel, floodplain.	45.7 acres		10,000			1,106	1,106	12,212
Subtotal			**672,033**	**2,000**	**800**	**19,849**	**19,168**	**713,850**
SOUTH REACH RE-VEG. (2000):								
Sow wildflower/grass seed on terrace.	5.6 acres			50	3,550	184		3,784
Harrow in seed.	4 hours		180			184		364
Spread straw over seeded areas.	300 bales		270	1,875	1,350	184		3,679

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Plant cuttings along base of terrace.	2,000 lf			1,000		276		1,276
Plant poles/wads along new channel.	154 items		2,600	1,800		276		4,676
Subtotal			**3,050**	**4,725**	**4,900**	**1,104**		**13,779**
NORTH REACH EXCAV. (2000):								
Lay out edges of cuts, fill, new channel.	44 gradestakes					553	1,800	2,353
Lay out haul routes, staging areas, etc.	½ day					276		276
Lay out ponds	½ day					276		276
Cut/save woody veg from fill areas.	40 hours			1,000		276		1,276
Construct/maintain haul routes/culverts.	4,600 lf		4,000		800	276		5,076
Excavate test pits for sand depth	12 pits		750			276		1,026
Push tailings westward to stockpiles.	269,439 cy	$0.45/cy	121,248			3,539	3,539	128,326
Push tailings to terrace reconstruction.	33,222 cy	$0.45/cy	14,950			481	481	15,912
Load and haul tailings to terrace recon	33,222 cy	$0.85/cy	28,239			398	398	29,035
Rough grade reconstructed terrace.	4.8 acres		1,000			276		1,276
Push stockpiled soil over terrace.	5,094 cy	$0.45/cy	2,292			276		2,568
Load and haul soil from pond sites.	3,640 cy	$2.50/cy	9,100			276		9,376
Spread soil; finish grade terrace, basins.	5.3 acres		1,500			276		1,776
Armor outside bends of new channel.	733 cy	$1.25/cy	916			276	276	1,468
Finish grade new channel, floodplain.	33.5 acres		7,500			829	829	9,158
Subtotal			**191,495**	**1,000**	**800**	**8,560**	**7,323**	**209,178**

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
NORTH REACH RE-VEG. (2000):								
Sow flower/grass seed on terrace/ponds.	5.3 acres			75	3,000	276		3,351
Harrow in seed.	4 hours		180			276		456
Spread straw over seeded area.	250 bales		225	1,563	1,125	276		3,189
Plant poles/wads along new channel.	110 items		1,950	1,350		276		3,576
Plant cuttings along base of terrace.	1,800 lf			900		276		1,176
Plant cuttings/nursery stock at ponds.	800 lf			400		276		676
Subtotal			**2,355**	**4,288**	**4,125**	**1,656**		**12,424**
WESTSIDE REACH EXCAV. (2000):								
Lay out channel re-route in quarry.						276		276
Excavate spawning channel in quarry.	4,333 cy	$2.00/cy	8,666			276		8,942
Line channel with spawning gravel.	1,111 cy	$0.85/cy	944		5,555	276		6,775
Finish grade spawning gravel.	0.7 acre		500			276		776
Open W-side channel at dredge pond.	300 lf		2,500			276		2,776
Mod. water diversions for fish passage.	2 diversions		2,000		3,000	553		5,553
Subtotal			**14,610**		**8,555**	**1,933**		**25,098**
WESTSIDE REACH RE-VEG. (2000):								
Sow wildflower/grass seed along banks.	1.0 acre			25	600	138		763
Rake in seed.	1.0 acre			400		138		538
Spread straw over seeded area.	50 bales		180	300	225	138		843

