2003) have observed harvesting of firewood, redwood, and other commercially or aesthetically (*i.e.*, stump burls) valuable wood products from mining sites accessed through unlocked gates.

To address this, LOP 2004-1 requires that educational signing regarding the importance of LWD for salmonids will be placed at access roads owned, controlled, or utilized by the gravel operators. In addition, in order to protect LWD deposited on mined gravel bars, all access roads owned or controlled by gravel operators will be gated and locked to reduce access.

An additional project design feature taken to minimize the loss of LWD is stockpiling of LWD material on the edges or upstream of extraction bars prior to bar skimming, which may allow for the natural redistribution of LWD during winter storms. This may be of limited benefit because vehicular access and firewood cutting is not restricted. Therefore NOAA Fisheries anticipates that the loss of LWD will still occur as a result of the proposed action, possibly resulting in continued declines in habitat quality in the action area and downstream reaches, and reducing the survival of adult or juvenile salmonidsof all three listed species.

2. <u>Increased Angling Pressure</u>

Where access is not restricted at extraction sites, increased angling pressure will result. In the past, extraction sites along the Mad River and lower Eel River have provided access to anglers. In fact, the Eel River PEIR (Humboldt County 1992) suggested that gates on the lower Eel River would be kept unlocked specifically to allow angler access. Although current angling regulations require the release of all non-hatchery fish, take may occur in form of harassment and hooking mortality. The effects of this on the overall salmonid populations is unknown as we assume that much, if not all, of the angling pressure would occur at other sites where access is not associated with the proposed action. However, during low-water periods, when adults are confined to specific pools in the lower river reaches such as the lower Eel River, access at the extraction sites could result in the take of several Chinook salmon adults prior to upstream migration and prior to annual low-flow angling closures. Although it is difficult to estimate the extent of take that could occur as a result of hooking mortality, NOAA Fisheries expects that on the order of 10-100 Chinook salmon adults and a lesser number of coho salmon and steelhead could be captured annually as a result of low-water angling and an unknown portion of these individuals will die due to hooking mortality facilitated by access at the extraction sites (pers. observation by S. Flanagan, fisheries biologist, NOAA Fisheries, 2003).

3. <u>Increased Vehicle Access</u>

Where extraction sites afford access to the active channel, the increased use by vehicles may adversely affect salmonids and redds by directly crushing them when vehicles cross the wetted channel, presumably for wood cutting, angling, or simply, "four-wheeling." Since these crossings are not subject to any of the provisions provided for in the proposed action, we anticipate that a much greater amount of take will occur due to increased vehicle traffic. The point where vehicles cross is often at the riffle crest, where spawning most often occurs and rearing juveniles may be present. Therefore, destruction of redds or crushing of juveniles of all three listed species may occur as a result of vehicle use in the wetted channel.

In the past, access roads to and from the extraction areas may have increased vehicle use throughout the year. This increased use may lead to rutting of the road surface, generation of fine sediment and subsequent delivery to the adjacent river channel. The proposed action requires that all access roads be gated and locked. NOAA Fisheries expects this provision will limit sediment delivery during the winter period. Consequently, we expect that the effects across the action area will be on the order of that seen from bridge construction with increases in turibidity causing displacements of salmonids in areas where road sediment enters the river.

4. Increased Need for Rock Slope Protection

The lateral instability (*i.e.*, increased bank erosion) evident in many of the action area reaches has resulted in the use of various bank stabilization techniques. The Mad River, in particular, has several extensive bank stabilization projects to protect roads, water withdrawal facilities and farmland from additional channel migration. Channel bed degradation has also raised concerns over the stability of area bridges. Numerous effects on salmonids are associated with these types of projects. Short-term effects associated with these projects include increased turbidity, equipment access in the low-flow channel, and dewatering of the channel during construction. Longer term effects include reduced interactions of streamside vegetation with the active channel. This results in less overhanging vegetation and decreased recruitment potential of woody debris.

G. Inter-Related and Inter-Dependent Effects of the Proposed Action

In considering the effects of the proposed action, NOAA Fisheries also assesses the effects of interrelated and interdependent actions that are likely to occur. For the proposed action, these involve effects to salmonids resulting from the development of the railroad and/or the Humboldt Bay shipping capacity for sediment hauling to areas where demand is high and prices are at a premium. Each of these is discussed below.

1. Increased Construction and Development

The use of in-stream gravel is widely used for construction and maintenance of roads and other infrastructure. Presumably, this facilitates increased development in the form of greater urbanization and rural development. Consequently, these inter-related activities have effects on salmonids, as was discussed in the *Status of the Species* and *Environmental Baseline* sections. However, in the absence of the proposed action, rock sources would likely be obtained from other sources, such as upland quarries.

2. Adverse Effects to Habitat from Railroad or Humboldt Bay Port Development

Recent economic analyses of re-establishing a rail link to California counties south of Humboldt County as well as development of a deep-water port in Humboldt Bay have identified gravel as one of the more important products that could be exported out of Humboldt County via one or both of these pathways (*i.e.*, by rail or ship). Development of rail service to Humboldt County would require extensive construction in the Eel River corridor where the railroad once ran. Port development would require increased dredging and construction of dock facilities, which would likely impact important salmonid rearing habitat such as eel grass beds. Additionally, increased ship traffic from larger vessels could result in increased shoreline erosion and sedimentation of existing eel grass beds.

3. Offsite processing areas

Once gravel is excavated from the river, it is taken to a processing area, typically near the site, to be washed, crushed and sorted. These processing sites may be areas of fine sediment generation if measures are not employed to contain the runoff. Similarly, if water used to wash gravel is not properly controlled, the effluent may enter the stream, causing increases in turbidity and effects on salmonids in the vicinity. Since the proposed action or the biological assessment does not describe the extent of these activities and their potential effects, we cannot accurately determine the extent of the effects. In the absence of this information, we assume that the post-extraction site reviews will be able to identify areas near the extracted bars that are potential sediment sources and provide mitigation measures. However, we still expect these areas and other areas not identified in the review process to deliver fine sediment to water courses. We expect the effects will be input of turbid water with consequent displacement of salmonids in the vicinity and short-term reductions in macro-invertebrate production.

VI. CUMULATIVE EFFECTS

NOAA Fisheries must consider both the "effects of the action" and the cumulative effects of other activities in determining whether the action is likely to jeopardize the continued existence of the three salmonid species considered in this Opinion or result in the destruction or adverse modification of SONCC coho salmon designated critical habitat. Under the ESA, cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NOAA Fisheries thinks that listed species may be affected by numerous State, tribal, local, or private actions that are reasonably certain to occur in the action area. These actions include those discussed below. Although each of the following actions may reasonably be expected to occur based on their past occurrence, we lack definitive information on the extent or location of many of these categories of actions. The following discussion provides available information on the expected effects of these activities on the salmonid species analyzed in this Opinion. Section 9 of the ESA prohibits take of fish and wildlife species listed under the ESA, unless exempted by Incidental Take Permits. However, this discussion is limitied to activities that are not currently covered under section 7 of the ESA. Take of State listed species is also prohibited under the California Endangered Species Act (CESA). In addition to the ESA and CESA, other laws regulating certain of these activities provide protections for listed species, especially the CWA, the California Environmental Quality Act (CEQA), the California Fish and Game Code, and the California Forest Practice Rules (FPRs). Enforcement of existing law is expected to reduce the impacts of these activities on listed species.

A. Timber Management

Timber management, with associated activities such as harvest, yarding, loading, hauling, site preparation, planting, vegetation management, and thinning, is the dominant human activity in the action area. Future timber harvest levels in the action area cannot be precisely predicted, however, we assume that harvest levels on private lands in Humboldt County in the foreseeable future will be within the approximate range of harvest levels that have occurred since the listing of the northern spotted owl in 1992. Based on data for recent years, the annual harvest level in Humboldt County is expected to be about 500 million board feet (California Board of Equalization 1998).

Implementation of Timber Harvest Plans under the FPRs has not consistently provided protection against unauthorized take in relation to Pacific salmonids listed under the ESA by NOAA Fisheries. NOAA Fisheries has informed the California Department of Forestry (CDF) of its ongoing concern over the lack of specific provisions for salmonids in the FPRs. Discussions continue on this issue between NOAA Fisheries, CDF, and California Resources Agency. Recent revisions to the FPRs address many concerns related to salmonids. However, until these issues are resolved, unauthorized take from direct, indirect, and cumulative effects to salmonids from timber harvest and its associated activities may be occurring and likely will continue to occur. The extent and amount of any unauthorized take of salmonids is unknown.

Reasonably foreseeable effects of timber management activities may also impact designated critical habitat for SONCC coho salmon. Within the action area, direct, indirect, and cumulative effects of timber harvesting may degrade the habitat features identified as essential for coho salmon critical habitat. The extent of the effect to critical habitat is unknown given the uncertainty of protective measures in THPs.

B. Control of Wildland Fires

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. An undetermined amount of suitable habitat for salmonids may be removed or modified by this activity. The forested setting that occurs upstream of much of the action area predisposes the watersheds to frequent wildland fires. The effects of wildland fire suppression range from increased sediment inputs to streams that further degrade habitat, to the effects of fire retardants and other chemicals, which may introduce toxic substances into watercourses. These could all lead to decreased spawner success, reduced juvenile rearing habitat and possibly toxic-induced mortaility in the case of fire suppressants.

C. Industrial Activities, Sawmills, and Associated Activities

Most sawmills located in the action area are expected to remain in operation for the foreseeable future, based on a relatively steady supply of timber, as discussed above. Facilities are expected to operate within applicable laws. Where waste water discharge may affect habitat for listed species, we expect that the ESA and the CESA will be enforced. Further large-scale industrial development is not anticipated, but if such development should occur, we expect that all applicable laws will be applied. Effects on listed species include increased sediment delivery, similar to that described for roads below, and possibly delivery of toxic materials that could result in mortaility of affected individuals.

D. Construction, Reconstruction, Maintenance, and Use of Roads

While the level of construction of new roads and reconstruction of old roads on private and state lands cannot be anticipated, we expect it to continue at a similar rate. Under current rates of road construction and maintenance, we expect road mileage to increase, principally on commercial forest lands where the roads are needed to access timber harvest areas. The increased emphasis on protection of aquatic resources is expected to result in higher standards for road construction, reconstruction, maintenance, and use as compared to historical standards. Improvement of environmental conditions related to roads throughout the action area is expected over the long term. Noticeable improvements in the short term are unlikely due to an expected increase in the number of road miles per square mile of land, the lack of comprehensive road standards, existence of numerous older, legacy roads within the action area, and lack of routine inspections and maintenance of existing roads. These trends will be especially noticeable on industrial timberlands. Roads will continue to adversely affect salmonids primarily through sediment delivery with consequent effects on spawner success and reductions in juvenile habitat.

