6.0 REVIEW OF IMPLEMENTED IMPACT SIGNIFICANCE THRESHOLDS AND MITIGATION MEASURES

Sediment management projects require environmental assessment and review pursuant to CEQA and/or NEPA. Impact assessment requirements generally vary depending on complexity, significance, and/or uncertainty associated with impacts and may range from a simpler MND/FONSI to comprehensive EIRs/EISs (Section 2.2.1). Mitigation measures are used to reduce adverse impacts below a level of significance.

Environmental documents prepared for sediment management projects have varied with respect to impact criteria and significance thresholds, and types of recommended mitigation measures. The CSMW desires better understanding of these differences to assist future environmental review and project implementation. This report section provides a review and evaluation to address the following questions of interest to the CSMW:

- *What are the biological thresholds of significance established by various cities and counties as guidelines to identify when mitigation under CEQA and NEPA may be required?*
- *What mitigation measures have been implemented to avoid adverse impacts to biota during beach nourishment and related sediment management activities?*
- *What types of methods have been used to minimize impacts associated with different beach nourishment methods? Has the effectiveness of any of these mitigation measures been demonstrated?*
- *Can an appropriate level of impact/mitigation measure be recommended for the species/habitat/ecosystem of concern?*

Section Topics:

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Section 6.1 reviews impact significance criteria and thresholds used during representative California sediment management projects. Section 6.2 provides an overview of mitigation measures. The next three sections review in greater detail the types of mitigation measures that may be implemented prior to construction (Section 6.3), during construction (Section 6.4), and after construction (Section 6.5). Section 6.6 summarizes mitigation measures by habitat and species.

6.1 Review of CEQA/NEPA Thresholds of Significance

Section 15065(a) of the CEQA Guidelines states that a project may have a significant effect if it has the potential to:

> (1) The project has the potential to*:* substantially degrade the quality of the environment*;* substantially reduce the habitat of a fish or wildlife species*,* cause a fish or wildlife population to drop below self-sustaining levels*,* threaten to eliminate a plant or animal community, or substantially reduce the number or restrict the range of an endangered, rare or threatened species.
>
> (2) The project has the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals.
>
> (3) The project has possible environmental effects that are individually limited but cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

The CEQA implementing guidelines (Cal. Code Regs., Title 14, § 15000 et seq) encourage public agencies to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. To be adopted for general use, the thresholds of significance must be developed through a public review process and be adopted by ordinance, resolution, rule, or regulation (http://ceres.ca.gov/topic/env_law/ceqa/guidelines/art5.html). A threshold of significance is defined in the CEQA implementing guidelines as:

> An identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant (§15064.7).

CEQ regulations for implementing NEPA (40 CFR Section 1508.27) specify that significance requires consideration of both context and intensity of the action. Context refers to analysis of several different contexts, as appropriate, such as the affected region, locality, and site-specific area including both short- and long-term effects. Intensity refers to the severity of impact, which includes consideration of beneficial and adverse impacts, unique characteristics and/or resources, degree to which the action may adversely affect an endangered or threatened species or its habitat, degree to which the effects are uncertain and/or likely to be controversial, whether it is anticipated that the action may contribute to a cumulatively significant impact on the environment, and/or threatens a violation of environmental protection laws.

Thresholds of significance are considered a proven method of streamlining the CEQA process; however, few agencies have formally adopted them (http://www.jonesandstokes.com/resource/rsrc_crs.htm#Thresh). Furthermore, adopted significance thresholds mainly focus on terrestrial and wetland resources with limited attention given to coastal marine habitats and resources.

Useful Online References for Thresholds of Significance in California

State website - http://www.ceres.ca.gov/planning/ceqa/thresholds.html

Counties with Adopted Thresholds of Significance

- San Diego - http://www.sandiego.gov/development-services/news/pdf/sdtceqa.pdf
- Ventura - http://www.ventura.org/planning/pdf/ordinanes_regs/Initial_Study_Assessment_Guidelines2_06.pdf
- Santa Barbara http://www.sbcountyplanning.org/

Results of the review indicate that criteria have become more explicit in definition of significance thresholds over time. However, there also has been a lack of consistency in the approach used to judge significance of sediment management projects in California.

A total of twenty-seven CEQA and/or NEPA documents prepared for representative sediment management projects in northern, central, and southern California were reviewed. Biological resource evaluations in those documents included significance criteria for one or more of the following resource categories, which are reviewed in greater detail in the subsections below:

- Federal- and/or State-Listed Sensitive Species.
- Essential Fish Habitat (EFH).
- Native Species and/or Other Sensitive Resources.
- Wildlife Movement.
- Commercial Fishing.
- Environmental policies.

Example significance thresholds for each of the above-listed criteria are reviewed in the following sections. Criteria are listed for all reviewed projects in Appendix D.1.

6.1.1 Federal-listed, State-listed, and/or Other Special Status Species

Impact assessments generally include separate evaluations for species covered under the federal Endangered Species Act (ESA) and California Endangered Species Act (CESA). Separate evaluations also may include candidate or proposed species for listing (Chambers 1992, 2001c, USACE 1994, 1995, 2000, 2002c), fully protected species (CRM 2000, MEC 2000), species of concern (Chambers 2000), or other sensitive species (USDN 1997a,b, USACE 2002d).

Criteria for evaluating federal-listed, state-listed, and/or other sensitive species include the potential to affect individuals, their habitat, and/or populations. Recent documents also consider disturbance, although criteria have not been standard among documents.

The County of Ventura (2006) considers the following impacts to endangered, threatened, or rare species as significant if:

- The project would directly or indirectly reduce species population, reduce species habitat, and/or restrict reproductive capacity.

The County of San Diego (2006) considers the following types of impacts as significant if the project would:

- Impact one or more individuals of a federal or state-listed endangered or threatened species.
- Impact 5 percent or more of a population of a state Species of Special Concern or County listed sensitive species unless a biologically-based determination can be made that the project would not have a substantial adverse effect on the regional long-term survival of the species.
- Impact the regional long-term survival of a County-listed species considered regionally less common.
- Increase noise and/or nighttime lighting to a level above ambient proven to adversely affect sensitive species.

Example significance thresholds that have been used to evaluate impacts to sensitive species from California sediment management projects are listed below in order of increasing detail (also see Appendix D.1):

- Potential for direct impact (USACE 1993, 1994b, 1995b, 1998a, 1998b, 1999a, 2001; USDN 1997a, b).
- Substantial adverse effects to individuals or its habitat (Chambers Group 2000, Chambers Group 2001, USACE 2002d).
- Degrade habitat for, or reduce, the population size (USACE 2000b).
- Population directly affected or habitat lost or disturbed (USACE 1994a, 1995a, 2000a).
- Population directly affected, breeding impaired, or critical foraging or breeding habitat lost or substantially affected (Chambers Group 1992, CRM 2000, MEC 2000a, USACE 2002c).
- Loss or disturbance or reduction in the numbers of or a restriction in the range of, or any other impact to any unique, rare, threatened, or endangered species of animals or plants or their critical habitat (Chambers Group 2002, City of Buenaventura 2002).

The above criteria illustrate that documents prepared a decade ago focused on direct impacts (i.e., loss); whereas, more recent documents have recognized the significance of indirect means by which sensitive species may be impacted from an action; e.g., through degradation of habitat and/or impairment of critical functions (e.g., breeding, foraging).

Federal agency actions with the potential to adversely affect federal-listed species and/or designated critical habitat require federal resource agency coordination or consultation (e.g., NMFS, USFWS) per Section 7 of the ESA. Candidate and/or proposed species are addressed by resource agencies during conferencing and considered when making natural resource decisions (USFWS and NMFS 1998). Similarly, the CESA requires that state lead agencies coordinate or consult with CDFG to ensure that state agency actions are not likely to jeopardize the continued existence of any species that is state listed as endangered, threatened, or rare. The CDFG also may make a Consistency Determination of whether conditions specified in a federal incidental take statement pursuant to a federal Section 7 consultation or a federal Section 10(a) incidental take permit are consistent with the CESA (Fish and Game Code Section 2080.1).

Federal and state resource agencies both recommend informal early coordination to avoid potential impacts to rare, endangered, and threatened species. Advantages of early consultation include appropriate mitigation planning to offset impacts to listed species and their essential habitats and a streamlined consultation process (USFWS and NMFS 1998).