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Plant cuttings/nursery stock on banks	3,600 lf			1,800		138		1,938
Subtotal			**180**	**2,525**	**825**	**552**		**4,082**
MONITORING (2001-05):								
Perform annual orthophoto survey.	1 survey						5,000	5,000
Perform annual transect re-surveys.	15 transects						4,000	4,000
Perform annual photo monitoring.	32 photopoints					1,380		1,380
Perform annual veg. monitoring.	14 transects			2,500			9,000	11,500
Perform annual redd counts (W-side).	10,600 lf			2,500			9,000	11,500
Prepare annual reports.	5 reports					5,200		5,200
Subtotal				**5,000**		**6,580**	**27,000**	**38,580**
1998-99 ADMIN./EDUCATION:								
Prepare invoices; pay bills; track budget	14 months					6,720		6,720
Prepare quarterly reports.	5 reports					2,600		2,600
Call/meet with landowners/agencies.	12 days					6,240		6,240
Provide training and outreach services.	12 days					6,240		6,240
Subtotal						**21,800**		**21,800**
2000 ADMIN./EDUCATION:								
Prepare invoices; pay bills; track budget.	12 months					5,760		5,760
Prepare quarterly reports.	4 reports					2,080		2,080
Call/meet with landowners/agencies.	12 days					6,240		6,240

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost: ;ees	Co-,certr Cost	Other Consulnts Cost	Total Cost
Provide training and outreach services.	12 days					6,240		6,240
Subtotal						**20,320**		**20,320**
2001-05 ADMIN./EDUCATION:								
Prepare invoices; pay bills; track budget.	10 months					4,800		4,800
Prepare quarterly reports.	1^ .ports					5,200		5,200
Call/meet with landowners/agenci- .	10 days					5,200		5,200
Provide training and -- .reach services.	10 days					5,200		5,200
Prepare fi- . project report (year 2005).	1 report					2,600		2,600
Subtotal						**23,000**		**23,000**
1998-99 TOTALS:								
Design						7,619	7,381	15,000
Funding						15,000		15,000
Surveys, Permits, Approvals					6,516	16,616	18,320	41,452
Contractor Recruitment						3,933	3,120	7,053
Administration/Education						21,800		21,800
Subtotal					**6,516**	**64,968**	**28,821**	**100,305**
Profit and Overhead (15%)					978	9,745	4,323	15,046
Total					**7,494**	**74,713**	**33,144**	**115,351**
1999-2000 TOTALS:								
Concurrent Studies							136,784	136,784

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
Total							**136,784**	**136,784**
2000 TOTALS:								
South Reach Excavation			672,033	2,000	800	19,849	19,168	713,850
South Reach Re-Vegetation			3,050	4,725	4,900	1,104		13,779
North Reach Excavation			191,495	1,000	800	8,560	7,323	209,178
North Reach Re-Vegetation			2,355	4,288	4,125	1,656		12,424
Westside Reach Excavation			14,610		8,555	1,933		25,098
Westside Reach Re-Vegetation			180	2,525	825	552		4,082
Administration/Education						20,320		20,320
Subtotal			**883,723**	**14,538**	**20,005**	**53,974**	**26,491**	**998,731**
Profit and Overhead (15%)			132,558	2,181	3,001	8,096	3,974	149,810
Contingencies (15%)			132,558	2,181	3,001	8,096	3,974	149,810
Total			**1,148,839**	**18,900**	**26,007**	**70,166**	**34,439**	**1,298,351**
2001-05 TOTALS:								
Monitoring				5,000		6,580	27,000	38,580
Administration/Education						23,000		23,000
Subtotal				**5,000**		**29,580**	**27,000**	**61,580**
Profit and Overhead (15%)				750		4,437	4,050	9,237
Total				**5,750**		**34,017**	**31,050**	**70,817**

Task	Quantity	Heavy Equipmt Unit Cost	Heavy Equipmt Total Cost	Manual Labor Cost	Materials Cost; Fees	Coopertr Cost	Other Consulnts Cost	Total Cost
GRAND TOTAL BY YEAR:								
1998-99 Total					7,494	74,713	33,144	115,351
1999-2000 Total (SHN)							136,784	136,784
2000 Total			1,148,839	18,900	26,007	70,166	34,439	1,298,351
2001-05 Total				5,750		34,017	31,050	70,817
Grand Total			**1,148,839**	**24,650**	**33,501**	**178,896**	**235,417**	**1,621,303**
GRAND TOTAL BY COMPONENT:								
Design/Surveys/Permits/Bidding/Admin					7,494	74,713	33,144	115,351
Concurrent Studies (SHN)							136,784	136,784
South Reach Excav/Re-Veg/Admin			877,607	8,743	7,411	44,673	24,919	963,353
North Reach Excav/Re-Veg/Admin			252,005	6,874	6,403	21,469	9,520	296,271
Westside Excav/Re-Veg/Admin			19,227	3,283	12,193	4,024		38,727
Monitoring/Admin				5,750		34,017	31,050	70,817
Grand Total			**1,148,839**	**24,650**	**33,501**	**178,896**	**235,417**	**1,621,303**