E. Gravel Mining, Quarrying, and Processing

In addition to the gravel extraction activities covered in this Opinion, other sediment extraction activities occur in more upland settings that ultimately have the potential for affecting the action area. The effects of quarries and rock mines on aquatic resources in the action area depend on the type of mining, the size of the quarry or mine, and distance from waters. Rock mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate. Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, increasing surface runoff. Mining may also cause the loss of riparian vegetation. Because the effects of quarries and rock mines depend on several variables, the effects of quarries and other commercial rock operations within the action area on listed species are unknown. Commercial rock quarrying will continue to be under the regulation of Humboldt County and the California Coastal Commission (for those activities conducted within the Coastal Zone). NOAA Fisheries expects the effects of these upland mining operations will be similar to those for roads, described above.

F. Habitat Restoration Projects

Because stream restoration projects are usually coordinated with one or more of the resource agencies, we expect that all applicable laws will be followed. Restoration activities that are not conducted pursuant to CDFG's Fisheries Habitat Restoration Program, which has a section 7 consultation and take exemption through the Corps, may cause temporary increases in turbidity, alter channel dynamics and stability, and injure or harass salmonids if equipment is used in the stream during restoration projects. Properly constructed stream restoration projects may increase habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. NOAA Fisheries does not know how many restoration projects are completed outside of CDFG's program, therefore the effects of these projects cannot be predicted. We anticipate the amount of upslope restoration projects to increase. These projects often focus on identifying source problems in an area (*i.e.*, roads) and applying corrective measures to eliminate or minimize the adverse effects to aquatic resources.

G. Agricultural Activities

Agricultural activities including grazing, dairy farming, and the cultivation of crops. The recent upward trend in value of dairy-related agricultural products (*e.g.*, milk, cows and calves, pasture, hay, and silage) in Humboldt County, for example, is expected to continue as human populations continue to increase (USDA 1998). As a result, the dairy industry near the action area, primarily in the lowlands of the Eel, Van Duzen and Mad River watersheds, is expected to persist. Impacts on water quality would be expected to be regulated under applicable laws.

The impacts of this use on aquatic species is anticipated to be locally intense, but the longevity of the impact depends on the degree of grazing pressure on riparian vegetation, both from dairy and beef cattle. Grasses, willows, and other woody species can recover quickly once grazing pressure is reduced or eliminated (Platts 1991) through fencing, seasonal rotations, and other measures. Assuming that appropriate measures are not taken to reduce grazing pressure, impacts to aquatic species are expected to increase with the predicted continuation or increase in grazing. Anticipated impacts include decreased bank stability, loss of shade- and cover-providing riparian vegetation, increased sediment inputs, and elevated coliform levels.

H. Residential Development

The moderate rate of human population growth in Humboldt County (about 2.8% increase from 1995 through 1998, California Department of Finance 1998) is expected to continue. In Humboldt County, most of this growth is expected to occur near the cities of Eureka, Arcata, and McKinleyville. Impacts on water quality related to residential infrastructure would be expected to be regulated under applicable laws.

Once development and associated infrastructure (roads, drainage, *etc.*) are established, the impacts to aquatic species are expected to be permanent. Anticipated impacts to aquatic resources include loss of riparian vegetation, changes to channel morphology and dynamics, altered watershed hydrology (increased storm runoff), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed. The presence of structures and/or roads near waters may lead to the removal of LWD in order to protect those structures from flood impacts. The anticipated impacts to listed salmonids from continued residential development are expected to be sustained and locally intense. However, given the predicted slow growth rate development within the action area, impacts are not expected to increase substantially over current levels, but rather, continue similar to past rates of degradation.

I. Recreation, Including Hiking, Camping, Fishing, and Hunting

Expected recreation impacts to salmonids include increased turbidity, barriers to movement, and changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating coliform bacteria and nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Impacts to salmonid habitat are expected to be localized, mild to moderate, and temporary. Fishing within the action area is expected to continue subject to the California Fish and Game Code. The level of take of salmonids within the action area from angling is unknown, but is expected to remain at current levels. Under current levels, listed salmonids are subject to considerable catch-and-release angling pressure. This is particularly prevalent in the fall when salmonids are holding in the lower rivers of the action area, awaiting rainfall and rising rivers. The numbers of fish hooked in any given year likely range into the thousands, with a portion of these subsequently dying due to hooking stress. Death of these adults likely continues to limit the abundance of the population as fewer adults are able to successfully spawn.

J. Water Withdrawals

An unknown number of permanent and temporary water withdrawal facilities exist within the action area. These include diversions for urban, agricultural, commercial, and residential use, along with temporary diversions, such as drafting for dust abatement. Due to the anticipated slow urban/residential growth within the action area and the expected increase in agriculture (dairy farming), the number of diversions and amount of water diverted is expected to increase gradually within the action area. Impacts to salmonids are expected to include entrapment and impingement of younger salmonid life stages, localized dewatering of reaches, and depleted flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment, and transport of LWD. Water diversions are expected to comply with applicable laws, including the ESA, California Fish and Game Code, and CWA.

K. Chemical Use

NOAA Fisheries anticipates that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used within the action area. Chemical application is under the jurisdiction of several Federal, State, and local agencies, and their use is expected to be conducted under applicable laws. Effects range from sub-lethal effects such as reduced reproductive success and to mortaility when chemicals occur in sufficient concentration. Most chemicals occurring in the action area likely derive from forestry operations in the upper portions of the watershed. Therefore, the risk of lethal concentrations occurring in the action area is extremely low. We also expect that sublethal effects of chemicals will be similarly low, given that the action area occurs along the lower rivers of Humboldt County where dilution of chemical inputs is likely to have occurred.

L. Global Warming

The Earth's climate has entered a period of more rapid warming than experienced over the past 1,000 years, and probably over an even longer period of time (IPCC 2001). The 1990s were the warmest decade in the instrumental record, both in terms of surface air and ocean temperatures, and the warmest in the past 1,000 years based on comparisons with northern hemisphere paleo-temperature proxies from ice cores, tree rings, and corals (Boesch 2002). Global climate models predict an average global temperature increase of 1.4-5.8°C by the end of the 21st century

(Boesch 2002). General circulation models suggest this recent warming is partially caused by anthropogenic increases in greenhouse gases (Boesch 2002).

The consequences of increased global temperatures are particularly important with respect to the ecological implications that will directly influence salmonid populations. Increased global temperatures can be expected to change precipitation and runoff patterns, ocean currents, storms, accelerate sea rise, and increase ambient temperatures. Some implications these changes have for salmon and steelhead include increased stream temperatures, seasonal changes in precipitation and runoff timing, increased opportunities for invasive species, biogeographic shifts in salmonid predators (e.g., increased mackerel abundance), and decreased upwelling (Boesch 2002). The predicted speed of these changes over the next century compared with expected species adaptation times and ability, given the depressed populations and reduced diversity of extant salmon and steelhead populations, is likely to severely limit the survival of a number of salmon and steelhead ESUs, especially those at the southern end of their range.

VII. INTEGRATION AND SYNTHESIS OF THE EFFECTS ON SALMONIDS AND CRITICAL HABITAT

The preceding analyses focused on both the likely direct effects and indirect effects from LOP 2004-1 on salmonids and their habitat in the action area for each river reach. This portion of the effects analysis summarizes this information for each species and considers the overall effects on the populations in the context of other activities occurring within the action area or influencing conditions within the action area (*Environmental Baseline* and *Cumulative Effects* sections). This analysis considers population-level effects from the five years of mining under the proposed action.

A. Effects on NC Steelhead

The proposed action will result in a number of direct effects to NC steelhead. Juvenile steelhead are present year-round in the action area. Therefore, our analysis indicates that juvenile steelhead are most vulnerable to the direct effects of mining given their presence in all of the reaches at the time of the proposed activities. We anticipate the number of steelhead juveniles injured or killed from the direct effects of mining will be relatively small. A small number of juvenile steelhead will be injured or killed from turbidity and fine sediment originating from trenches, and contact with equipment during trenching and stream crossing construction. We expect individual juvenile steelhead would be injured or killed, relative to the footprint of the activity, as a result of stream diversion for trenching operations. However, we expect stream diversions to be used infrequently because wet trenching will be limited. Under the proposed action, we expect wet-trenching to occur in the South Fork Eel River and the lower Van Duzen River. Although we expect some dry trenching may occur, particularly in the reaches where alternative extraction techniques are preferred over skimming, we do not expect wet-trenching to occur elsewhere in the action area. Adult steelhead stranding in trenches is a possibility under LOP 2004-1. While we expect trenches will be designed to avoid stranding, we cannot rule out the possibility that unpredicted shifts in channel location will occur and strand adults, which occurred on the Mad River in 2003. Based on our analysis of effects, we expect that up to five adult salmonids (a combination of any of the three species) may become stranded in any given year of LOP 2004-1 implementation.

Our analysis of indirect effects, related primarily to changes in habitat, suggests that steelhead juveniles are the species and life history stage most vulnerable to the effects of the proposed action. However, we cannot discount the potential indirect effects of mining on steelhead redds from increased scour. Our analysis indicates that the proposed action will inhibit natural habitat recovery processes. We also anticipate minor, more localized reductions in the quality and quantity of habitat. We note that extraction will occur during this same period at several nearby sites not included in this Biological Opinion (these sites have been the subject of previous opinions). We expect that harm to individual juvenile steelhead may occur in the various river reaches, primarily due to localized reductions in habitat quality.

Summer steelhead use a number of the mining reaches in the action area for holding through the summer prior to their upstream migration and spawning. Summer steelhead represent an important life history type of the NC steelhead ESU. In fact, summer steelhead in the Middle Fork Eel River seem to represent the southern extent of this life history type for any steelhead population (Busby *et al.* 1996). Although Busby *et al.* (1996) determined that summer steelhead did not represent a distinct monophyletic unit, they did not discount the potential for genetic differences between summer- and winter-runs of steelhead in the NC ESU. Thus, although there is currently no identified relationship between genetics and steelhead run timing, life history diversity still exists within the NC steelhead ESU. This diversity is important for buffering against both short-term and long-term (*e.g.*, climate change) environmental stochasticity and allows the population to use a wider array of environments. This may be especially important for steelhead near the peripheries of their range where conditions for salmonid survival are marginal and subject to greater variation. In essence, diversity increases the likelihood of species survival in a spatially and temporally varying environment.