Useful Online References Regarding Federal and State Endangered Species Consultation

http://www.fws.gov/endangered/consultations /s7hndbk/s7hndbk.htm

http://www.CDFG.ca.gov/hcpb/ceqacesa/cesa/ cesa.shtml

6.1.2 Essential Fish Habitat

Essential Fish Habitat (EFH) is managed under the Magnuson-Stephens Fishery Conservation and Management Act (refer to Section 2.5.1). This act protects waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. Federal agencies and permit applicants must consult with NMFS on actions that may adversely affect EFH, which is identified and described for managed species in Fishery Management Plans (FMPs). FMPs for Federal waters off the coasts of California, Oregon, and Washington address Pacific coast groundfish, commercial and recreational west coast salmon fisheries, and northern anchovy/coastal pelagics (http://www.nmfs.noaa.gov/habitat/habitatprotection/profile/pacificcouncil.htm).

NMFS (2004) EFH guidance provides the following definitions of adverse and substantial adverse effects:

- Adverse effect means any impact that reduces quality and/or quantity of EFH, including direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).
- Substantial adverse effects are defined as effects that may pose a relatively serious threat to EFH and typically could not be alleviated through minor modifications to a proposed action; e.g., major harbor development with significant dredging and filling, channel realignments, or shoreline stabilization near EFH.

NMFS (2004) guidance notes that it is difficult to conceive of situations involving active construction in EFH without crossing the "may adversely affect" threshold. However, NMFS (2004) stated that incorporation of avoidance and minimization measures into the proposed action may eliminate or lessen the need for additional conservation measures. Types of appropriate avoidance and minimization measures may include careful alternatives analysis, design stipulations, "best management practices", time-of-year restrictions; avoidance of submerged aquatic vegetation and shellfish beds, and/or monitoring (NMFS 2004).

Examples of criteria and significance thresholds that have been applied to California sediment management projects include (also see Appendix D.1):

- Adversely affect fisheries protected under essential fish habitat designation (SANDAG and USDN 2000).
- Potential to impact essential fish habitat (USACE 2001).
- Substantial adverse effects would occur to fish species or habitat listed in the Fishery Management Plans (USACE 2002d).

The last of the above three examples provides a more explicit description that the EFH assessment considers both habitat and species compared to the first two examples. However, all three lack clear definition of criteria used to assess adverse effects. NMFS guidance states assessments should address both a reduction in quality and/or quantity of EFH.

6.1.3 Native Habitats and/or Other Sensitive Resources

Criteria for evaluating native habitats and/or species, other than those covered under the Endangered Species Act, have varied in CEQA and/or NEPA documents. Some documents leave the description general; e.g., biologically important habitats, environmentally sensitive habitat, or habitat of any fish, wildlife, vegetation (Chambers Group 1992, USACE 1994a, 2000b,d).

Other documents are more specific in description of habitats and/or populations of concern (e.g., kelp beds, surfgrass, eelgrass, reefs with perennial biota, marine mammal haul out areas, Areas of Special Biological significance) (e.g., USACE 1994a, USDN 1997a,b, CRM 1997, 2000, MEC 2000a, Chambers Group 2001c, 2002, City of Buenaventura 2002).

Significance thresholds for non-covered native species generally address direct effects to populations and loss and/or degradation of habitats.

The County of Santa Barbara (2006) uses the following guidance criteria to assess whether disturbance to habitat or species may be significant:

a. Substantially reduce or eliminate species diversity or abundance.

b. Substantially reduce or eliminate quantity or quality of nesting areas.

c. Substantially limit reproductive capacity through losses of individuals or habitat.

d. Substantially fragment, eliminate, or otherwise disrupt foraging areas and/or access to food sources.

e. Substantially limit or fragment range and movement (geographic distribution or animals and/or seed dispersal routes).

f. Substantially interfere with natural processes, such as fire or flooding, upon which the habitat depends.

The County of San Diego (2006) guidelines consider the following types of impacts as significant if the project would:

- Prevent wildlife access to foraging habitat, breeding habitat, water sources, or other areas necessary for their reproduction.
- Substantially interfere with connectivity between blocks of habitat, or would potentially block or substantially interfere with a local or regional wildlife corridor or linkage.
- Create artificial wildlife corridors that do not follow natural movement patterns.
- Increase noise and/or nighttime lighting in a wildlife corridor or linkage to levels proven to affect the behavior of the animals identified in a site-specific analysis of wildlife movement.

Examples of criteria and significance thresholds that have been applied to California sediment management projects include (also see Appendix D.1):

- Potential impacts to plankton, invertebrates, fish, eelgrass, marine mammals (USACE 1993, 1994b, 1995b, 1998a, 1998b, 1999a, 1999b, Tekmarine and Analytic Planning Service 1990).
- Burial of 10 percent or more of a shoreline or subtidal habitat and associated biological communities for a period > 1 year and which are directly attributable to the sediment placement site program; (2) The loss of 10 percent or more of surfgrass habitat which does not recover over a period of one year following shoreline sediment placement activities (CRM 1997).
- If there is substantial loss in the population or habitat of any native fish, wildlife or vegetation (substantial loss defined as any change in a population which is detectible over natural variability for a period of 5 years or longer); and/or If there is a net loss in the habitat value of a sensitive biological habitat including marine mammal haul-out site or breeding area, seabird rookery, or Area of Special Biological Significance (USACE 1994a).
- Substantial loss of a population or habitat where long-term loss (greater than one year) was projected and/or sensitive resources such as reefs, surfgrass beds, and kelp beds were affected for a period of time that would substantially reduce the ability of the resource to recover (e.g., surfgrass criteria of > 2/3 cover for > 6 months was used to limit long-term damage) (CRM 2000).
- Degradation of biologically important habitats and/or areas of high biological activity, create a long-term (over 10 years) measurable change in species composition and/or abundance beyond that of normal variability, and/or creation of a long term (over 10 years) measurable change in ecological function within a localized area (USACE 2000b).

The above examples illustrate that biological criteria have varied with respect to duration and/or extent of loss and/or habitat modification considered significant. For example, significance thresholds have been defined as substantial degradation for > 1 year (CRM 2000, Chambers Group 2001c), substantial loss for ≥ 5 years (Chambers Group 1992, USACE 1994a, USACE 2002c), or measurable change in species composition and/or abundance for > 10 years (USACE 2000b). Significance thresholds also have varied in definition based on extent of impact; e.g., beyond the immediate vicinity of the study site (USACE 2002c), > 10 percent of habitat or shoreline (Chambers group 1992, CRM 1997), or substantial (USACE 1994a, CRM 2000, MEC 2000a, Chambers Group 2001c).

An issue of importance with respect to impact is the time period over which the impact occurs. For example, impact determinations based on a period of one year may be sufficient for short-term construction-related effects, but may be insufficient to account for press disturbances associated with sand migration transport. Time scales for beach profile equilibration and alongshore spreading occur over different time scales depending on project length and volume, grain size, and wave environment, but generally range from few to several years (NRC 1995). Recovery rates after dredging and/or beach nourishment may range from < 1 to several years depending on existing conditions (Section 5.2.3.6). Therefore, duration thresholds for sediment management projects should exceed one year to distinguish short- from long-term impacts.

A concern with significance thresholds based on prolonged periods of disturbance (e.g., 5 to 10 years), besides reduction in ecosystem productivity, is potential reduction in habitat resiliency. Available scientific information indicates populations and habitats differ in tolerance and resiliency (e.g., recovery) to environmental variability and impacts (Section 5.2.3.6). For example, kelp beds and reefs may require several years to recover from natural environmental extremes that occur on decadal scales or less (e.g., ENSO, PDO) (Section 3.3.5, 3.3.6). Therefore, significance thresholds based on 5- to 10-year time frames may substantially reduce or eliminate available recovery periods between natural environmental extremes and, as a consequence, may not be sufficiently protective to prevent irreversible habitat loss.