Table 2. Scott River Preliminary Floodplain Restoration Project
PILOT REACH FUNDING SOURCES

Source	Agency/ Participant	Appl. Deadline	Dollar Amount	In-Kind Amount	Total Amount
FEDERAL (65%):					
Partners For Wildlife Grant Program	USFWS	10/96	15,000	0	15,000
Partners For Wildlife Grant Program	USFWS	10/97	10,000	0	10,000
Jobs-In-The-Woods Grant Program	USFWS	10/98	200,000	0	200,000
CWA Section 319(h) NPS Grant Program	EPA/SWRCB	4/99	250,000	0	250,000
Saltonstall-Kennedy (S-K) Grant Program	NMFS	5/99	250,000	0	250,000
WRDA Section 206 Grant Program	ACOE	12/98	329,000	0	329,000
Northwest Salmon Initiative/Klamath Restoration Program	USFWS	?	0	0	0
Subtotal			**1,054,000**	**0**	**1,054,000**
NON-FEDERAL (35%):					
Partners For Wildlife	Hesseldenz	N/A	0	15,000	15,000
Partners For Wildlife	Alexander	N/A	0	10,000	10,000
Salmon/Steelhead Restoration Account (SB 271) (SHN)	CDFG	10/98	86,000	51,000	137,000
Salmon/Steelhead Restoration Account (SB 271)	CDFG	10/99	250,000	0	250,000
Sale of dredge tailings	Moore	N/A	135,000	20,000	155,000
Subtotal			**471,000**	**96,000**	**567,000**
TOTALS:					
Federal			1,054,000	0	1,054,000
Non-Federal			471,000	96,000	567,000
Total			**1,525,000**	**96,000**	**1,621,000**

RESTORATION OF REMAINING DREDGE TAILINGS REACH

Once initial restoration of the 1.3-mile pilot reach has been completed, the same approach could then be applied to the remainder of the dredge tailings reach, pending the securing of additional funding and the satisfying of additional permits and approvals requirements (most notably landowner approvals). The juxtaposition of the pilot reach to other sub-reaches along the entire dredge tailings reach is shown in Figure 11 and a cost estimate and potential funding sources for remaining restoration are given in Tables 3 and 4 at the end of this section.

Sub-reaches shown in Figure 11 consist of the 1.3-mile Callahan-to-Wildcat-Creek reach (at the upstream end of the tailings reach), the 1.1-mile Wildcat-Creek-to-Sugar-Creek reach, and a combination of the 0.5-mile reach from Sugar Creek to the pilot reach and the 0.5-mile reach from the pilot reach to the downstream end of the tailings. If restoration were to be initiated at the top of the dredge tailings reach, then the pilot reach could be split in half and combined with adjacent sub-reaches to create a 1.3-mile Sugar-Creek-to-Alexander-Residence reach and a 1.0-mile Alexander-Residence-to-end-of-tailings reach. Each of these reaches has logical end-points, and initial floodplain widening on each reach could be completed during one season. Completion of floodplain widening throughout the entire tailings reach would take 4 years. [Note: with enough funding obtained at one time, it would be possible to complete the entire dredge tailings reach in as little as one year by either hiring a very large excavation company from out of the area or by hiring several local companies to work concurrently on different sub-reaches; for purposes of this report, however, it is assumed that funding would be spread over several years.]