Summer steelhead observations in the action area are consistently coincident with higher quality pools. We do not expect a decline in number or quality of these pools as a result of the proposed action. Therefore, we expect the current summer steelhead population will persist under the proposed action. We expect that the proposed action will continue to limit the holding habitat available for summer steelhead in the action area, but not appreciably diminish the ability of the individuals of the population to survive and reproduce since the principal spawning and holding areas are well upstream of the action area. In the absence of the proposed action, NOAA Fisheries expects that pool quality may increase at a greater rate than with the proposed action. However, these changes in pool quality will be principally dictated by changes in upstream delivery of sediment and woody debris.

Taken together, we do not expect the proposed action will appreciably alter the distribution of NC steelhead in the action area. Furthermore, we expect the reductions in juvenile abundance expected in the action area as a result of the proposed action will not be detectable in returning adult abundance. Adults may be killed if stranded in trenches, although this loss may not occur every year if it occurs at all. We expect the trenches will increase the reproductive success of steelhead by providing increased access to spawning habitat. On balance, we expect trenches constructed under LOP 2004-1 will provide a benefit to the species. Therefore, we do not expect the proposed action will reduce the distribution and abundance of steelhead in the action area.

Therefore, we do not expect the proposed action will appreciably reduce the likelihood of survival and recovery of the NC steelhead ESU.

B. Effects on CC Chinook Salmon

The action area encompasses a significant portion of the habitat for CC Chinook salmon, including some of the largest river systems that currently support CC Chinook salmon; a considerable portion of which is spawning habitat. Populations in these rivers comprise a significant portion of the CC Chinook salmon ESU, and its diversity and these populations are essential for the survival and recovery of the ESU as a whole. The Van Duzen River, and South Fork Eel River portions of the action area are especially important for CC Chinook salmon spawning. Therefore, the action area is critical to the survival and recovery of the CC Chinook salmon ESU. Incidental capture of adults in ocean and freshwater fisheries, coupled with the poor habitat conditions of the action area and current small population sizes, reduces the resilience of the population to losses of adult salmon and their redds and decreased smolt-to-adult survival.

The proposed action will affect multiple life stages of Chinook salmon in the action area. A very small number of juvenile Chinook salmon will be injured or killed during stream crossing construction or trenching operations. The proposed action will slightly reduce egg-to-fry success for CC Chinook salmon primarily because redd scour and sedimentation is expected to increase in some areas. However, many of these impacts are expected to occur in more localized settings adjacent to specific extraction areas and reductions in emergence rates will be limited to a few individual redds. We anticipate stranding of adult Chinook salmon may occur in trenches due to unforeseen changes in river configuration, although this loss may not occur every year if it occurs at all. We do not expect more than five adults will become stranded in any given year as a result of implementation of LOP 2004-1. We expect the trenches will increase the reproductive success of Chinook salmon by providing increased access to spawning habitat. On balance, we expect trenches constructed under LOP 2004-1 will provide a benefit to the species. Beyond this benefit, the affected Chinook salmon populations are unlikely to experience either positive or negative growth as a result of the proposed action since habitat will remain in a relatively similar state and the losses of juveniles due to the proposed action will be a very minor when compared to the high mortality rates these early life history phases typically experience (Groot and Margolis 1991). Therefore, we do not expect the proposed action to appreciably reduce the distribution and abundance of returning adults in the action area. Consequently, we do not expect the proposed action will appreciably reduce the survival and recovery of the CC Chinook salmon ESU.

C. Effects on SONCC Coho Salmon

The proposed action will primarily influence adult coho salmon in the action area. Coho salmon juveniles that emigrate from tributaries into the mainstem Mad River due to poor conditions and/or density dependency will be forced into simplified habitat where competition will occur. However, our analysis indicates that the proposed action will not further simplify this habitat, as evidenced by the aggradation of the lowermost Mad River. Elsewhere in the action area, juvenile coho salmon infrequently use the lower river reaches for rearing, particularly during the time of the proposed activities when direct effects are expected. However, we expect that adult coho may become stranded in trenches constructed under LOP 2004-1. We do not expect stranding to occur every year, if at all. In any given year, we expect no more than five adult coho would be stranded due to unforeseen changes in river configuration near the trench. However, we expect the trenches will increase the reproductive success of coho salmon by providing increased access to spawning habitat. On balance, we expect trenches constructed under LOP 2004-1 will provide a benefit to the species. Therefore, we do not expect the proposed action will reduce the distribution and abundance of coho salmon in the action area. Therefore, we do not expect the proposed action to appreciably reduce the likelihood of survival and recovery of the SONCC coho salmon ESU.

D. Effects on SONCC Coho Salmon Critical Habitat

Implementation of the proposed action will maintain habitat in a simplified state. Although we expect habitat recovery could occur in the action area if other habitat influencing processes improved, the recovery would be inhibited by the proposed action. The specific river reaches in the action areas that support coho salmon are especially important because much of the habitat outside these areas is similarly degraded and less ecologically functional. For example, the mainstem Mad River upstream of the action area is currently less viable for coho salmon, mainly because of high temperatures and a higher stream gradient than the lower Mad River in the action areas. Therefore, the Mad River action area, with moderated temperatures because of the coastal climate and lower gradient slope, is essential for the conservation of the Mad River population of SONCC coho salmon. Since we do not expect further decline in habitat quantity or quality, the conservation value of that habitat will not be appreciably diminished. However, any further decline in ecological function of coho salmon habitat in these rivers will substantially reduce its conservation value. Therefore, NOAA Fisheries has determined that SONCC coho salmon critical habitat is not likely to be destroyed or adversely modified so as to appreciably diminish the value of the critical habitat for the conservation of SONCC coho salmon.

VIII. CONCLUSIONS

After reviewing the best available scientific and commercial information, the current status of SONCC coho salmon and its designated critical habitat, CC Chinook salmon, and NC steelhead, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NOAA Fisheries biological opinion that gravel mining under LOP 2004-1 for the five-year permit period, ending December 31, 2008, is not likely to jeopardize the continued existence of threatened SONCC coho salmon, NC steelhead, and threatened CC Chinook salmon, and is not likely to adversely modify or destroy SONCC coho salmon critical habitat.

IX. INCIDENTAL TAKE STATEMENT

Take is defined as to harass, harm, pursue, hunt, shoot, kill, trap, capture or collect, or attempt to engage in any such conduct [ESA section 3(18)]. NOAA Fisheries further defines "harm" as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering" (November 8, 1999, 64 FR 60727). Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity. Under the terms of sections 7(b)(4) and 7(o)(2)of the ESA, taking that is incidental to and not the purpose of the agency action is not considered a prohibited taking, provided that such taking is in compliance with the terms and conditions of this ITS.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this ITS. If the Corps: (1) fails to assume and implement the terms and conditions or fails to require the applicant to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NOAA Fisheries as specified in the ITS [50 CFR § 402.14(i)(3)].

A. Amount or Extent of the Take

NOAA Fisheries anticipates that annual gravel mining operations under LOP 2004-1 over the five-year permit term will result in take of SONCC coho salmon, CC Chinook salmon and NC steelhead. This will primarily be in the form of harm to salmonids by impairing essential behavior patterns as a result of reductions in the quality or quantity of their habitat. NOAA Fisheries anticipates that the number of individuals harmed will be low. NOAA Fisheries anticipates that a small number of juveniles may be killed, injured, or harassed during heavy equipment use while constructing and removing temporary stream channel crossings or during instream trenching. In addition, NOAA Fisheries expects that adults and juveniles may become stranded in trenches and wetland pits. Although, the trenches will be designed to avoid stranding, unexpected river changes may cause stranding of fish with mortality before fish rescue operations commence. While we cannot reliably estimate the number of individuals that may become stranded in a given year, NOAA Fisheries expects that on the order of five adult and 10 juvenile salmonids (in any combination of the three species) may become stranded in trenches.

The take of the listed salmonids above will be difficult to detect because finding a dead or injured salmonid is unlikely as the species occurs in habitat that makes such detection difficult. The impacts of gravel mining under LOP 2004-1 will result in changes to the quality and quantity of salmonid habitat. These changes in the quantity and quality of salmonid habitat are expected to correspond to injury to, or reductions in, survival of salmonids by interfering with essential behaviors such as spawning, rearing, feeding, migrating, and sheltering. Because the expected impacts to salmonid habitat correspond with these impaired behavior patterns, NOAA Fisheries is describing the amount or extent of take anticipated from the proposed action in terms of limitations on habitat impacts. NOAA Fisheries expects that physical habitat impacts will be: (1) limited to the areas described in Table 13 below, (2) compliant with the project design features of LOP 2004-1 and this ITS, and (3) within the expected effects of the proposed action as described in this Opinion. Critical project design features in LOP 2004-1 include limiting extraction to no more than 175,000 cy/yr on the Mad River, implementing a head-of-bar buffer, giving preference to alternative extraction techniques on the South Fork Eel River, Lower Eel

River and Mad River, and limiting skim widths to no more than 90 feet as measured across the top of the extraction. We expect more frequent use of alcoves, trenches and narrow skims in these reaches in lieu of traditional skimming. Where skimming does occur in these reaches, it will occur in more confined settings (*e.g.*, the lowermost Mad River as described in this Opinion) or be smaller in extent and be located away from the low-flow channel and not adjacent to spawning habitat.

Table 13. For each river, gravel bar sites are listed from the most upstream site to the most downstream site, and are not necessarily contiguous. The approximate length of each site is measured along the center-line of the stream, adjacent to each bar. Data was provided by Humboldt County Planning Division (April 26, 2000), except for the Cook's Valley site and the Fort Seward site where data was provided by the Corps (June 27, 2000), and the McKnight site, where data was provided by the Corps (June 25, 2001).