A numerical threshold of ≥10% loss has been used to distinguish impacts greater than what may be attributed to natural variability. A potential concern with a set numeric limit is that natural environmental variability may substantially exceed that level. A BACI (before-after-control-impact) sampling design generally is recommended so that impact can be judged within the context of natural variability (Section 7.2.3). This approach minimizes conclusions based on Type 1 sampling errors (e.g., concluding an impact which did not actually happen (Green 1993, Underwood and Chapman 2003).

In the case of surfgrass, which may naturally experience seasonal sand accretion and erosion, significance thresholds have been defined as > 2/3 cover for > 6 months to limit long-term damage (CRM 2000) or burial that results in loss (MEC 2000a). The criteria based on persistent sedimentation of > 2/3 length of surfgass blades (CRM 2000) is supported by available information that indicates that prolonged partial burial of seagrass blades results in mortality (Fonseca et al. 1988, deWit et al. 1997, Reed and Hollbrook 2003); however, scientific data are lacking to understand what depth of blade burial and for how long leads to irreversible habitat loss of surfgrass. Therefore, use of a numerical threshold for depth of burial is arbitrary until this data gap is filled.
The above examples illustrate that criteria have varied from being vaguely defined (e.g., substantial in area) to more specific with respect to definition of spatial and/or temporal extent of impact. An advantage of defining significance thresholds with greater specificity is the potential to use them as a feedback loop during project design so that projects may be

designed below a level of significance. However, limited scientific data are available to support specific quantitative criteria. Underwood (2000) provides a relevant argument that experimental designs of sampling programs would be greatly improved if decision-makers and managers accepted the challenge to be clearer about what sorts, frequencies, and sizes of impacts they need to detect and manage resources. Development of standardized biological significance criteria for marine habitats in coordination with resource agencies would help address this issue by ensuring greater consistency of impact evaluations in CEQA and/or NEPA documents that could be refined over time based on results of permit required monitoring programs to yield consistent standards for resource protection.

6.1.4 Wildlife Movement

Significance thresholds for wildlife movement generally consider interference and/or introduction of barriers to movement. Sometimes factors that may affect normal activities of wildlife also are considered. Examples of criteria and significance thresholds applied to California sediment management projects include (also see Appendix D.1):

- Interferes (or impedes) substantially with the movement of any resident or migratory fish or wildlife species (Chambers Group 1992, 2000, 2001, 2002; CRM 2000, MEC 2000a, USACE 1994a, 2002c, 2002d).
- Cause the introduction of any factors that could hinder the normal activities of wildlife or cause a deterioration of their habitat (City of Buenaventura 2002).
- Introduction of barriers to movement of any resident or migratory fish or wildlife species and/or introduction of any factors (e.g., light, fencing, noise, human presence, and/or domestic animals) which could hinder the normal activities of wildlife (Chambers Group 2002).

Reported concerns of sediment management projects include interference with grunion spawning, migration of Pacific herring and salmonids, movement of fish between coastal habitats and estuarine nursery habitats, movement of plovers, movement patterns of whales, displacement of sea otters, and/or nesting of sea turtles (NRC 1995, Greene 2002). Available reports indicate that interference with movement, migration, and/or displacement may be associated with physical alteration of habitat (e.g., berms, scarps), barriers (e.g., pipelines), shoaling (e.g., inlet closure), noise, artificial lighting, and/or increased human activities (Sections 3, 4, 5.). Therefore, impact criteria that include specific reference to potential factors that may affect wildlife movement may help ensure that potentially important factors are not overlooked during impact assessment.

6.1.5 Commercial Fishing

Potential impacts to commercial and/or recreational fishing may be an important consideration for some California sediment management projects; e.g., those implemented in the vicinity of commercial aquaculture, oyster, lobster, sea urchin, and/or trap fisheries (e.g., SANDAG and USDN 2000, USACE 2000b). Commercial fishing conflicts also are a concern with offshore sand mining (Cooper 2005, Murray). Examples of criteria and significance thresholds that have been applied to California sediment management projects include:

- Potential for impacts to commercial oyster beds (USACE 1999a, 2001).
- If the project reduced or precluded fishing activity by 10% or more during the peak season, if the project permanently excluded 10% or more of a local fishing area, if any fish/shellfish population of commercial or recreational importance has the potential to be reduced by 10% or more in the local area, and/or if the project resulted in increased losses or damage to traps and nets (MEC 2000a, SANDAG and USDN 2000).
- Create a measurable change in commercial fishing opportunities, such that: (a) 10% or greater loss of, or preclusion from, current productive fishing grounds in the project area for more than 10% of the open or peak season, and/or (b) 10% or more of the fishermen regularly using fishing grounds in the project area are precluded from fishing for 10% or more of the open or peak season (USACE 2000b).

The above criteria include two different approaches to impact assessment. One approach addresses factors that may interfere with fishing activities (e.g., exclusion from fishing areas, preclusion of fishing activity, gear damage and/or loss). The other approach addresses the potential to impact populations of important fisheries species or mariculture areas. Generally, potential impacts to managed species populations are evaluated with the EFH impact assessment.

Generally, insufficient data are available to support impact evaluations with significance thresholds of 10% for fishery populations. Available data for commercial and/or recreational landings are recorded by port of landing and large geographical areas (fish blocks), which may display annual fluctuations in excess of 10% from a complex variety of reasons such as inaccuracies in reporting, El Niño and La Niña events, and export market demand (CDFG 2001). Some of the challenges associated with impact assessments of managed fisheries at a project-specific level may benefit from a process that includes coordination with local fishing organizations and resource agencies to review fishery impact areas of concern, significance thresholds, and measures to minimize interference and resource protection.

6.1.6 Environmental Policies

Generally, CEQA/NEPA documents specify the regulatory background relevant to the existing conditions and impact evaluations for each environmental issue area, including biological resources. The potential for possible conflicts between the proposed action and federal, state, and local plans, policies, and controls for the area of concern is part of the required assessment of environmental consequences of an action under CEQA (Section 15063) and NEPA (Section 1506.2(d)). Compliance issues relevant to biological resources may be found on the CEQA Initial Study Checklist (http://ceres.ca.gov/ceqa/):

- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan.
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

6.2 Overview of Mitigation Measures

Mitigation is the process used to avoid and/or minimize impacts to the environment and may include (40 CFR Section 1508.20):

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures may occur throughout all project phases ranging from pre-construction to post-construction. Pre-construction phase mitigation measures generally focus on project design, buffer distance between impact source and sensitive resources, sediment compatibility, and/or refinement of construction plans to avoid and/or minimize potential impacts. Construction phase mitigation measures may include discharge location controls, buffers, prohibition zones, schedule restrictions (environmental windows), equipment operational controls, best management practices (BMPs), and/or monitoring. Post-construction measures generally include impact verification monitoring and compensatory mitigation, if necessary.

This report section reviews mitigation measures identified in CEQA/NEPA documents and/or permit requirements for several California sediment management projects (Appendix D.2). In addition, recommendations for minimizing impacts to biological resources are identified from the literature review and results of the reviews conducted in previous report sections. The review addresses the following general and specific questions of interest to the CSMW:

- *What mitigation measures have been implemented to avoid adverse impacts to biota during beach nourishment and related sediment management activities? Has the effectiveness of these mitigation measures ever been demonstrated?*
- *What types of prohibition zones have been permit-required surrounding various sensitive bird nesting and nearshore foraging areas? What are the reported bases for these zones? Have the dimensions been based on scientific data, do they relate to potential foraging ranges or nesting territories, do they reflect measured impact ranges, are they based on professional judgment or uncertainty-based conservatism*
- *Do typical bird breeding season limitations reflect the actual time the area is used for breeding and nesting? Can historic lengths of time or areas under limitation be safely revised? What types of information and process are needed to objectively review and establish appropriate sediment management permit conditions associated with breeding season restrictions?*

- *What are the types of methods that have been used to minimize impacts associated with different beach nourishment methods?*

Mitigation measures are reviewed by project phase in which they would be implemented. In addition, mitigation measures are organized into categories based on identified similarities in methods of implementation and/or type of impact the measures address. Monitoring activities that represent mitigation measures to avoid and/or minimize impacts are identified according to project phase in this report section; however, more detailed discussions of monitoring are given in Section 7.

A standardized format is used to review mitigation measures, which includes description of the measure, reference to relevant reports, and consideration of effectiveness. Relevant reports include examples of sediment management projects that recommended and/or implemented the referenced mitigation measure.