Following completion of initial floodplain widening and interim river bar management, the entire 4.7-mile dredge tailings reach could then be fine-tuned in one season. Fine-tuning would involve re-grading the floodplain where necessary to improve its function, widening and/or repair of floodplain edges where necessary to reduce any active lateral erosion, reconstructing the river channel cross-sectional shape and/or meander where necessary to increase stability, and planting additional riparian vegetation along the river channel and elsewhere in the floodplain where conditions appear suitable enough to warrant the effort.

Following fine-tuning, an additional 5 years of follow-up maintenance could be provided during the 5-year monitoring period. This would include continued river bar management, lateral erosion repair, and riparian planting. During this 5-year time period and the preceding 5 years of initial restoration, the gravel quarry could be gradually removing and processing tailings from the western edge of the floodplain (in addition to river bar management), thereby gradually widening the floodplain further. Also during this time period, fine sediment should be depositing over the widened floodplain during flood events, which will gradually fill interstitial spaces in the substrate and thereby help bring flows back to the surface and provide suitable habitat conditions for riparian vegetation.

The desired ultimate product of these restoration activities would be complete tailings removal, re-establishment of a very stable and densely-vegetated valley-wide floodplain with fine-textured soils, and re-establishment of perennial flows. This ecologically restored landscape could either be left in a totally natural condition or could be carefully managed for grazing and other uses as long as these uses did not destabilize or impair the function of the system. Complete restoration could even include the re-introduction of beaver. It is important to note, however, that re-introduction or natural re-colonization of beaver prior to full re-establishment of riparian vegetation and stable floodplain conditions could jeopardize recovery of the system, particularly if beaver arrive on the scene in the early stages of recovery. Restoration should roughly follow the opposite sequence as the degradation of the river system; beaver were the first to be lost so they should be the last to return.

Deep pool development will probably take the longest time to occur. Bedrock pools were most likely not common along this reach prior to dredging, since very little bedrock is currently exposed and extensive dredging would not have been possible if much bedrock occurred near the surface. The deeper substrate gravels and cobble were apparently cemented together prior to dredging, however, based on anecdotal information regarding dredging operations and on the presence of a substantial amount of broken-up cemented material in the tailings piles (Moore, personal communication). Cemented substrate would have easily enabled the development of bedrock-like pools prior to dredging, but it will be many years before the disturbed substrate becomes re-cemented. Deep pools could also develop after enough large woody debris accumulates in the restored river channel from on-site and off-site sources to create spill-overs and log jams. This process will also take many years, particularly for on-site sources to become established. Beaver dams would be another source of pools, but as above, it will be many years before the system is ready to support beaver. In the short-run, shallower meander pools at bends in the river will need to suffice for this type of habitat.

Figure 11. Breakdown of Entire Dredge Tailings Reach Into Restoration Sub-Reaches