Stream	Length (ft)	Gravel Bar Site Name
Middle Eel River	3646	Vroman and Maynard Bars
	4160	Truck Shop and Scotia Bars
	8340	Dinner Creek and Three Mile Bars
	8398	Elinor Bar
	4844	Holmes Bar
	7900	Dyerville, South Fork and Bowlby Bars
Lower Eel River	1117	Hansen Bar
	1754	Upper Sandy Prairie Bar
	3507	Canevari - Sandy Prairie Bar
	2160	Lower Sandy Prairie Bar
	3413	Warswick Bar
	2807	Singley Bar (downstream of Fernbridge)
Lower Mad River	2219	Essex Bar
	1000	Miller Almquist Bar (near Hwy 299 bridge)
South Fork Eel River	809	Cook's Valley (at the Humboldt/Mendocino County line)
	1218	Tooby Park/Garberville
	2097	Randall Sand and Gravel/Tooby Park/Garberville
South Fork Eel (cont'd)	1854	Wallen/Johnson Redway Bar (near the town of Redway)
Lower Van Duzen River	2304	Pacific Lumber Bar (near the town of Carlotta)
	661	Thomas Bess Ranch
	15506	Van Duzen Ranch
	1890	Leland Rock Gravel Bars

Stream	Length (ft)	Gravel Bar Site Name
Lower Trinity River	2000	McKnight Bar (near the town of Salyer)
	4497	Big Rock (near the town of Willow Creek)
	834	Klamath River Aggregate (near the town of Hoopa)
North Fork Mattole	4909	Cook Bar (at confluence with mainstem Mattole River)
Upper-Mid Eel	2000	Satterlee Bar near Fort Seward, at approximate river mile 68
Bear River	975	Branstetter Bar

B. Effect of the Take

NOAA Fisheries determined that the proposed action, as described, is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon or NC steelhead.

C. Reasonable and Prudent Measure

NOAA Fisheries considers that the following reasonable and prudent measure is necessary and appropriate to minimize take of SONCC coho salmon, CC Chinook salmon and NC steelhead.

The Corps shall:

1. Ensure that the monitoring necessary to track changes to salmonid habitat quality and quantity in the vicinity of gravel extraction sites is implemented.

D. Terms and Conditions

The Corps, and its permittees, must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are non-discretionary.

RPM 1. Ensure that the monitoring necessary to track changes to salmonid habitat quality and quantity in the vicinity of gravel extraction sites is implemented.

a. The Corps, the applicants, CHERT and NOAA Fisheries will develop an extraction reach-specific monitoring plan by December 31, 2004. Final approval of the monitoring plan must be obtained from NOAA Fisheries prior to implementation.

b. The Corps, NOAA Fisheries and CHERT shall review cross-section protocols. If necessary, cross-section protocols shall be modified based on input from CHERT, the Corps or NOAA Fisheries. Proposals for modification will be circulated among these three entities and the permitees for review and comment prior to approval and implementation.

c. Ensure that all required monitoring is completed and that monitoring reports are provided to NOAA Fisheries each year by January 15. Reports shall be submitted to:

Irma Lagomarsino
Supervisor Arcata Area Office
National Marine Fisheries Service
1655 Heindon Road
Arcata, CA 95521

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, or to develop additional information.

NOAA Fisheries considers the following conservation measure consistent with these obligations, and, therefore, should be implemented by the Corps:

1) Measures should be taken to ensure that offsite processing areas are not sources of fine sediment delivery. These measures may include, but are not limited to, creating stilling basins, silt fences and routing of effluent to areas where it may infiltrate into the soil.

2) Volume allocations for the Mad River should be tailored to the geomorphic conditions of the reach. For example, analysis of cross-section data indicates that the lower, more confined setting found in the lower river is less sensitive to extraction than the upper reach, where the river is less confined and more sensitive to channel enlargement. Future volume allocations should reflect the different response of each section of the Mad River.

In order for NOAA Fisheries to be kept informed of the actions minimizing or avoiding effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of the implementation of the conservation recommendations.

XI. REINITIATION OF CONSULTATION FOR LOP 2004-1

This concludes formal consultation on the actions and processes described in LOP 2004-1 procedure. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the extent of incidental take is exceeded, (2) new information reveals effects of the agency action may affect listed species or critical habitat in a manner or to an extent not considered in the Opinion, (3) the agency action is modified in a manner that causes an effect to the listed species or critical habitat not considered in the Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount of incidental take is exceeded, consultation shall be reinitiated immediately.

For example, reinitiation of consultation may be required if (1) the extraction volumes that were analyzed in the Opinion (the average CHERT recommended volumes for the period from 1997-2003) are exceeded for the South Fork Eel River (75,486 cy/yr), Middle Eel River (138,083 cy/yr), Van Duzen River (160,544 cy/yr), or the lower Eel River (405,185 cy/yr), and result in habitat changes not anticipated in this Opinion; or (2) critical project design features such as limiting extraction to no more than 175,000 cy/yr on the Mad River, implementing a head-of-bar buffer, giving preference to alternative extraction techniques on the South Fork Eel River, Lower Eel and Mad River, and limiting skim widths in the lower two miles of the Van Duzen River to no more than 90 feet as measured across the top of the extraction, are not implemented. Reinitiation of consultation is also required if additional sites other than those listed in of the ITS Table 13 are authorized by LOP 2004-1.

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APPENDIX A

Implementation of the flow based minimum skim floor elevation

The 35% exceedence flow water surface elevation can be marked on the gravel bar by staking the water surface elevation as the flow recedes in the spring. The flow recorded at the USGS gage is not always accurate and is later corrected based on physical measurements and adjustments to the data. To account for this we are requesting the water surface elevation be marked at two flows near the 35% exceedence flow, so that an estimate of the actual water surface elevation at the 35% exceedence flow can be found by interpolating between the two recorded points. The actual elevation of the 35% exceedence flow can be calculated using the attached excel worksheet.

Based on the last 10 years of flow record, the 35% exceedence flow has always occurred after March 1 in Humboldt County Rivers. The number of occurrences after March 1 varied between one and six times with the latest occurrence at the end of June. It is recommended that you begin checking the daily average stream flow on the USGS website in the later part of February in order to be familiar with the flows occurring near your section of the river.

Steps to mark the minimum skim floor elevation

Check the "real time daily average flows" on the USGS website at the appropriate gage for your site (the links are listed below). Check whether the stream flow has been receding over the past few days and whether the current daily average flow is equal or less than the high flow in the table for your gage.. When you are finished checking the flows, click the back arrow on the top of the browser to come back to this page.

Gravel Reach	35% exc. flow (cfs)	High flow	Low flow	Link to USGS real time daily average flow data
Trinity River	4700	5900	3700	http://waterdata.usgs.gov/ca/nwis/uv?dd_cd=02&format=gif&period=7&site_no=11530000
Mad River	900	1200	700	http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11481000&agency_cd=USGS
Lower Eel, Middle Eel	3800	4800	3000	http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11477000&agency_cd=USGS
South Fork Eel	900	1200	700	http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11476500&agency_cd=USGS
Van Duzen	500	700	400	http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11478500&agency_cd=USGS
Mattole	670	950	500	http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11469000&agency_cd=USGS

If the current daily average stream flow is greater than the high flow in listed in the table, then continue checking the website each day and repeat step number one until the high flow or less is reached and the stream flow is receding.

If the current daily average stream flow is equal to the high flow or less and the flow is receding, **mark the water surface elevation** on your bar as described in step 4 note the date and time the bar is marked on the 35% worksheet.

Mark the water surface elevation on your bar in enough locations to be able to identify the water surface elevation of the 35% exceedence flow at the time of survey, at all cross sections. It is recommended that the water surface elevation be marked with a solid stake, pounded at least a foot into the bar, in case there are more high flows after this date.

Continue monitoring the website each day. When the flow is between the 35% exceedence flow and the low flow listed in the table, **mark the water surface elevation** at the same locations used in step3. On the worksheet, note the date and time that the stakes were placed.
When it is time to survey the pre-extraction cross-sections go to the website and record the corrected flow for the days that you marked your flows using the flows listed in the USGS Recent Daily Average Flow site (link provided in the worksheet). Enter these new flow numbers into the worksheet.

Use the calculated elevation shown on the worksheet to mark the elevation of 35% exceedence flow on the bar.

Note the elevation of 35% exceedence flow on the cross sections.

If there is an access problem due to high flows, water surface elevations can be marked on the accessible side and translated to the other side later during surveying.

Take photographs of the flows that are marked on the bar to document their locations. Note that NOAA Fisheries will be spot-checking during this time.

HEC modeling can also be used to determine the water surface elevation at the 35% exceedence flow, or used as corroboration of the water surface elevation at this flow.

For questions regarding this sheet contact: Margaret Tauzer (Margaret.tauzer@noaa.gov)

Appendix B

Definitions associated with gravel extraction

Traditional skimming
Skimming or scalping of gravel from exposed gravel bars involves the use of excavating machinery to remove the uppermost layer of gravel. Historically, skimming may have been performed as far down as the water surface, however, to be eligible for authorization under LOP, skimming shall be performed above the 35% exceedence flow water surface elevation of the low flow channel, and on exposed (dry) bars, within the active channel that is typically inundated annually. After skimming, the bar must be graded in order to be left smooth, free of depressions and with a slope downstream and/or to the low-flow channel. Traditional skims are typically laid out as curvilinear benches along the outside of gravel bars, and are typically no wider than about half the exposed bar surface width. Traditional skims include the minimum head-of-bar buffer (described below).

Head-of-bar Buffer
The upstream end of the bar (head of bar) will not be mined or otherwise altered by the proposed action. The minimum head of the bar shall be defined as that portion of the bar that extends from at least the upper third of the bar to the upstream end of the bar that is exposed at summer low flow. Therefore, the upstream one-third portion of the bar as exposed at summer low flow is provided as the minimum head-of-bar buffer. The intent of the head-of-bar buffer is to provide protection of the natural stream flow steering effect provided by an undisturbed bar.

Variances to the minimum head-of-bar buffer may be considered on a case-by-case basis (e.g., for narrow skims) if the proposed alternative provides equal or greater protection. The specific nature of the proposed variance must be described, along with sufficient biological, hydrological, and sediment transport rationale to support the recommended alternative. Modifications in the default hear-of-bar buffer dimension shall, at a minimum, provide for protection of the adjacent cross-over riffle, by limiting extraction to the area downstream of the entire riffle, and if the modified buffer maintains the steering flow provided by the upstream portion of the meander.

Narrow skims
Narrow skims taper gradually at each end and are not adjacent to riffle locations.

Van Duzen River
Narrow skims along the lower two miles of the Van Duzen River shall be limited to a maximum width of 90 feet across the top of the extraction. This width is designed to contain average peak flows of 1,000 cfs commonly seen during the early period of adult salmonid migration in November and December. The minimum skim floor shall be equal to the water surface elevation of the 35% exceedence flow.