No reviews of mitigation effectiveness were identified from the literature review. For those measures that do not involve avoidance of impact; i.e., minimization measures, the general lack of information on effectiveness represents an important data gap that if filled could help streamline environmental review and permitting.

The approach taken in this document is to consider potential effectiveness of mitigation measures based on review the rationale and technical basis of the measure with respect to potential spatial and/or temporal scales of impact, biological response, and/or environmental factors. For example, the effectiveness of prohibition zones (buffers) relates to spatial factors such as noise attenuation, suspended sediment plumes and deposition rates, sediment transport rates, and differences in tolerance levels of sensitive resources. Most buffers, including those used for breeding birds, generally are determined during the pre-construction phase of project planning, and are reviewed in detail in Section 6.3.5. Some buffers are applied during construction and are reviewed along with other location controls in Section 6.4.1.

Seasonal limitations (environmental windows), including those that apply to birds, are based on the rationale that avoidance of the breeding season is the most effective means for protecting sensitive species populations. Schedule and/or seasonal restriction mitigation measures are applied during construction. Those that have been applied to California sediment management projects are reviewed in detail in Section 6.4.2.

Mitigation measures are reviewed in Sections 6.3 through 6.5 according to project phase. Summaries of mitigation measures are given in Section 6.6 according to type of sediment management activity and beach nourishment placement location, habitats, species, and ecological functions the measures address. For projects with sensitive resource constraints and/or potential fisheries management concerns, the process used to identify mitigation measures is one of the most important activities that can be conducted with respect to streamlining environmental review and permitting. A recommended coordination process and mitigation considerations specifically for essential fish habitat and sensitive species are presented in Section 6.6. The specific questions of the CSMW regarding buffers, seasonal restrictions, and mitigation measures associated with different placement methods also are addressed in Section 6.6.

6.3 Pre-Construction Phase Mitigation Measures

Several activities and/or measures may be taken during the pre-construction phase to avoid direct and minimize indirect impacts to biological resources during project implementation (Table 6.3-1). Measures may address sediment compatibility issues, optimizing project design and implementation strategies, environmental coordination, and monitoring surveys to support final design and permit requirements. Each of these topics is addressed in the following subsections. Types of monitoring that may be required during pre-construction are identified in this section; description and review of pre-construction monitoring are presented in Section 7.3

6.3.1 Sediment Compatibility and Quality

Sediment testing is required prior to any sediment management activity involving dredging and/or discharge of materials into marine and estuarine waters. Sediment testing of the physical and chemical properties of the substrate provides the initial step (or screen) for determining suitability of material for beach nourishment and/or identification of other alternative disposal options.

Potential source sediments for beach nourishment must be free of substantial contamination and of suitable grain size characteristics as part of the permitting process (Section 5.2.3.2). Sediment compatibility criteria for California beach nourishment projects have been defined with respect to percent content of fine sediments (silt/clays), percent content of coarse particles, particle shape, color, and compaction.

Mitigation measures address minimizing the differences of source sediments from those of the receiver site. In the case of beach nourishment, the compatibility criteria apply throughout the entire sand placement profile since erosion will expose different layers of the fill over time. For dredging, the issue is retaining compatibility of the surface substrate characteristics with that of surrounding sediment. These compatibility considerations generally apply unless the sediment management project represents an enhancement or restoration effort.

Relevant Reports:

- RPG 67 (USACE 2006) specifies beach nourishment material must be at least 80% sand and have less than 10% sand difference from the receiving beach. Permit requirements also specify preparation of an Aesthetic Qualities Report that includes a qualitative comparison of proposed discharge material with the qualities of the receiving beach.
- Sediment compatibility requirements for several opportunistic sand programs specify that source sands must match color of existing beach after natural color change, should not include particles larger than cobble sized and not constitute greater than 10% of beach fill volume, particle shape must not be substantially angular or jagged shaped and not constitute greater than 10% of beach fill volume, and must not form a hardpan crust after repeated wetting (Moffatt & Nichol 2000a, 2000b, 2005a, 2006a).

- The SCOUP project defines optimum sands as having a fines fraction within 10% of that of the existing dry beach sediments (Moffatt & Nichol 2006a). Less than optimum sands are defined as being within 10% of that of the existing nearshore sediments that exist along a beach profile.

Table 6.3-1. Types of pre-construction phase mitigation measures to avoid and minimize impacts during sediment management projects.

Pre-Construction Mitigation Measures	Equipment	Burial	Sedimen -tation	Turbidity /Water Quality
Maintain Sediment Compatibility and Quality				
Minimize difference in sediment characteristics unless enhancement is conducted		X	X	X
Minimize change in surface substrate unless enhancement is conducted		X	X	X
Environmental Design				
Avoid direct impacts to sensitive habitats	X	X	X	X
Match project volume to environmental constraints	X	X	X	X
Maintain hydrodynamics unless enhancement is conducted			X	X
Avoid steep scarps and slopes			X	
Environmental Implementation Strategy				
Avoid repetitive disturbance in same year[1]	X	X		
Use multiple small sites instead of one large site[1]		X	X	
Incorporate refuge areas[1]	X	X		
Reduce Maintenance Frequency Over Time				
Incorporate dune restoration[1]			X	
Use sedimentation basins and source control	X		X	
Habitat Buffers				
Buffer to minimize turbidity impacts	X	X	X	X
Buffer to minimize sedimentation impacts				
Sensitive Species Buffers				
Buffer to protect fishery spawning grounds	X	X	X	X
Buffer to minimize impacts to sensitive birds	X			X
Buffer to minimize impacts to marine mammals	X			
Environmental Coordination and Notifications				
Prepare hazardous materials management plan	X			X
Prepare inlet monitoring and response plan			X	
Conduct U.S. Coast Guard notification to minimize hazards and interference with other uses	X			
Conduct environmental training program	X	X	X	X
Mitigation and Monitoring Program				
Finalize mitigation and monitoring plan	X	X	X	X
Pre-construction surveys and monitoring	X	X	X	X

Note[1]: Measures to promote recovery rates and/or to minimize frequency of sediment management activity are listed under equipment if associated with dredging or burial if associated with beach nourishment.

The following two mitigation measures address compatibility issues and considerations of effectiveness with respect to minimizing impacts to biological resources. Construction monitoring to ensure compatibility of sediments with permit requirements and to ensure no substantial adverse characteristics over time are addressed in Sections 6.4.5.1 and 6.5.1.1.

6.3.1.1 Minimize Difference in Sediment Characteristics Unless Enhancement is Conducted

This measure addresses minimizing differences in sediment grain size characteristics between source and receiver sites unless change represents an enhancement of beach habitat quality.

Consideration of Effectiveness:

Matching sediment characteristics between source and existing sediments is considered an effective precautionary measure for minimizing impacts to biological resources. A substantial body of literature describes the interrelationship between beach morphology, slope, and grain size (Hesp and Short 1982, McLachlan 1983, Wright and Short 1984). These interacting environmental influences, and in particular grain size have been related to invertebrate community structure and habitat quality (Straughan 1982, McLachlan 1990, Dexter 1992, Thompson et al. 1993, McLachlan 1996, Brown and McLachlan 2002, Defeo and McLachlan 2005). Alteration of benthic community structure may result when sediment grain size distribution becomes substantially coarser (McLachlan 1996) or finer (Rakocinski et al. 1996, 2001).

Several references emphasize the importance of sediment compatibility of source sands for beach nourishment to facilitate benthic recovery and minimize impacts to biological resources (e.g., Parr et al. 1978, Gorzelany and Nelson 1987, VanDolah et al. 1994, NRC 1995, Peterson et al. 2000a,b, Burlas et al. 2001, Greene 2002, Boyd et al. 2004, Versar 2004, Speybroeck et al. 2006). Use of compatible sediments also has been reported as being necessary for providing suitable nesting substrate for endangered piping plovers (Melvin et al. 1991, Melvin 2005) and sea turtles (Crain et al. 1995, Steinitz et al. 1998). Peterson (2000b) stated that to minimize habitat degradation associated with beach nourishment, sand grain size should not be smaller than natural beach, shell content should be low, mud ball content should be low, and toxic chemicals should be absent.