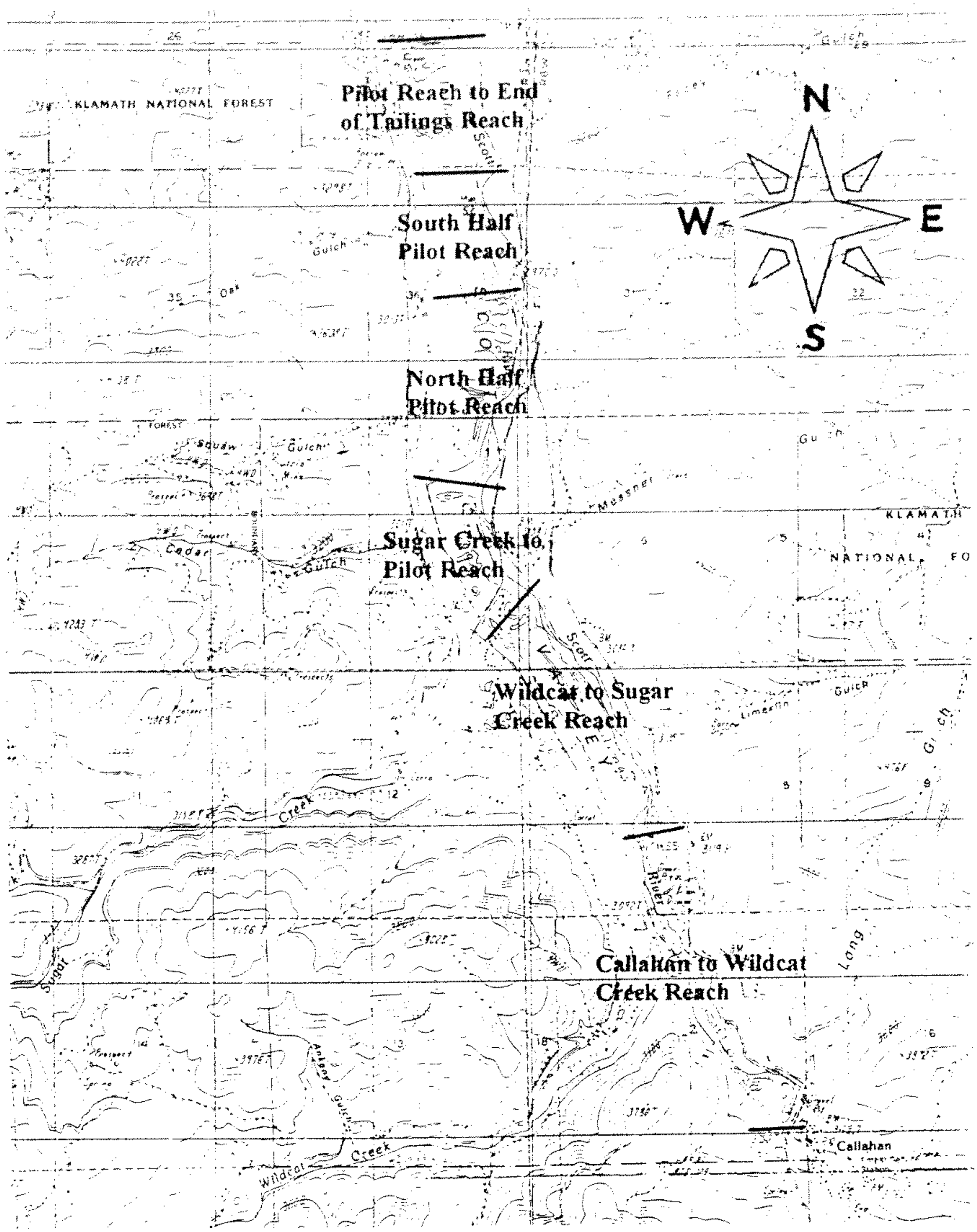


Table 3. Scott River Preliminary Floodplain Restoration Project
FULL DREDGE TAILINGS REACH RESTORATION COST ESTIMATE

River Reach	Length	Year	Estimated Cost
Pilot restoration reach	1.3 mile	2,000	1,600,000
Callahan to Wildcat Creek	1.3 mile	2,001	1,600,000
Wildcat Creek to Sugar Creek	1.1 mile	2,002	1,400,000
Sugar Creek to top of pilot reach	0.5 mile	2,003	600,000
Bottom of pilot reach to end of tailings	0.5 mile	2,003	600,000
Entire tailings reach (fine-tuning of floodplain, channel, re-veg)	4.70 mile	2,004	800,000
5-year follow-up (river bar management, erosion repair, monitoring, etc.)	4.70 mile	2005-2008	1,000,000
Total			**7,600,000**

Table 4. Scott River Preliminary Floodplain Restoration Project
FULL DREDGE TAILINGS REACH RESTORATION FUNDING SOURCES

Source	Agency/ Participant	Dollar Amount	In-Kind Amount	Total Amount
FEDERAL (65%):				
Partners For Wildlife Grant Program	USFWS	25,000		25,000
Jobs-In-The-Woods Grant Program	USFWS	200,000		200,000
CWA Section 319(h) NPS Grant Program	EPA/SWRCB	250,000		250,000
Saltonstall-Kennedy (S-K) Grant Program	NMFS	250,000		250,000
WRDA Section 206 Grant Program	ACOE	4,200,000		4,200,000
Northwest Salmon Initiative or Klamath Restoration Program	USFWS	0		0
Subtotal		**4,925,000**		**4,925,000**
NON-FEDERAL (35%):				
Partners For Wildlife	USFWS		25,000	25,000
Salmon/Steelhead Restoration Account (SB 271)	CDFG	336,000	51,000	387,000
Sale of dredge tailings	?	460,000	80,000	540,000
Undetermined non-federal source(s)	?	1,723,000		1,723,000
Subtotal		**2,519,000**	**156,000**	**2,675,000**
TOTALS:				
Federal		4,925,000		4,925,000
Non-Federal		2,519,000	156,000	2,675,000
Total		**7,444,000**	**156,000**	**7,600,000**