Lower Eel River
Narrow skims that are adjacent to the low flow channel, but are not adjacent to entire riffle areas, will also be considered for the lower Eel River. These narrow skims may have a minimum vertical offset of 2 feet above the water surface elevation of the low flow channel. Narrow skim widths will be determined on a site specific basis, but narrow skims must: (1) not increase

channel braiding; (2) not lower the elevation at which flows enter secondary channels; (3) avoid the higher portions of the annually inundated bar surface; and (4) must promote channel confinement.

Mad River

Narrow skims on the Mad River shall be limited to a maximum width of one-third the exposed bar width, as measured at the widest point of the bar, and shall have a minimum skim floor at least as high as the water surface elevation of the 35% exceedence flow.

Horseshoe skims

This method extracts gravel from the downstream portion of gravel bars, with large horizontal and vertical offsets from the low flow channel, and an opening to the channel at the most downstream end of the excavation. These areas are excavated to a depth above the water table, with steeper (3:1) slopes on the sides, and gentler (6:1) slopes at the head of the excavation. The large horizontal and vertical offsets are intended to remove the excavation area away from frequent flow inundation and are intended to minimize effects to listed salmonid species by disconnecting the mined surface from frequent flow inundation. Due to less frequent flow inundation, horseshoe shaped skims may take larger flow events to replenish than traditional skim designs depending on the unaltered bar height between the excavation and the stream. The floor of the horseshoe skim must always remain, at a minimum, above the water surface elevation of the 35% exceedence flow, and the minimum head-of-bar buffer shall be used.

Alcove

Alcove extractions are located on the downstream end of gravel bars, where naturally occurring alcoves form and may provide velocity refuge for juvenile salmonids during high flows, and potential thermal refuge for juvenile salmonids during the summer season. Alcove extractions are irregularly shaped to avoid disturbance of riparian vegetation, and are open to the low flow channel on the downstream end to avoid stranding salmonids. Alcoves are extracted to a depth either above or below the water table, and are small in area and volume extracted, relative to other extraction methods.

Exposed Bar

The bar area subject to annual flow inundation and active sediment transport and replenishment cycles, lacking transitional vegetation colonization, grasses and shrubs. Area may contain sparse patches of widely scattered individual woody plants.

Wetland pits

Wetland pits are irregularly shaped excavations (to avoid excavating riparian vegetation) located on the 2-to-5 year floodplain surface. An excavator digs out the sediment below the water table and leaves the sides of the pit sloped. Wetland pits allow for gravel extraction away from frequently inundated gravel bar surfaces, and most salmonid habitat features. Wetland pits will only fill with sediment during high flow events, on the order of every 2-to-5 years, and typically over a multi-year period. Wetland pits must have vegetation, either existing or planted, around their perimeter, and must contain some type of cover elements, such as woody debris.

Trenching

Wet trenching

The wet trenching method of extraction is used to excavate sediment directly from portions of the channel, after the stream flow has been diverted to a secondary channel location. The wet trenching method of extraction would only be used when there is the additional objective of improving instream salmonid habitat by the limited use of sediment removal, and where the diversion of the low flow channel into a secondary channel that provides salmonid habitat is possible.

Dry trenching

The dry trenching method of extraction may be both shallow and stay above the water table, or deep and extend below the water table. The dry trenching method involves gravel bar excavation on the exposed (dry) bar surface. A gravel berm may be constructed with materials on site to isolate the trench from the channel, or the trench may be far enough from the low flow channel to not require a berm to separate it. Material is then excavated from inside the trench to a depth that is limited by the reach of the equipment, and by the annual, site specific recommendations provided by CHERT. After excavation, and when the sediment in the trench has settled, the berm is breached on the downstream end, and the trench is connected to the river to prevent fish stranding. Alternatively, the berm may be constructed to be naturally breached during normal Fall flows.

APPENDIX C

Humboldt County 2a(ii) Wild and Scenic River
River Descriptions/Agency Responsibility

River	Segments	Mileage	Agency	Designation
Eel	NF-Soldier Basin to Forest Boundary(FB)	15	USFS(SRNF)	Recreational
	NF-FB to confluence w/ Mainstem (includes Round Valley Indian Reservation lands)	16	NPS	Recreational
	MF-Headwaters to FB(Confluence with Black Butte Ck and MF Eel.)	18	USFS(MNF)	Recreational
	Main Stem-(legal description) to southern BLM boundary	13 +/-	NPS	Recreational
	Main Stem-South BLM boundary to confluence w/ Outlet Creek	13	BLM	Recreational
	Main Stem-Confluence of Outlet Creek to Mouth	?	NPS	Recreational
	SF-Headwaters (Section 4 Ck) to Confluence w/ Rattlesnake Ck adjacent to Hwy 101 (Leggett)	17	BLM	Recreational
	SF-Confluence w/ Rattlesnake Ck to Main Stem	50	NPS	Recreational
Van Duzen	Powerline above L. Larabee Ck to confluence with Eel.	?	NPS	Recreational
	Dinsmore bridge to powerline crossing above Little Larabee Ck.	?	NPS	Scenic
Trinity	Mainstem- Lewiston Lake to FB/ confluence with NF Trinity R.	17	BLM	Recreation
	Mainstem – East FB to W. FB (Shasta Trinity NF)	33.2	USFWS (STNF)	Recreation
	Mainstem –East FB to W FB (6 Rivers)	15	USFS (SRNF)	Recreation
	Mainstem – FB, Crossing Yurok land to Hoopa Indian land	1	NPS	Scenic
	Mainstem- Hoopa Indian land to confluence w/ Klamath R.	2	NPS	Scenic
	New River –Headwaters to confluence w/ mainstem Trinity R.	21	USFS (STNF)	Recreation
	SF – Hum. Co. line to Todd Ranch in Sec 18, T5N	?	USFS (SRNF)	Wild
	SF- Todd Ranch to confluence w/ mainstem Trinity R.	?	USFS (SRNF)	Scenic
	NF Trinity- Headwaters to Mainstem	15	USFS (STNF)	Recreation

APPENDIX D

CONDITIONS OF LETTERS OF PERMISSION ISSUED UNDER "Gravel Mining and Excavation Activities in Humboldt County"

GENERAL CONDITIONS:

1. The Department of the Army has relied in part on the information provided by the permittee. If, subsequent to issuing this permit, such information proves to be false, incomplete, or inaccurate, this permit may be modified, suspended, or revoked, in whole or in part.

2. Permittees whose projects are authorized by this LOP shall comply with all terms and conditions herein. Failure to abide by such conditions invalidates the authorization and may result in a violation of the law, requiring restoration of the site or other remedial action.

3. An LOP should not be considered as an approval of the design features of any authorized project or an implication that such is considered adequate for the purpose intended. A Department of the Army permit merely expresses the consent of the Federal Government to the proposed work insofar as public rights are concerned. This permit does not authorize any damage to private property, invasion of private rights, or any infringement of federal, state or local laws or regulations. Nor does it relieve the permittee from the requirement to obtain a local permit from the jurisdiction within which the project is located and to address all non-encroachment restrictions within a floodway of such local jurisdiction as identified by the Federal Emergency Management Agency.

4. This LOP procedure may be modified or suspended in whole or in part if it is determined that the individual or cumulative impacts of work that would be authorized using this procedure are contrary to the public interest. The authorization for individual projects may also be summarily modified, suspended, or revoked, in whole or in part, upon a finding by the District Engineer that immediate suspension of the project would be in the public interest.

5. Any modification, suspension or revocation of the District Engineer's authorization shall not be the basis for any claim for damages against the United States.

6. This permit does not authorize the interference with any existing or proposed Federal project, and the permittee shall not be entitled to compensation for damage or injury to the structures or activities authorized herein which may result from existing or future operations undertaken by the United States in the public interest.

7. No attempt shall be made by the permittee to prevent the full and free public use of all navigable waters of the United States, at or adjacent to the project authorized herein.

8. There shall be no unreasonable interference with navigation by the existence or use of the permanent and temporary structures authorized herein.

9. The permittee shall make every reasonable effort to conduct the activities authorized herein in a manner that will minimize any adverse impact of the work on water quality, fish and wildlife, and the natural environment, including adverse impacts to migratory waterfowl breeding areas, spawning areas, and riparian areas.

10. The permittee shall allow the District Engineer and his authorized representative(s) to make periodic inspections at any time deemed necessary to assure that the activity being performed under this authorization is in accordance with the terms and conditions prescribed herein.

11. The impact of activities authorized by LOP using this procedure on cultural resources listed, or eligible for listing, in the National Register of Historic Places (NRHP), shall be taken into account by the U.S. Army Corps of Engineers (Corps) prior to the initiation of work. If previously unknown cultural resources are encountered during work authorized by this permit, the San Francisco District shall be notified and the sites avoided until the Corps can assess their eligibility for listing in the NRHP. Sites determined to be eligible for listing in the NRHP shall require consultation between the Corps and the State Historic Preservation Office and/or the Advisory Council on Historic Places. Cultural resources include prehistoric and historic archeological sites, and areas or structures of cultural interest which occur in the permit area.

12. All temporary fills within waters of the U.S. shall be removed in their entirety.

13. All extraction activities in the vicinity of federal projects shall be coordinated for required setback distances with the Corps office prior to application for a permit.

14. Heavy equipment working in wetlands shall be placed on mats, or other measures shall be taken to minimize disturbances to soil.

15. No authorization will be granted under this LOP procedure for any activity that is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Endangered Species Act, or that is likely to destroy or adversely modify the critical habitat of such species. Permittees shall notify the District Engineer if any listed species, proposed species or critical habitat might be affected by, or is in the vicinity of, the project, and shall not begin work until notified by the District Engineer that the requirements of the Endangered Species Act have been satisfied and that the activity is authorized.

16. The project shall not significantly disrupt the movement of those species of aquatic life indigenous to the water body or those species that normally migrate through the project area.

APPENDIX E

Physical Monitoring and Submittal Preparation Guidelines For Gravel Extraction in Humboldt County

Ground surveys and aerial photography provide the primary basis for physical monitoring of extraction areas in Humboldt County. They are also essential for project planning, proposal preparation, field reviews, project modification, and compliance verification. Although technological advancements in recent years have lowered the costs and increased the accuracy of digital terrain modeling (DTM), the more conventional cross section surveys are still in common use by Humboldt County's mining industry. Consequently, the guidelines below focus on conventional cross section surveys. However, use of DTM-based monitoring information is encouraged and should provide much of the same information (e.g., elevations of the water surface, top of silt band, etc.) mentioned below.