Burrowing capabilities of several bivalves and crustaceans inhabiting sandy beaches are related to grain size characteristics (Dugan et al. 2000b, Nel et al. 2001, de la Huz et al. 2002, Yannicelli 2002). Species also show preferences for sediment grain size that is reflected in their distribution patterns (Dugan and Hubbard 1996, Dugan et al. 200b, Speybroeck et al. 2006). Therefore, substantial changes in substrate conditions have the potential to alter habitat suitability for resident fauna.

Turbidity plumes relate to silt/clay content of dredged and/or placed sediments. Therefore, sediment characteristics will influence temporal and spatial effects of turbidity during construction and sedimentation during and after construction.

Sediment management activities may include enhancement and/or restoration actions that address rehabilitation of sediments to reduce contaminant loadings and/or removal of excess sedimentation that contributes to habitat degradation. In those cases, post-project substrate characteristics may represent a beneficial change from existing conditions.

In erosional "hot spots" substrate characteristics may vary from cobble to sand or bedrock to sand across seasons. The sand scoured rocky substrate may support few biological resources (e.g., MEC 2000a). Beach nourishment that changes scoured rocky substrate with little to no biological resource use to persistent sandy beach habitat represents a beneficial change in substrate characteristics (e.g., SAIC 2006).

Critical impact thresholds with respect to substrate compatibility have not been established. A precautionary mitigation measure that minimizes change of sediment characteristics from existing conditions, unless the change represents enhancement, is considered prudent based on ecological considerations and the substantial body of literature recommending this measure.

6.3.1.2 Minimize Change in Surface Substrate Characteristics of Beach and/or Dredge Areas Unless Enhancement is Conducted

This measure addresses minimizing changes to the substrate surface after beach nourishment or dredging to facilitate recovery and/or foraging by resident fauna.

C*onsideration of Effectiveness:*

Beach nourishment materials consisting of sand or a combination of sand, gravel, or shells is considered acceptable as nesting substrate for sensitive bird species such as piping plovers (Melvin et al. 1991). A change of substrate characteristics from cobble to sand can improve primary habitat for invertebrates, foraging habitat for shorebirds, and spawning habitat suitability for California grunion (SAIC 2006).

Surface beach substrate characteristics may influence shorebird distribution and foraging capabilities (Quammen 1982). Sediment too coarse or high in shell content can inhibit a bird's ability to extract food from the substrate (Baird 1993, Greene 2002, Peterson et al. 2002). If the fill material contains a high proportion of shells, a solid floor of shells may form through a process termed cementation, in which chemical precipitates (in the form of new crystals) form in the pores of a sediment or rock, binding the grains together (Speybroeck et al. 2006).

Color, density, and grain size shape may influence heat retention capacity of sands (USACE 1989), although the ecological consequences of such changes are unknown (Speybroek et al. 2006). Sediment color, compaction, density, shear resistance, moisture content, and gas exchange influence the environmental suitability of beach sands as nesting habitat for turtles (NRC 1995).

Beach sand grains generally are rounded and smooth as a result of sand transport movement. Ecological consequences of introducing sediment with angular grains are unknown. Impact concerns could include interference with burrowing capabilities of benthic invertebrates, decrease in habitat suitability for grunion spawning, increase in scour effects on vegetated habitats, and/or interference with foraging of secondary consumers (fish, birds). Although coastal processes would round the grains over time, potential adverse impacts could last for several years until the beach fill was fully reworked.

A similarity of surface substrate characteristics after dredging is considered an important factor with respect to benthic community recovery rates (Hurme and Pullen 1988, Kenny and Rees 1996, Newell et al. 1998, Boyd et al. 2004).

6.3.2 Environmental Design

This measure involves incorporation of protective measures in the design of the project to avoid and/or minimize impacts to sensitive biological resources. Modeling and/or other analytical methods may be used to optimize design based on predicted performance and/or environmental considerations.

Generally, optimizing project design to minimize environmental impacts is considered to be the most effective measure from the perspective of environmental review, permitting, and resource protection. Because of limited understanding of critical impact thresholds, the success of this measure has the potential to improve with appropriate monitoring feedback loops and application of lessons learned to future project designs.

6.3.2.1 <u>Avoid Direct Impacts to Sensitive Habitats</u>

This measure considers existing conditions to select receiver and/or borrow site locations to avoid direct impacts to sensitive habitats such as:

- Coastal strand.
- Productive intermediate to dissipative beach types.
- Perennial rocky intertidal and subtidal reefs.
- SAV habitats.
- Critical habitat of sensitive species unless enhancement.
- Substantial spawning grounds of fishery species.

Relevant Reports:

- The 2001 San Diego Regional Beach Sand Project avoided direct placement on perennial rocky intertidal, surfgrass areas, and at locations with sensitive inshore reefs directly offshore SANDAG and USDN 2000, MEC 2000a).
- The 2003 Goleta Beach Nourishment Demonstration Project avoided direct placement on rocky intertidal and surfgrass areas (Moffatt & Nichol 2003).
- The impact of beach nourishment will be less on beaches dominated by organisms recruited from pelagic larvae than ones where organisms also include species whose entire life history is within the beach system (Reilly and Bellis 1983).

Consideration of Effectiveness:

Avoidance of sensitive resource areas is the most protective of mitigation measures.

Project areas with critical habitat for snowy plovers in the vicinity should be carefully evaluated with respect to beach erosion concerns. Sandy beach provides important foraging, resting, and/or nesting habitat for snowy plovers. However, these functions have the potential to be diminished for wintering populations under erosive beach conditions. Beach nourishment may enhance habitat functions for snowy plover by increasing sand persistence and width. However, disturbance of plovers may occur from the activity. Determination of whether beach nourishment in critical habitat should be avoided or implemented outside the breeding season should be determined on a project-specific basis in consultation with USFWS and (see Section 6).

Beach type is a relevant consideration for harbor maintenance dredging projects that include beach placement as a beneficial use alternative for suitable sediments. It also is a consideration for beach nourishment projects. Seasonally and/or persistent erosive beaches appear to support fewer biological resources than beaches with persistent sand (Section 3.3.2). In contrast, dissipative and productive intermediate beaches with persistent sand depth across seasons support the highest diversity of biological resources (Section 4.2.6). Impacts may be less when sand is placed on erosive and/or urbanized beaches than on less disturbed, dissipative, or productive intermediate beaches. Selection of erosive and/or disturbed beaches as beach nourishment receiver sites is environmentally preferred to minimize impacts to California sandy beach resources. However, human use patterns also should be considered. High levels of human disturbance may degrade habitat function on urbanized beaches. Therefore, potential benefits to biological resources from beach nourishment may be minimal at urbanized beaches.

6.3.2.2 Match Project Size to Environmental Constraints

This measure involves selection of appropriate project size to meet shoreline protection needs in balance with environmental impacts. In this context, an appropriate-sized project is one that provides shoreline protection benefits without loss or substantial degradation of native habitats.

Relevant Reports:

- The 2001 San Diego Regional Beach Sand Project included modeling and existing condition surveys to refine project design with respect to beach receiver site project lengths, volumes, and schedules to avoid and/or minimize impacts to sensitive reefs, SAV, California grunion, and California least tern. The project was modified from 3 million to 2 million cy and receiver site footprints were modified to minimize potential impacts to reefs based on modeling results. Pre-construction habitat suitability and nesting surveys were conducted to refine project schedules (MEC 2000a, Moffatt & Nichol 2000, SANDAG and USDN 2000).
- The BEACON South Central Coast Beach Enhancement Program included use of an analytical model to predict the depth of sand cover over the beach profile offshore the fill and comparing that to locations of sensitive biological resources to “back into” the sand quantity that would not cause biological impacts as determined by the project biologist (Moffatt & Nichol 2005a).
- The SCOUP project design for the cities of Encinitas, Solana Beach, Coronado, and Imperial Beach, California include volume, placement, and schedule

restrictions to avoid and/or minimize impacts to biological resources (Moffatt & Nichol 2006b).

- The National Institute of Coastal and Marine Management of the Netherlands (2004) recommends the following key management principle for coastal erosion management: When taking measures, try to work with natural processes or leave natural processes as undisturbed as possible.