IMPACTS AND MITIGATION

Biological Impacts and Mitigation

There are 45 isolated pockets of riparian vegetation totaling 16.0 acres within the pilot reach, and 8 remnant dredge ponds (freshwater marsh) totaling 1.8 acres within the pilot reach. Most of these riparian pockets and all of the dredge ponds are artifacts of dredging activities. Nonetheless, they do provide important habitat for riparian and wetland-dependent species, primarily birds. There are also about 12.9 acres of riparian vegetation along the westside channel, 2 trout fishing ponds (former quarry ponds) surrounded by grass near the westside channel, and 2 active quarry ponds lacking surrounding vegetation.

The proposed project will require the filling of 11 of the riparian pockets (totaling 3.3 acres) and 1 pond (0.1 acre), in order to create a setback levee to keep the river from shifting to the west side of the valley as well as facilitate the stockpiling of relocated tailings. The 2 active quarry ponds will also need to be filled for the same reasons. Another pond which is long and narrow and will become part of the floodplain will need to be partially filled in order to prevent it from being captured by the river. After being filled, however, it will still be part of the floodplain and available for re-vegetation with riparian species.

This short-term loss of about 3.4 acres of riparian and wetland habitat will be partially mitigated in the short-run, however, by about 2 acres of westside channel and riparian zone creation, 1 acre of eastside pond creation, and about 27 acres of new floodplain creation, and will be more fully mitigated in the long-run by about 70 acres of riparian woodland restoration in the widened floodplain. In addition, quarrying activities have already resulted in the creation of the 2 trout fishing ponds which have been set aside and could be re-vegetated with riparian species, and more ponds will be created as quarrying activities progress.

The remaining 34 pockets of riparian vegetation and 7 ponds (freshwater marsh), totaling about 14.0 acres in size, will be avoided. Of the riparian pockets to be avoided, 6 are within the existing floodplain and will be left in place, 11 will become part of the widened floodplain, and 9 will not only become part of the widened floodplain but will also be strategically located along the new river channel to provide channel armoring and streamside habitat. Of the ponds to be avoided, 5 will become part of the widened floodplain and 2 will be incorporated into the new river channel to provide interim pool habitat.

Regarding the westside channel, salmon and steelhead gaining access to this channel through the fishery enhancement component of the proposed project could be affected by existing water diversions along this channel by either being impeded from upstream migration or being trapped in diversion ditches during downstream migration. These impacts will be mitigated by re-designing the water diversions to avoid creating upstream migration barriers and by installing adequate screening to prevent entrainment of downstream migrants.

Water quality will be protected throughout the project area during restoration activities by limiting earthmoving to the time of year when river flows are either low or dry, installing temporary culverts in situations where flowing surface water needs to be crossed by heavy equipment, and seeding and strawing restored terraces prior to the onset of the wet season. Existing factors which reduce the potential for water quality problems include the river flows going subsurface during most of the dry season and the lack of fines in the dredge tailings.

Landowner Impacts and Mitigation

To the extent that restoration activities on private lands will improve habitat and population numbers of species protected under the Endangered Species Act, private landowners could be subject to increased restrictions on land and water use. This will be mitigated by preparing a Memorandum of Understanding between regulatory agencies and private landowners which will give affected landowners safe haven protection under the Endangered Species Act.