Monitoring cross-sections are permanent, monumented cross sections whose purpose is to document yearly and long-term changes in river channel elevation and morphology at extraction sites and adjacent reaches. They also aid in extraction planning, field reviews, and, in some cases, estimation of volumes extracted.

Extraction zone cross-sections are temporary, seasonal cross-sections used for the planning an extraction, for estimation of the actual volume extracted, and for evaluating compliance with approved gravel plans. The extraction zone is the total area that will be extracted and/or graded as a result of gravel extraction activities.

Cross-sections, maps, and associated calculations (such as replenishment and extraction volumes) must be prepared by or under the direction of a State of California Licensed Land Surveyor or an authorized Professional Engineer and certified as to content and accuracy.

The guidelines below were modified from those in the original LOP 96-1. Additionally, NOAA Fisheries shall receive copies of all electronic cross sections.

I. Standards for Monitoring Cross-Sections

1. Number and layout of required cross sections for an extraction project to follow the guidelines below. Please consult with CHERT for assistance or clarification as needed.

   a. A hypothetical center line for the 'frequently scoured' river channel, measured equidistant from both banks and delineating the zone of frequent bedload movement (annual scour and deposition) must first be established to determine the high flow channel direction and the along-channel length of the project reach. This zone is typically devoid of large trees and excludes low floodplains and terraces

b. If the radius of curvature is less than ten times larger than the average frequently scoured channel width of the project reach, the reach is considered a bend. If the radius of curvature is more than ten times larger than the average actively scoured channel width of the project reach, the reach is considered straight.

c. Cross-sections shall be oriented perpendicular to the center line.

d. Cross-sections shall be no more than 400 feet apart on bends and 500 feet apart in straight reaches. If the length of the project reach is not evenly divisible by 400 or 500 feet, the number of cross-sections should be rounded to the next larger number. Longer distances between cross sections or abandonement and replacement of cross sections may be allowed on a case-by-case basis.

e. The first cross-section shall extend across the channel at the upstream limit of the project reach (entire project site); the last cross-section shall extend across the channel at the downstream limit of the project reach.

2. Cross-sections must extend completely across the river channel (so as to include all actively scoured channel width) and to terminate on the 100-year floodplain or equivalent surface.

a. Two bench marks (permanent monuments) shall be established for each bar above the watercourse's active banks and in positions such that they will not be eroded away by all but the most destructive flood events.

b. Bench marks to be tied to a common vertical and horizontal control datum, the 1988 North American Vertical Datum (NAVD88) and to the 1983 North American Datum (NAD), among all extraction sites. Cross-sections to be tied to a common vertical and horizontal control datum among all extraction sites. This is specified as the 1988 North American Vertical Datum (NAVD) and 1983 North American Datum (NAD) elevation for sea level.

c. Cross-section endpoints and benchmarks shall be clearly monumented and labeled in the field and accurately located on current air photos and maps. A common color of flagging, or environmentally benign painting to be used to mark cross-sections at all sites.

d. Cross-section endpoints must be placed far enough away from eroding banks that they will not be removed by relatively frequent flows (e.g., by floods smaller than the 10-year event).

e. Cross-sections must be resurveyed from the same endpoints each year New cross-sections may be added as necessary (e.g., major shifts in the river's course) and should be oriented approximately normal to the channel center line.

f. Pre-extraction cross-section surveys need only include those portions of each cross-section inundated by the previous winter's highest flow, but plots must include accurate representations of all ground topography between endpoints and clearly label where older (previous survey) data are used. This is included as a cost saving measure for areas where it is clear no scour or deposition has occurred since the previous survey.

g. If the cross-section becomes inundated by late-season high flows after the pre-extraction survey is completed, the cross-section must be resurveyed (at a minimum, the inundated portions, as described above).

h. All monitoring cross-sections should be surveyed each spring, regardless of whether extraction took place in them in the previous year. If flow conditions make below-water portions of the cross section unsafe to survey, those sections may be completed later in the year as conditions allow, but prior to fall rains.

i. Post-extraction surveys need only be resurveyed through those portions of the cross-section altered by extraction, temporary stockpiles, road construction, or other types of ground disturbance.

j. Stake or spray paint the following points on the ground in each cross-section at time of survey (to facilitate the CHERT relating the cross-section at time of survey to the ground during field review):
   - water's edge on both sides of river; or if this is not practicable (e.g., steep, unstable slope), stake at 10 ft offset (measured along ground surface) from water's edge. Position of stake to be included in survey.
   - the top of the silt band, if visible.
   - the 35% flow exceedence level, if available.
   - on both sides of river, one hub (2 inch by 2 inch wooden stake), painted brightly and labeled, shall be driven in nearly flush with the ground at the survey point closest to midway between water's edge and cross-section endpoint. Exception: this is not required if it would put the stake in a steep, unstable bank.
   - Stakes should be labeled with cross-section and station number (horizontal distance from left end point).

k. Maximum distance between any two elevational points along a cross-section shall be 50 feet, including wetted portion. Exception: if ground outside wetted channel is essentially level for a distance of 500 feet, distance between points can be increased to 100 feet. All obvious breaks in slope must still be included.

l. Net cross-sectional area change pre-extraction to post-extraction (gravel removal), or post-extraction to next year's pre-extraction (replenishment), as appropriate, should be calculated for each cross-section and presented in tabular form. Measurements and calculations should be included.

m. The survey data for each cross section should be provided to the CHERT on a 3.5" diskette, 'zip' disk, or CD as a digital file in ascii text format (alphanumeric, tab-delimited). A paper printout of the data should also be supplied. The data should be grouped by cross-section and organized from L bank to R bank, using the format below:

XS 20+78, Smith Bar, Duke Ready Mix Site, Big River			
Point No.	Horizontal Distance	Elevation	Description
1	0	154.9	Ground at LB rebar
2	45.3	149.3	BIS (break in slope)
3	73.3	147.1	Top scarp
4	79.1	142.6	Base scarp
etc.	etc.	etc.	etc.

n. Monitoring cross-sections to be used for planning/designing extractions should be surveyed at least several weeks prior to the desired beginning date of operations to allow sufficient time for the review and approval process. Cross-sections following mining (including any parts of cross sections not surveyed pre-mining due to unsafe flow conditions <u>and</u> parts of cross sections affected by mining operations) are to be surveyed and submitted with the other post-extraction materials as soon as practicable after mining ends, and definitely before winter high flows occur.

II. Standards for Extraction Zone Cross-Sections

1. Number and layout of extraction cross sections for an extraction project to follow the guidelines below:

   a. A hypothetical center line for the proposed extraction, located equidistant from both edges of the extraction zone and extending down its long axis must be established.
   b. A minimum of five equally-spaced extraction cross-sections to be surveyed in each extraction zone or area.
   c. Cross-sections shall be oriented perpendicular to the extraction center line.

2. Extraction cross-sections to be surveyed prior to extraction, and used to design extraction, calculate extraction volume, and review extraction proposals.

3. Extraction cross-sections to be resurveyed after extraction is complete. Extraction cross-sections need not be resurveyed in subsequent years.

4. Extraction cross-sections require temporary (seasonal) monuments at each end, such as stakes or rebar, which can be relocated after extraction is complete.

5. Extraction cross-sections should be clearly staked and marked on the ground so that the CHERT can readily locate them in the field.

III. Preparation of Cross-Sections Plots

All Cross-Sections shall be prepared according to the following criteria:

A. Plots should denote the position and elevation (to the nearest 0.1 foot) of the following points:

1. end points and hubs
2. the top of the silt band adjacent to the low flow channel, if visible
3. the 35% flow exceedence level, if available.
4. the water's edge at time of survey
5. edge of vegetation stands
6. any other features useful for field orientation and review.

B. Cross-sections at all sites to be plotted at the same simple, usable vertical and horizontal scales and . All cross-sections must have a vertical exaggeration of 10. Scales to use for cross-sections are as follows:

Cross Section Width	Paper Size	Horizontal Scale
≤ 500 ft.	8 ½" x 11"	1 in. = 100 ft.
500 ft. - 1200 ft.	8 ½" x 14"	1 in. = 100 ft.
≥ 1200 ft. - 1600 ft.	8 ½" x 14" or 11" x 17"	1 in. = 100 ft.
≥ 1600 ft.	8 ½" x 14" or 11" x 17"	1 in. = 100 ft.

C. Cross-sections can be cut and stacked so that whole cross-sections can be placed on one page. Cross-sections that are cut and stacked must be consistently presented each year.

D. Cross-sections to be surveyed and drafted consistently so that the right bank (RB) of the river as you face downstream is at the right side of the drafted cross-section. Zero (0) distance in cross-sections to be at the left (LB) endpoint as you face downstream.

E. Cross sections to be plotted on gridded paper, where the grid logically corresponds to the scale at which the cross-section is plotted. We suggest a grid of 10 squares to the inch. Grid to be visible in the reproduced paper copies provided to the CHERT.

F. Cross sections to have clearly labeled vertical and horizontal axes. Each cross section should have its own horizontal axis to facilitate measurement of distances (rather than a single set of axis labels at bottom of page). Each cross-section should have its origin on a heavy grid line.

G. Any vertical or horizontal datum or endpoint changes should be clearly noted along with the length and direction of change(s) on the cross section plots.

H. All monitoring cross sections shall also include:

1. Where discernible, elevation and position of high-water marks for previous winter's flow (floodmarks); these should be consistently determined among cross-sections.

2. Water-surface elevation and location (both banks) at time of survey

3. Cross-sections to include the river bottom (especially location of the thalweg) as well as the water surface. Water surface elevation alone is insufficient; the bed must be included.

4. Elevation and location of top of silt band ("bathtub ring") if visible at time of survey

5. Location of major vegetation breaks, e.g., edge of willows or riparian forest

6. Water discharge at time of survey (from nearest USGS gage) to be shown in cross-section legend.

7. Floodmarks, top of silt band, water's edge, monuments, CHERT reference stakes should all be clearly labeled in the cross-section and their elevations indicated.

8. Spring cross-section data all monitoring cross-sections shall include the current year's spring cross-section overlain on the previous year's spring and fall (if any) cross-sections. The area of actual extraction should be lightly shaded or hatched. Water-surface should be shown with a dotted line, and its date clearly indicated.

9. For pre-extraction survey, total volume change since the previous year's post-extraction survey (i.e., replenishment) should be calculated using double end-area or computer generated digital terrain models. All measurements and calculations should be included and verified by a California Licensed Land Surveyor or appropriately authorized engineer.