Consideration of Effectiveness:

Burial and/or sedimentation may result in habitat loss and/or degradation of sensitive hard bottom and/or SAV habitats, if present, depending on depth of cover and duration of effect. Therefore, project size (volume) is an important consideration with respect to potential for and/or extent of impact. However, whether the volume results in impact will depend on site-specific factors such as reef heights, local physical conditions, coastal processes and rates, and wave characteristics.

Models have been developed to predict sand persistence and transport after beach nourishment (e.g., GENESIS). However, predicting sand increase along beach profiles when there are nearshore reefs is a deficiency of existing models, which do not include valid assumptions for shorefaces with different geologic characteristics than sand (Pilkey et al. 1993, 1994). Pilkey (1994) recommends an iterative, empirical approach that includes monitoring as a feedback loop to improve project design over time.

One strategy is to avoid sand placement in areas with reefs offshore. This rationale is supported by studies that have reported burial of hard bottom reefs resulting from implementation of several beach nourishment projects in Florida (Navqi and Pullen 1982, Lindeman and Synder 1998, Goreau 2001, Coastal Planning & Engineering 2004a, b). Other studies indicate that beach nourishment may be accomplished without significant impacts to nearshore reefs and/or SAV when project size is kept relatively small to avoid overtopping and/or substantial sedimentation of reefs (SANDAG and USDN 2000, MEC 2000a, Moffatt & Nichol 2000c).

Based on the above considerations, a precautionary approach is warranted for beach nourishment projects in areas where sensitive habitats are within the area of potential effect. Because of gaps in knowledge with respect to significance thresholds, the success of this measure has the potential to improve with appropriate monitoring feedback loops and application of lessons learned to future project designs.

6.3.2.3 Maintain Hydrodynamics Unless Enhancement is Conducted

This measure addresses maintaining hydrodynamics during sediment management projects to extent practicable.

Relevant Reports:

- Reduced water quality (anoxia) associated with changed hydrodynamics and deposition of fine particulates and organics has been reported for deep, offshore borrow pits (NRC 1995, Newell et al. 1998, Brynes et al. 2004b).

- Restoration dredging to increase tidal flushing and improve water quality and habitat for marine and estuarine resources has been permitted at several lagoons in California (e.g., Batiquitos, Bolsa Chica, San Dieguito).

Consideration of Effectiveness:

Measures have been recommended to reduce changed hydrodynamics during offshore sand mining, such as:

- Conduct shallow dredging over a larger area rather than creation of deep pits covering a limited area.
- Use modeling and pre-borrow assessments to avoid areas where fine sediment may be trapped in the borrow site.
- Limit overdredge depths to two feet to minimize changed hydrodynamics.

Newell et al. (1998) reviewed that infill rates of sand extraction areas depend on currents and sediment mobility. Deep pits may be slow to fill (> 5 years). Shallow dredge furrows may infill over tidal cycles in areas with high sand mobility, but commonly take 1 to 4 years under a variety of environmental conditions.

Development of anoxic conditions and sedimentation of fines and particulates in deep pits may occur (NRC 1995, Newell et al. 1998). However, Hitchcock and Bell (2002) noted little evidence of this with deployment of an underwater camera in aggregate extraction pits based on little visual difference in turbidity. Fisheries concerns with deep pits include risks of snagging towed gear within the depression, and general unsuitability for beam trawling.

Removal of as little as 1.6 ft (0.5 m) of the sediment surface will eliminate the benthos (Newell et al. 1998); therefore, the primary consideration with offshore borrow site dredging is recovery rates. Generally, less change to hydrodynamics and substrate conditions are expected with shallow rather than deeper dredged depths. Less change to hydrodynamics and substrate conditions favors more rapid invertebrate recovery (Section 5.3.2.2).

Maintenance of tidal flushing is essential to healthy embayments and support of nursery functions for marine fishery species. Maintenance of good water quality also is critical to health of nearshore spawning grounds and ecosystem. Use of dredging methods that maintain and/or enhance water quality is ecologically sound management.

6.3.2.4 Avoid Steep Scarps and Slopes

This measure addresses minimizing impacts to habitat suitability and/or use patterns by sensitive resources.

Relevant Reports:

- Changes in beach profile (linked to grain-size distribution of nourishment sands) can lead to changes in the hydrodynamics of the intertidal zone; an increase in slope resulting in an increase in wave energy, leads to a more stressful environment and less diverse and abundant fauna (Speybroeck et al. 2006 based on consideration of Kaufman and Pilkey 1983 and McLachlan 1983).

- Low beach slope (10:1, horizontal: vertical) is a recommended design criteria for beach nourishment in areas with endangered piping plovers (Melvin 2005).
- NMFS (2002) recommended that discharge of dredged material on erosive river shorelines be contoured so that beach slopes have a minimum steepness of 10 to 15% to prevent stranding of salmonids (NMFS 2002).

Consideration of Effectiveness:

Beach nourishment sand placement on the beach results in a steeper slope until the beach equilibrates and reaches a more stable profile (NRC 1995). This may result in a shorebreak at the beach rather than a nearshore bar (Moffatt and Nichol 2006a). Speybroeck et al. (2006) state that significant changes of beach profile can give rise to a changed morphodynamic beach state, causing a slow recovery and maybe a permanent shift in ecological community structure.

Beach slope is an important factor associated with benthic resource development, habitat suitability for grunion spawning, and habitat suitability for sensitive plovers. Benthic invertebrate development is greater on gentle than steep slope sandy beaches (Short and Hesp 1982, McArdle and McLachlan 1992, Defeo and McLachlan 2005). This is an important consideration with respect to forage prey for shorebirds, including sensitive plovers. Melvin (2005) reviewed that design criteria for beach nourishment should include 10:1 beach slopes for endangered piping plover; however, it was noted that a 6:1 slope was okay for chick access to feeding habitat.

Beach slope also is an important consideration for fish spawning. Grunion eggs are deposited high in the intertidal for better drainage and oxygen availability (Martin and Swiderski 2001). Therefore, beach slope may be influential factor to habitat suitability for grunion. No definitive information on beach slope relationships with grunion habitat suitability was identified from the literature survey. Straughan (1982) noted grunion occurrence on beaches was associated with gentler slopes. Martin (2007 personal communication) noted that grunion do not use steep beaches for spawning. This is understandable based on consideration of the swash zone, which is narrow at beaches with steep slopes and wide at beaches of low slope (McArdle and McLachlan 1992).

As-built beach slopes for the 2001 San Diego Regional Beach Sand project ranged between 10:1 and 20:1 (horizontal:vertical) (SANDAG and USDN 2000). Grunion eggs were observed during monitoring surveys two to four years later on the Moonlight Beach receiver site (SAIC 2006), which was built with a 20:1 slope (SANDAG and USDN 2000).

NMFS (2002) recommended a minimum steepness of 10 to 15% to prevent stranding of salmonids associated with slope repair in erosion areas along the Columbia River.

Because as-built beach slopes of beach nourishment projects will change as a beach equilibrates under natural erosion and accretion processes (NRC 1995), consideration of beach slope during the construction phase is mainly relevant to the first year after sand placement. Based on the above considerations, beach slopes of 10:1 or greater may minimize short-term impacts to biological resource habitat suitability than steeper as-built slopes.

6.3.3 Environmental Implementation Strategies

6.3.3.1 Avoid Repetitive Disturbance in Same Year

This measure involves minimizing disturbance at a beach nourishment location from multiple project activities that may be conducted in the same year to minimize recovery rates and impacts to sandy beach resources.

Relevant Reports:

- Small, opportunistic sand placement projects in San Diego County that are conducted between March 1 and May 31 are required to not exceed 25,000 cy per month, be scheduled no less than two weeks apart, spaced at least 150 ft (46 m) apart, and not involve disturbance of previous placement locations to minimize impacts to invertebrate recruitment; placement is restricted during summer (Moffatt and Nichol 2006b).

Consideration of Effectiveness:

Sandy beach invertebrates have a seasonal recruitment and peak productivity period (spring-summer) and seasonal low (fall-winter) (Section 4.2.6). Studies have shown that recovery rates are faster when beach nourishment is concluded prior to the peak recruitment period, but may result in slower recovery during the first year after placement if beach nourishment activities occur in spring and/or summer and/or multiple sand placement events occur (Reilly and Bellis 1983, Versar 2004). Placement during spring and/or summer does not appear to affect long-term recovery. Diverse benthic invertebrate populations were observed two years after beach nourishment at three sites in the City of Encinitas that had received sand at different times between the months of June and August during the 2001 San Diego Regional Beach Sand Project (SAIC 2006).