The owners of the gravel quarry could also be affected by financial implications associated with receiving and stockpiling tailings removed from the floodplain during restoration. The quarry owners will be asked to pay for these tailings to help offset restoration costs, and Siskiyou County would normally tax these tailings on an annual basis until they are used. These impacts will be mitigated by seeking an interest-free loan for purchase of the stockpiled tailings through a state program which provides such loans for conservation purposes, and by requesting an interim tax waiver from the County until such time that a particular area of stockpiled tailings will begin to be processed. The latter mitigation is based on the fact that if the tailings were left in place they would not be taxed, and that they are being moved to the quarry site by an entity other than the quarry owners for immediate purposes other than quarrying.

The quarry owners will also need to revise their reclamation plan, use permit, and NPDES permit based on the changes in quarry operations resulting from participation in restoration efforts. To mitigate this impact, the costs of these revisions will be covered by the restoration project.

Landowners whose tailings are removed from their land and transported to the quarry will in effect be giving away quarrying materials worth about 25 cents per cubic yard for gravel and cobble and 75 cents per cubic yard for sand. If these materials are donated to the project, they should qualify for a charitable contribution which could yield income tax benefits. If landowners want compensation for tailings materials, this could be accomplished by granting mineral rights to the quarry owners in exchange for a percentage of the sale of the quarry materials at such time they are processed and sold.

The existing trout ponds within the pilot reach which are rented out on a daily basis for fishing purposes could be impacted if the flows feeding them are reduced or if trout escape into the extended westside channel near these ponds. To mitigate these impacts, an adequate flow will be maintained through the ponds and their inlets and outlets will be screened. Screening will also protect salmon and steelhead from being caught in the ponds by anglers. To the extent that continued quarry operations will create more ponds in the future, opportunities for renting ponds for fishing purposes could increase over time.

Owners of water diversions along the westside channel could be impacted by the cost of reconstructing their diversions to improve fish passage. To mitigate for this, the reconstruction costs will be covered by the project. Over the long-run, these owners could also be impacted by gradual loss of flows in the westside channel as substrate interstitial spaces in the river channel and floodplain become filled and year-round river flows become re-established. This will probably take many years, however, and it is very unlikely that westside channel flows would completely stop. By this time, all of the tailings would probably be removed anyway and the westside channel would be part of the river's floodplain. This would enable seasonal diversions to be made directly from the river, as long as these diversions were done in such a way as to not degrade the restored river system.

All landowners along the westside channel, including the quarry owners, are currently at risk of the river breaking through the tailings during a flood event and shifting to the west side of the valley. This could result in substantial damage to quarry equipment, riparian vegetation, water diversions, and riverside terraces. This is a pre-existing risk, but floodplain widening without mitigation would make this risk much greater. This problem will be mitigated by constructing a substantial setback levee between the widened floodplain, the quarry, and other low areas in the tailings using materials removed during floodplain widening. In addition, floodplain widening will reduce hydraulic forces during floods, and with diligent river bar management, the setback levee should not experience significant lateral erosion. The wider floodplain and larger setback levee working in concert should eliminate the risk of breaching.

Over the longer run, however, it is intended that the floodplain continue to be widened as stockpiled dredge tailings comprising the setback levee are gradually quarried. This could only be done, however, if upstream sediment input is brought under control and the floodplain and river channel within the tailings reach show consistent evolution toward regaining stability. If stability is being regained as the floodplain is further widened and the setback levee is gradually removed, then at such time that the setback levee is gone, there should no longer be any significant risk of major erosion or riparian damage to the west side of the valley. Hydraulic energy associated with flood events should be completely dissipated by a fully recovered and re-vegetated floodplain.

Regarding impacts on land-uses other than quarrying, the dredge tailings area is currently unusable other than for limited grazing adjacent to tailings piles along the westside channel. It is unlikely that residential or commercial development would ever be approved in the tailings area. Conversion of the tailings to active floodplain with riparian vegetation would therefore not reduce land-use options, and if carefully done, could significantly increase grazing opportunities and aesthetics over the current situation. The only potential impacts to land-use outside the tailings area would be river terrace erosion, which could hopefully be prevented through careful restoration, and increased land-use regulation, which could be avoided through the safe haven clause of the M.O.U.