10. For post extraction cross-section data, all monitoring cross-sections which overlap the extraction area shall include the current year's post extraction cross section data overlain on the current year's pre-extraction cross-section data and the previous year's post extraction cross-section data and the original prescription recommended by the CHERT. The post-extraction cross-section should be shown with a solid line, the pre-extraction with a dashed line. The actual area of extraction should be lightly shaded or hatched.

11. Electronic files with cross section data shall be submitted by Dec. 31. These files should be in ASCII or a compatible format with X-Y coordinates corresponding to the hard-copy plots, where X is the horizontal distance from the left (facing downstream) monument or endpoint and Y is the elevation referenced to NAVD88. Header information shall be included with each cross section file that indicates the date of survey, cross section number, mining site, and river. Other relevant information (e.g., lost/re-established endpoints, etc.) shall also be included. Files shall be submitted in CD-ROM or other common media. A 'Read Me' text file may also be included if explanation of other issues is necessary.

I. All Extraction Cross-Sections shall also include:

1. Spring extraction cross-sections shall include the pre-mining cross-section data overlain onto the proposed mining configuration. The proposed area of extraction should be lightly shaded or hatched. Should changes be required for project approval, extraction cross sections shall be re-submitted with the approved mining configuration replacing the proposed configuration prior to commencement of mining.

2. Post extraction cross-sections shall include the post-mining cross-section data overlain on the previous year's post extraction (if any) and the current year's pre extraction cross-section data and the approved mining configuration. The actual area of extraction should be lightly shaded or hatched.

3. All plotted configurations should be clearly distinguishable from one another and clearly labeled.

4. The net cross-sectional area change pre-extraction to post-extraction should be calculated for each cross-section. Total volume extracted should be computed, using double end area or computer generated digital terrain models. All measurements and calculations should be included in tabular form and verified by a California Licensed Land Surveyor or appropriately authorized engineer.

IV. Preparation of Maps

A. All pre-extraction site maps are to be prepared on a color air photo of good quality from current year (see exception below). Site maps should show the entire project area, the proposed extraction area, and other pertinent features at a scale of approximately 1:6,000 (1 in = 500 ft). This may require reduction or enlargement of original air photos.

B. Pre-extraction photos should be taken when the river is low enough to see the channel. Earlier photos may be used for preliminary planning so long as they reasonably reflect current conditions, but a current set is required for final project approval.

C. All monitoring and extraction cross-sections should be accurately located and labeled on the site map. In particular, the end points of each cross-section must be located as close as possible to their true positions.

D. The horizontal limits of both the approved and actual extraction areas (if they are different) should be accurately shown on a site map included with the post-extraction submittal, along with cross section as described above. Only current year air photos shall be used for post-extraction submittals.

APPENDIX F

BIOLOGICAL MONITORING REQUIREMENTS FOR GRAVEL EXTRACTION IN HUMBOLDT COUNTY, CA

The purpose of the biological monitoring is to identify adverse impacts that can be avoided, minimized and mitigate by mapping important resources such as fish habitat and riparian vegetation. This monitoring plan is not a river management plan but part of the Corps regulatory requirements to ensure protection of the aquatic ecosystem.

Each applicant will study his/her project reach which shall include the gravel extraction reach (or zone) and distances upstream and downstream of the gravel extraction area equal to half the gravel extraction reach. Modifications to the project reach may be made by the Corps for projects in close proximity to other gravel operators, and for projects that span large distances with relatively small excavations.

Each Class A applicant shall submit the following biological monitoring data to be obtained by a qualified biologist. Each applicant is responsible for ensuring that all data submitted are accurate and obtained by qualified individuals. Failure to employ qualified individuals may require resurveying, and or suspension of the permit.

A. Vegetation

1. All vegetation in each project reach was mapped, at a scale of 1 inch = 500 feet, during the 1996 year or first year of operations for riparian and wetland vegetation and formatted to be consistent to the USFWS National Wetlands Inventory methodology. Mapping of changes in vegetation were required once each year under LOP 96-1. This schedule shall continue under the modified LOP 96-1. Yearly summaries in vegetation changes in age structure and areal coverage can be supplied using stereoscopic aerial photos. Vegetation mapped shall extend a minimum of 100 feet from the top of the banks of the watercourse, or until a change in land use or paved road is found.

B. Anadromous Fish

The Corps, the applicants, CHERT and NOAA Fisheries will develop an extraction reach-specific monitoring plan by August 30, 2004, which will replace the anadromous fish monitoring requirements of the modified LOP 96-1 procedure. The monitoring plan will be reviewed by NOAA Fisheries and approved by the Corps prior to implementation. In the interim, the following biological monitoring will be required.

Wetland Pits: Snorkel surveys of wetland pits, by a qualified fisheries biologist, shall be required to monitor and assess juvenile stranding after high flows that inundate the wetland pit have receded. Wetland pits shall each be surveyed for stranded juvenile salmonids as soon as winter flows have receded, if the winter flow inundated the wetland pit. During the summer season the wetland pit will be re-surveyed if stranded juvenile salmonids were previously found in order to assess survival. In addition, a monitoring plan that assesses salmonid stranding, which includes a fish rescue plan, if it is needed, shall be submitted as part of the pre-extraction mining plan when wetland pits are used as the extraction methodology.

Trenching: A monitoring plan that assesses salmonid stranding, which includes a fish rescue plan, if it is needed, shall be submitted as part of the pre-extraction mining plan when trenching is used as the extraction methodology.

C. Birds

Any gravel operation that begins in the spring (March, April or May) may adversely affect nesting and brooding activities of avian species. Monitoring of avian species to determine use of riparian areas and gravel bars according to sex, age, and breeding status may be required of any operator that commences gravel extraction before June 1. Monitoring shall include point counts and mist netting and shall be approved by CDFG and USFWS personnel.

Appendix G

Summary of Studies Estimating Sustainable Yield for the Mad River

This appendix reviews recent work conducted on the Mad River to better understand sustainable yield amounts.

Excavating an average volume that is equivalent to or exceeding the average deposited volume causes channel enlargement, as described below. The enlargement can be in the form of channel widening, lowering or both. Annual sediment replenishment to a particular sediment removal site, and to the reach in general, is highly variable. Years with high intensity, long duration storms recruit more volume than on a low intensity water year. This can result in natural aggradation of the channel in the extraction reach during a high flow year and a natural enlargement of the channel during low flow years. The variability is difficult to quantify but when more sediment is extracted than is recruited on average, an overall sediment deficit will occur. Over time, the result will appear as channel enlargement as the deficit is made up by the sediment stored in the banks and bed of the channel. The average recruited volume is estimated for the entire extraction reach. In theory, sediment recruitment varies throughout the reach and sustainable extraction volumes should vary by location along the reach. However, the sediment budget is based on average values. Even with their limitations, sediment budgets are useful for planning and long-range management of sediment extraction industries. A combination of a conservatively applied sediment budget and conservation of important geomorphic forms and functions is a dual management strategy that best protects salmonid habitat.

CHERT has defined sustained sediment yield as the total average sediment recruited to the upper end of the extraction reach (MAR). The CHERT estimate of MAR is 150,000 cy/yr, with 200,000 cy/yr as a high-end estimate (assuming a bulk specific weight of 1.4 tons per cubic yard, Lehre 1993). CHERT has recommended an annual average extraction on the Mad River greater than 100% of their high-end estimate of sustained yield. The average of the CHERT recommendations between 1997-2002 was 220,704 cubic yards. Lehre (1993) recommended an average total extraction not to exceed 150,000 cy/yr to keep the Mad River in its current state. In order to induce recovery of bed elevation, Lehre recommended that average total extraction should be limited to no more than 100,000 cy/yr.

The most recent estimate of the long-term average annual sustained yield is described in Knuuti (2003). The sustained yield estimate from Knuuti (2003) is 93,000 to 100,000 cy/yr, assuming a bulk specific weight of 1.38 tons per cubic yard. Knuuti's definition of sustained yield is the amount of sediment that is, on average, annually deposited in the extraction reach between the hatchery and the Highway 299 bridge (no net change in stored sediment). This is different than the CHERT definition of sustained yield as being the volume recruited into the upper end of the extraction reach. The objective of Knuuti's estimate of sustained yield is to maintain the river in its current condition, with no net aggradation, degradation, or channel widening (bank erosion).

Although the average total volume extracted under LOP 96-1 (177,078 cy/yr) was less than high-end estimate of MAR, the volumes recommended by CHERT and authorized by the Corps during LOP 96-1 (average of 220,704 cy/yr between 1997 and 2002) exceed CHERT's high-end estimate of MAR (200,000 cy/yr). CHERT has noted that some volumes of gravel proposed for extraction, and provided as part of the pre-extraction mining plans on the Mad River during LOP 96-1, have exceeded the previous year's bar replenishment volumes. As far back as the 1997 CHERT report (Klein *et al.* 1998), CHERT described that extraction of 200,000 cy/yr is too much volume for the Mad River, and may be leading to excessive bank erosion. CHERT recommended that extraction volumes be held to its low-end estimate of MAR, 150,000 cy/yr (Klein *et al.* 1998; note that the 150,000 cubic yards assumes a bulk specific weight of 1.4 tons per cubic yards. 150,000 cubic yards is equivalent to 135,000 cubic yards at a bulk specific weight of 1.55 tons per cubic yards. As discussed further in this section, we use 1.55 tons per cubic yard as an appropriate bulk specific weight for the Mad River materials).

To analyze the future effects of LOP 2004-1, NOAA Fisheries assumes the maximum allowable volume of 175,000 cubic yards will likely be recommended by CHERT and authorized by the Corps during each mining season. Although the gravel operators did not always mine 100% of the recommended and authorized volumes under LOP 96-1, they could have mined the recommended and authorized volumes annually. Studies by Kondolf and Lutrick (2000) and more recently, Knuuti (2003), have attempted to estimate the sustainable extraction volume based on estimates of volume lost or stored in the extraction reach and comparing that to volume extracted. The studies rely on cross section data that contains errors and is controversial to utilize. To avoid the argument about the quality of the cross sections utilized by Knuuti (2003) and by Kondolf and Lutrick (2000), NOAA Fisheries has gathered the available volume estimates into the extraction reach and volume estimates out of the extraction reach to make a simplified estimate of volume stored in the reach. Table 1 shows the estimates of input and output, the sources of information, the estimated storage (volume in minus volume out), estimated contributions from the North Fork Mad River, and an estimate of the volume stored in the extraction reach below Highway 299.