The mitigation measure, which allows unrestricted placement during fall-winter, restricts sand volume and avoids repetitive placement disturbance during spring, and restricts placement during summer. This measure was developed by the primary author for the SCOUP program to minimize impacts to invertebrate recruitment and forage base development on an annual basis for opportunistic sand programs that may involve more than one placement in a year.

6.3.3.2 Multiple Small Rather than One Large Receiver Site

This measure involves a regional strategy of use of several smaller projects rather than a single large beach nourishment project to minimize impacts to biological resources.

Relevant Reports:

- A succession of small projects (0.5 mi, 0.8 km or less) carried out in non-sequential order should have less long-term impact than a single grand-scale nourishment project (Reilly and Bellis 1983).

- Choose a number of smaller projects (< 2,624 ft, < 800 m) rather than a single large nourishment project (Speybroeck et al. 2006).
- The 2001 San Diego Regional Beach Sand Project included placement of 2 million cy at 13 beach sites. The nourishment strategy included use of sites as feeder beaches to provide shoreline protection benefits at the receiver sites and downcurrent locations (SANDAG and USDN 2000). The sites ranged in size from 0.1 to 0.8 mi (0.16 to 1.3 km). Nearshore reefs and kelp beds were located in the vicinity of several of the smaller sites.

Consideration of Effectiveness:

Limiting the size of individual receiver sites appeared to be an effective strategy to minimize impacts to nearby sensitive resources during The 2001 San Diego Regional Beach Sand Project, which placed approximately 2 million cy of sand on 13 receiver sites ranging in size from 101,000 to 421,000 cy (SANDAG and USDN). A five-year pre- and post-construction monitoring program reported no significant adverse impacts to rocky intertidal, nearshore reefs, and kelp beds (AMEC 2005). Controlling the sand placement volume was the approach taken for minimizing the potential for sedimentation. The sand placement volumes in areas of hard bottom ranged from 101,000 to 132,000 cy, representing approximately a quarter of the volume placed at beaches with sand habitat offshore. Those sand volumes were based on site-specific considerations and should not be considered as prescriptive.

Use of smaller sites also may be a relevant consideration for minimizing impacts to nearshore biota. Siltation in the nearshore occurs during and after beach nourishment as a result of sediment reworking and deposition of fines outside the turbulent breaker zone. This will occur over a relatively shorter-time frame when sands are hydraulically pumped onto the beach than if placed near the backshore. The amount of silt deposition is a function of sand volume and percent fine content of the source materials, and persistence is a function of hydrodynamics. Parr et al. (1978) reported short-term silt-loading in the nearshore after hydraulic placement of approximately 1 million cy at Imperial Beach, California; siltation was not obvious after the first storm season. Parr et al. (1978) reported that there was short-term enhancement (mainly to crustaceans) from the siltation. In contrast, Rakocinski et al. (1996, 2001) found persistent silt-loading in the nearshore after hydraulic placement of > 5 million cy on the beach at Perdido Key, Florida. Substantial alteration of the benthic community was associated with the silt-loading with that project.

Use of smaller sites has been recommended to minimize impacts to secondary consumers such as fish and shorebirds (Reilly and Bellis 1983, Speybroeck et al. 2006). However, review of invertebrate recovery rates over a wide range of project sizes indicates that project timing and substrate characteristics are more influential to beach nourishment recovery rates than project size per se (Section 4.2.6). This primarily relates to seasonal recruitment patterns of invertebrates. However, if nourishment activities are prolonged and/or substantially extend through the seasonal recruitment period, recovery may be delayed (Section 4.2.6).

Based on the above considerations, it appears that use of multiple, smaller sites may be an effective strategy for minimizing impacts at any particular location. This may be particularly important in areas with nearby sensitive resources to minimize effects of indirect impacts due to sand transport and turbidity associated sedimentation. This nourishment strategy also may be relevant for minimizing impacts in areas where hydrodynamics are less energetic and persistent, silt-loading may be an issue. In addition, this measure may be effective for minimizing area of disturbance to secondary consumers if project implementation would extend into the spring-summer productive season.

Because large projects require a longer time period to construct, the use of multiple, smaller sites may represent a strategy for minimizing duration of disturbance to recruitment. However, that would depend on project-specific schedule considerations. If a large project was completed during the fall-winter period when invertebrate recruitment is absent to minimal, then project size may make little difference in areas with few environmental constraints

6.3.3.3 Incorporate Refuge Areas to Minimize Recovery Rates

This measure includes retaining refuge patches within borrow site area to minimize benthic community recovery rates.

Relevant Reports:

- To minimize impacts and promote recolonization of mined areas, the total removal of substrate should be avoided and small areas within the project area should be left to serve as refuge patches that would promote recolonization and serve as habitat for mobile species (Diaz et al. 2004).
- Burlas et al. (2001) reported relatively rapid recolonization of the benthic community (within 2.5 years) after borrow site dredging that involved dredging of bathymetric peaks rather the depressions. It was suggested that strong currents and sand movement quickly infilled the dredged areas with similar sediment.
- Greene (2002) reviewed that relatively shallow, dredging (approximately 3 ft) by hopper dredge over larger areas that result in a series of ridges (undredged areas) and furrows (dredge areas) rather than deep dredging of smaller areas is advocated in South Carolina, whenever feasible. Studies showed that the dredge depressions had infill rates of 21 to 34% per year and the ridges were hypothesized as providing a immediate source of sediment and recolonizing fauna after dredging (Jutte et al. 1999a, 2001 cited in Greene 2002, Jutte et al. 2002).
- Slower recovery rates have been reported for deep pits created by anchored hopper dredges compared to relatively shallow furrows produced by trailer suction hopper dredges (Newell et al. 2004).

Consideration of Effectiveness:

Benthic community recovery, when complete, assumes that the community will be similar to that prior to disturbance. Invertebrates recover by two primary mechanisms: larval recruitment and immigration (Newell et al. 1998). Consequently, leaving undredged ridges between dredged furrows may be effective in facilitating recolonization after disturbance.

An important consideration with offshore borrow site dredging is intensity of disturbance. Boyd et al. (2004) reviewed that commercial marine aggregate extraction using trailer dredging leads to creation of furrows with undisturbed deposits in-between, with an increased proportion of undisturbed deposits at sites dredged at lower intensities than at high intensities. In a local context, controlling the level of dredging intensity and allowing undredged deposits to act as refugia was considered a potentially effective mitigation measure for enhancing the rehabilitation of commercially dredged areas. From a management context, however, it was pointed out that controlling the level of dredging intensity has the potential to increase the size of the area dredged and further information is needed to establish boundaries of dredging intensity to ensure maximum management value.

Limited information is available to support science-based decisions with respect to management of offshore borrow sites. Further work is required to understand overall ecosystem impacts (e.g., fish/shellfish populations, associated fisheries) associated with dredging larger areas, but to shallower depths versus dredging smaller areas, but to deeper depths.

6.3.4 Reduce Maintenance Frequency Over Time

6.3.4.1 <u>Incorporate Dune Restoration</u>

This measure involves incorporating dune restoration and/or rehabilitation into beach nourishment projects to decrease the frequency of renourishment and to enhance ecological functions of the beach-dune system.

Relevant Reports:

- The dune placement technique of beach nourishment with stabilization involving vegetation, sand fencing, and/or thatching has been used to provide natural shoreline protection in several areas along the east and Gulf Coasts of the United States and internationally (Section 3.3.1).

Consideration of Effectiveness:

Coastal dunes store sediments and may provide shoreline protection benefits from substantial storm wave runup (Section 3.3.1, coastal change hazard figure). In other geographic areas, dune restoration has been successfully combined with beach nourishment to provide a more natural shoreline to combat erosion.