Political/Financial Impacts and Mitigation

Political impacts could be arise from a high cost-to-benefit ratio for the project, or from a perceived or actual project failure. Given the anticipated high cost of the project, it will be very important to demonstrate that the project's benefits will outweigh this cost. This must be done carefully, however, because perceived project failure could occur if people develop unrealistic or inaccurate expectations of what the project will accomplish, particularly in the short-run. To avoid these problems, it will be critically important to clearly and frequently communicate the project's goals, methods, timetable, progress, benefits, and limitations to everyone involved.

Actual project failure could arise if the wider floodplain simply results in increased aggradation beyond the capacity of river bar management to keep it in check, and as a result, there is no demonstrable short-term improvement in floodplain and channel stability or longer-term improvement in flows or riparian vegetation. There is some risk that this could happen, but given what is glaringly wrong with the system, it is unlikely that floodplain widening would not yield observable benefits.

One way to avoid failure is to not get too carried away with river channel construction, terrace restoration, or re-planting too early in the recovery process, since these are the features most vulnerable to failure. Other factors which have a bearing on risk of failure are the likely infeasibility of widening the entire 4.7-mile floodplain in one season, the starting of restoration in the middle of the tailings reach rather than at the top, and the continued input of coarse sediment from the upper watershed. Unless complete project funding is obtained at one time, there is no choice but to take a multi-year approach to floodplain widening. Restoration could start at the upstream end if landowners agree and interim measures can be taken in the pilot reach to delay further lateral erosion and reduce the risk of levee failure. The most significant risk factor, however, is sediment input from the upper watershed, and this can be mitigated by taking actions to reduce upper watershed erosion and sediment transport concurrently with floodplain widening in the dredge tailings reach.

Regarding financial impacts, the $7.6 million estimated cost of restoring the dredge tailings reach is admittedly very high compared with most river restoration projects. Due to the enormous amount of earthwork involved, however, this project is very similar to highway and dam construction. Using local examples of dams that were proposed but not built, the estimated cost of the Callahan Dam and Reservoir was $11 million in 1956 dollars, the estimated cost of the Grouse Creek (East Fork) Dam and Reservoir was $4 million in 1957 dollars and $5.4 million in 1971 dollars, and the estimated cost of the Noyes Valley Dam and Reservoir was $23 million in 1991 dollars (DWR 1960, USDA 1971, DWR 1991). Given that these projects were proposed by government agencies to address some of the resource needs of the Scott River watershed, they provide some perspective on levels of funding seriously contemplated by these agencies. Since most funding for dredge tailings restoration will be federal and most of the rest will come from the state, the local cost should be negligible. Conversely, the local economic benefit of over $7 million in outside money coming into the local area will be very substantial.

Given the nature of the proposed restoration project, there is no way to mitigate financial impacts to federal and state sources by reducing overall project scope, only by spreading the project out over time. On the other hand, the tailings will eventually be moved, whether it is done by the restoration project, quarrying, or natural flood events, and the longer it takes, the more damage that will occur from lateral erosion and aggradation, and the longer it will take for fishery and riparian recovery to occur. Given this, it would behoove funding sources to not spread the project over too long a timeframe; otherwise, resulting property and resource damages will most certainly exceed restoration costs

CONCLUSION

The proposed project design should achieve the goals of the preliminary restoration plan by establishing a more functional floodplain, reducing lateral erosion, restoring eastside river terraces, reducing the likelihood of the river breaking through to the west side of the valley, providing interim salmon and steelhead spawning and rearing habitat, and providing a successful example of a major cooperative restoration project between private landowners and government agencies. The proposed project is also consistent with the goals of the Klamath Act Program, including restoration of salmon and steelhead habitat (Goal I), promoting public education (Goal IV), and taking a cooperative approach (Goal V).

By achieving these goals, the project will take an essential first step toward long-term fishery and riparian habitat restoration and will provide interim fishery enhancement. The project will also help protect adjacent and downstream land and improvements, re-create usable land lost to erosion, and catalyze future restoration projects along the Scott River. Additional project benefits will include improved visual quality and increased land value. Biological, landowner, and political/financial impacts associated with the proposed project can be fully mitigated, thereby enabling the project to be mutually beneficial to all parties involved.

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