The previous estimates of bedload transported out of the reach were assumed to be equivalent to transport past the Arcata gage at the Highway 299 crossing. They did not include an estimate of the volume of sediment that is stored in the lower end of the extraction reach below Highway 299 to Highway 101. To estimate a volume for the entire extraction reach, we increased the estimated volumes by the proportional increase in active channel area in the lower reach. The active channel area in the lower reach is estimated as 79 acres from a 1988 ortho-photo. The active channel area of the entire extraction reach is estimated as 483 acres from 1988 and 1993 ortho-photos. Therefore, we increased the volume by a factor of 0.16, and adjustments were made to the volumes based on a bulk specific weight of 1.55 tons per cubic yards.

The volume recruited into the reach excludes volume input from tributaries that flow into the extraction area, except for the North Fork Mad River. Most of the Mad River tributaries in the extraction reach have very small watersheds or flow through long flat reaches that do not carry significant volumes of gravel. The only tributary that carries a significant amount of gravel and cobble-sized bed material is the North Fork Mad River. It has a watershed area of approximately 41 square miles, approximately one-tenth the size of the Mad River watershed above the Blue Lake gage. We adjusted the recruitment volume by scaling to watershed area to account for the additional sediment contribution from the North Fork Mad River.

Knuuti's (2003) volumes were calculated using a bulk specific weight of 1.38 tons per cubic yards. The Brown (1975) volumes and Lehre *et al.* (1993) volumes assumed a bulk specific weight of 1.4 tons per cubic yards. Bulk specific weight is defined as the weight of the sediment deposit divided by its bulk volume, as situated in the gravel bar. These are typical values for sand-sized feldspar and quartz and probably representative of the sand-sized sediment in the Mad River. The bed-surface samples at the Arcata gage taken by the USGS on November 20, 1972, indicate a range of sediment between 0.4 mm to 27 mm with an average size of about 8 millimeters. Two bed-surface samples, taken by a Humboldt State University Geology class in October of 1989, near the Blue Lake hatchery found a sediment size range of 5 to 40 mm, with an average of about 14 mm. The bulk specific weight of sediment increases with size, resulting in a higher weight per volume as the size gets larger. The bulk specific weight of the natural mix of sand with larger sediments on the gravel bar is different than adding or weighting the bulk specific gravity by size contribution. If the majority of sediment is large with enough sand to fill the voids, the bulk specific weight may be larger than the value recorded for the large size sediment. In another case, where most of the sediment is sand with some larger particles embedded, the bulk specific gravity would probably be closer to the value for the sand size. Table 2 shows the bulk specific weight of different sediment sizes and how it affects the stored sediment volume estimation by Knuuti (2003).

Another consideration is the fact that the bulk density of sediment on the bar is higher than the bulk density of sediment loaded into a truck. Once the sediment is loaded on a truck, the sediment is not as well compacted, and there is less weight per cubic yard of material. The bulk specific weight of sediment on a truck would be lower than the same sized material when it is on the undisturbed bar. We are considering the bulk specific weight of material stored on the bar.

The value used in Knuuti (2003) represents coarse sand, as reported by Shen and Julien (1992) in **Table**Table 2. Lehre *et al.* (1993) used the value of 1.4 tons per cubic yard in his analysis for the Mad River PEIR. Multiple measurements made on gravel bars in Redwood Creek near Orick by USGS and Redwood National and State Park found bulk specific weights of 1.5 - 1.6 tons per cubic yard values (pers. comm. with M. Madej, geologist, USGS, 2003). Measurements of bulk specific weight in the Mad River extraction reach are needed to help determine the best estimate of bulk specific weight. Redwood Creek is an adjacent watershed to the Mad River, has similar geology, is oriented in the same the direction and has similar hydrologic response to precipitation. Therefore, until measurements are available for the Mad River, we think it is reasonable to use 1.55 tons per cubic yard, the average of Redwood Creek. The total annual extraction volume should be adjusted when new values for the bulk specific weight are available for the Mad River extraction reach. Table 2 shows the adjustments we made to arrive at our estimate of sediment volume stored in the extraction reach of the Mad River using the above assumptions.

The estimate of total volume stored in the extraction reach in Table 1 represents the difference between estimates of sediment into the reach and sediment out of the reach. The estimate of annual average stored sediment in the extraction reach ranges between 69,000 - 154,000 cy/yr. The range of values in Table 1 represents the best estimate available for the amount of sediment that is stored in the reach annually. Some of the weaknesses of each of the methods of estimation are included in the table. One common weakness is that the estimates are based on 30-year-old data and a limited quantity of data. However, the values are within the same order of magnitude and probably represent a realistic estimation of possible volume stored in the extraction reach. The volume extracted probably has an impact on the natural volume that would be transported through the reach. In other words, when more sediment is extracted, up to a certain point, more sediment will deposit and less will transport through the reach. Bedload measurements taken during 1970 - 1973 were probably influenced by volume extracted during those years. All estimates of the Mad River bedload have relied on a small dataset for bedload taken in the 1970s or very small dataset of bed material samples. These factors, along with the utilization of bedload equations known to carry large uncertainty, make average annual bedload estimations very crude. In addition, the annual fluctuation of bedload is dependent on the magnitude and duration of the storm flows for that year as well as on the supply of sediment from upstream. There is an exponential increase in bedload with increasing storm magnitude. The estimation of the average annual recruitment does not take into account that the majority of sediment moves during a high flow year or that there could be several years of low flow years with very little sediment transport. The sustainable volume of sediment that can be extracted annually depends on the length of time considered sustainable. In other words, if the average annual storage were known with certainty and that quantity were extracted every year, over time the river would probably remain in equilibrium. Even if over the long term the river is in equilibrium, there may be several years of drought where, if the average annual depositional amount were extracted, the river would degrade and it may have a significant impact on salmonids. The values in Table 1 represent a range of estimated average annual depositional volumes in the Mad River extraction reach. The sustained yield volume should be within the range of estimates. The sustained yield is just a management tool, and the range of values are crude estimates, but even if the exact average annual deposition volume were known, mining at that volume cannot protect against short term degradation. In years of low sediment input, *i.e.* low storm magnitude and durations, the volume extracted should be less than the average estimate where in years of high sediment input the volume extracted may be toward the high end of the estimate. Over time the volume extracted should remain at or below the average volume deposited, to maintain current conditions in the extraction reach. Because of the errors in estimating sustained yield volumes, the volumes must be adjusted by checking for channel degradation or aggradation over time.

Table 1. Estimate of volume stored in the Mad River mined reach based on the difference of the estimated input minus the output from the reach.

Method used for volume in	**Volume into reach (tons/yr)**	**Method used for volume out**	**Volume out of reach (tons/yr)**	**Average Stored Volume (tons/yr)**	**Average Stored Volume (cy/yr) (bulk spec wt. = 1.55 tons/cy)**	**Addition from North Fork (cy/yr)**	**Addition from the reach between highway 299 and 101 (cy/yr)**	**Estimate of average volume stored in the mining reach (cy/yr)**	**Weakness of method**	**Strengths of method**
Knuuti (2003) bedload rating curve	183,000	Knuuti (2003) bedload rating curve	45,000	138,000	89,000	9,200	18,200	116,000	Based on handfull of measurements, assumes bedload at Kneeland = input to reach, past data may not represent current conditions	Uses actual data for the area, probably best method to use to calculate sediment load if there is enough data.
Knuuti (2003), Brownlie bedload equation	228,000	Knuuti (2003), Brownlie bedload equation	100,000	128,000	82,600	8,500	16,900	108,000	Based on small dataset, equation was developed for sand bed streams, lots of error associated with sediment equations	Knuuti reported that Brownlie is the best fit to the available data
Knuuti (2003), Brownlie bedload equation	228,000	Knuuti (2003) bedload rating curve	45,000	183,000	118,100	12,100	24,100	154,000	See above	
Knuuti (2003) Sweasy dam	182,000	Knuuti (2003) bedload rating curve	45,000	137,000	88,400	9,100	18,100	116,000	Sweasy dam filling may not represent bedload, does not include NF Mad or Canon Creek	Local data specific to the river, has been used by others
Knuuti (2003) Sweasy dam	182,000	Knuuti (2003), Brownlie bedload equation	100,000	82,000	52,900	5,400	10,800	69,000	See above	See above
Brown (1975), USGS bedload rating curve (Brown)	170,000	USGS bedload rating curve (Brown)	60,000	110,000	71,000	7,300	14,500	93,000	Old report (1975), small dataset for bedload rating curve	Based on published USGS report

Method used for volume in	**Volume into reach (tons/yr)**	**Method used for volume out**	**Volume out of reach (tons/yr)**	**Average Stored Volume (tons/yr)**	**Average Stored Volume (cy/yr) (bulk spec wt. = 1.55 tons/cy)**	**Addition from North Fork (cy/yr)**	**Addition from the reach between highway 299 and 101 (cy/yr)**	**Estimate of average volume stored in the mining reach (cy/yr)**	**Weakness of method**	**Strengths of method**
10% of suspended sediment load	178,600	2% of suspended sediment load	44,000	134,600	86,800	8,900	17,800	114,000	Uses the small set of bedload data to estimate percent of bedload, but 2-10% = typical values.	Uses very large data set for suspended sediment values
Lehre (1993), Lehre high estimate	210000	Lehre (1993), Brown bedload rating curve with flow data from 1962-1992	43400	166,600	107,500	11,000	22,000	141,000	Uses old rating curve (Brown 1975)	Uses more recent flow data (1962-1992)
							Range =	69,000 - 154,000 cubic yards		

Table 2. Example of how bulk specific weight affects volume estimate.

	Sediment size	Bulk Specific Weight tons/cubic yards*	Volume based on Knuuti (2003) low estimate (cubic yards)	Volumes based on Knuuti (2003) high estimate (cubic yards)
fine sand	1/4 - 1/2 mm	1.27	101,000	109,000
medium sand	1/2 - 1 mm	1.32	97,000	104,000
coarse sand	1 - 2 mm	1.36	94,000	101,000
coarse sand	2 - 4 mm	1.39	92,000	99,000
gravelly sand	4 - 8 mm	1.46	88,000	95,000
fine gravel	8 - 16 mm	1.50	86,000	92,000
medium gravel	16 -32 mm	1.63	79,000	84,000
coarse gravel	32 - 64 mm	1.71	75,000	80,000

*Specific weights from "Handbook of Hydrology" (Shen and Julien 1992).