Coastal dunes have been degraded and/or eliminated along most of southern California's coastline and habitat quality of many of the dunes in central and northern California have been degraded by non-native species that may provide less optimum shoreline protection (Section 3.3.1). The feasibility of incorporating dune restoration with beach nourishment projects in California likely will vary depending on site-specific constraints. Some beaches are backed by seacliffs and some end at urban development such as Pacific Coast Highway (101) and/or commercial/residential development. However, sufficient backshore may be present to support dune restoration in some areas. In addition, it may be possible to increase the shoreline stabilization function and habitat quality of existing dunes by removal of exotic, invasive species and revegetation with native species. Dune revegetation generally requires a gradual program of replacement to minimize the likelihood of blowouts (CNPS 1996). Dune restoration and/or revegetation should take into consideration potential use of the beach by threatened snowy plovers, which prefer sparse vegetation. Based on lessons learned on the East Coast of the United States, Melvin (1991) reported that beach nourishment projects are more attractive to endangered piping plovers if it is not subsequently planted with beach grass or crisscrossed with snow fencing.

6.3.4.2 Use Sedimentation Basins and Source Control

This measure involves dredge design and watershed source control activities to minimize dredge maintenance frequency and adverse impacts associated with sedimentation in coastal embayments.

Relevant Reports:

- Ecosystem restoration of Upper Newport Bay, California incorporated sediment basins to trap erosion runoff from the watershed (USACE and County of Orange 2000).
- Lagoon-wide dredging of Agua Hedionda Lagoon, California incorporated a sediment basin to trap erosion runoff from the watershed (MEC 1997b).
- Addressing source control by identifying excess watershed sedimentation inputs and implementing management techniques to reduce excessive maintenance frequency is recommended as a measure to reduce cumulative impacts by the NMFS (Hanson et al. 2003).

Consideration of Effectiveness:

Incorporation of features in project design to reduce the frequency of maintenance dredging is desirable from ecological as well as economic perspectives. Studies have shown that invertebrate community structure and habitat quality relates to frequency of disturbance. Simple benthic communities dominated by opportunistic species characterize maintenance channels that are frequently dredged (McCauley et al. 1977, Newell et al. 1998). Benthic habitats also may be degraded by frequent sedimentation associated with depositional areas (MEC 1995c). Therefore, use of design features and/or source control BMPs to reduce sedimentation effects may be effective for minimizing impacts to biological resources associated with maintenance dredging in coastal embayments.

6.3.5 Habitat Buffers

Several sediment management projects have been implemented in California with protective buffers, barriers, and/or prohibition zones in areas with sensitive biological resources. Buffer distances from sensitive habitat typically are determined based on consideration of indirect impacts such as turbidity (Section 6.3.5.1) and sedimentation (6.3.5.2). For sensitive species, the primary considerations are noise and/or turbidity. Buffer considerations for sensitive species are reviewed in Section 6.3.6.

6.3.5.1 Buffer to Minimize Turbidity Impacts to Sensitive Habitats

Relevant reports and effectiveness considerations are reviewed separately below for beach nourishment, offshore borrow site dredging, and embayment dredging.

Relevant Reports:

Beach Nourishment

- Turbidity plumes during 7 California beach nourishment projects at Goleta Beach, Surfside-Sunset Beach, Dana Point, and Agua Hedionda Lagoon indicate plumes may range 1,500 ft upcurrent and > 1.9 mi (3.1 km) downcurrent under strong currents, but generally are less than 1,000 ft (< 300 m) (Section 5.5.3.6). Use of dikes or swales may limit plume lengths to ≤ 300 ft (≤ 100 m) under average wave conditions without rip currents.
- Review of TSS monitoring data from 2 California beach nourishment projects indicate TSS concentrations may be substantially elevated in the surf zone directly offshore the discharge location (e.g., mean values > 400 to >1,000 mg/L) during unconfined discharge. One study measured moderate TSS (> 200 mg/L) up to 1 mi (1.6 km) downcurrent and lower, but detectable elevations of TSS (96 to 127 mg/L at distances 1.9 mi (3.1 km) downcurrent (Sherman et al. 1998). Background concentrations during non-storm conditions ranged from 17 to 26 mg/L. TSS values of 24 to 66 mg/L were measured off the discharge location outside the breaker zone during a separate beach nourishment program, confirming that plumes do not always extend beyond t he breaker zone.
- Turbidity monitoring during 7 California beach nourishment projects confirm visual observations that plumes do not always extend beyond the surf zone. For example, values outside the breaker zone offshore the discharge location sometimes were similar to background values (e.g., 1 to 16 NTU). Other times values offshore the discharge location were 2 to 7 times higher (e.g., > 20 to 225 NTU) than outside the plume (< 10 to 110 NTU). Values outside the plume indicate monitoring covered average (≤ 16 NTU) through high wave and/or storm conditions (> 20 to 110 NTU). Too few sampling locations were sampled with the reviewed projects to determine the primary, longshore extent of the plume.
- Similar findings were reported during monitoring of beach nourishment projects on East Coast. Reilly and Bellis (1983) reported TSS concentrations in the surf zone off the discharge location of 1,760 to 4,700 mg/L during unconfined discharge.
- Turbidity plumes during the several million cy Asbury Park to Manasquan Inlet Beach Nourishment Project, New Jersey were primarily within the surf zone (Wilber et al. 2006). TSS values near the bottom in the surf zone (64 mg/L) and in the nearshore (34 mg/L) were 1.7 to 3 times higher than background concentrations (20 mg/L) (Wilber et al. 2006). Plumes generally were on the order of 1,312 ft (400 m) long. Background values of 81 to 425 mg/L were measured near the bottom during storms.

- Review of available reports suggest TSS values under high wave and substantial storm events may range from 400 to 2,900 mg/L near the bottom (< 1 ft, < 0.3 and 100 to 500 mg/L at elevations between 1 and 2 ft (0.3 and 0,6 m) off the bottom (Beach and Sternberg 1992, Ogston and Sternberg 1995, Wilber et al. 2006). Instantaneous (< 1 minute) maximum concentrations of > 10,000 to 40,000 mg/L may be measured at the bottom during high wave conditions (Beach and Sternberg 1988) or during large, river floods (Ogston et al. 2000, Warrick and Milliman 2005).

Consideration of Effectiveness:

Review of available turbidity monitoring data indicates that suspended sediment concentrations may be elevated in the surf zone over a considerable distance associated with rapid littoral transport. However, concentrations outside the breaker zone may be more localized (Section 5.5.3.5). Measured turbidity plumes may range from < 1,000 ft (300 m) to several miles (kilometers) long and from 50 to 1,000 ft (15 to 300 m) wide. Turbidity plumes may vary depending on presence or absence of rip currents and weather conditions (average versus high waves, average versus storm conditions). Use of dikes or swales appears to be effective at reducing length and presumably concentration of turbidity plumes (Sections 5.5.3.5, 6.4.4.2).

<u>Offshore Borrow Site Dredging</u>

The following buffer distances were recommended in several California CEQA and/or NEPA documents to minimize potential turbidity impacts to kelp beds and subtidal reefs from offshore dredge operations (Appendix D.2):

- 300 to 500 ft (91 to 152 m) for the 2001 San Diego Regional Beach Sand Project (MEC 2000a).
- 1,000 ft (305 m) for the BEACON Beach Nourishment Demonstration Project (Chambers 1992).
- 300 ft (91 m) for the Cabrillo Beach Nourishment Project (Tekmarine and Analytic Planning 1990).

The following monitoring studies indicate that turbidity plumes may be relatively localized during offshore dredging of sands.

- Monitoring at six offshore borrow sites during the 2001 San Diego Regional Beach Sand Project indicated that elevated turbidity occurred at distances between 250 and 500 ft (75 and 150 m) downcurrent, but similarly lower turbidity occurred between 250 and 1,500 ft (75 and 450 m) upcurrent (Section 5.5.3, Figure 5.5-6). Measurements at distances farther than 500 ft (150 m) downcurrent were not made; therefore, the downcurrent extent of the plume was not determined.
- TSS concentrations substantially declined within 820 ft (250 m) of four commercial aggregate dredges during normal operations off the United Kingdom, and rapidly decayed to background levels over a distance of 656 to 1,604 ft (200-500 m) during dredging in Moreton Bay, Australia (reviewed in Newell et al. 1998).

- The main deposition of sand during commercial hydraulic dredging was within 500 ft (150 m) of the dredge in the Baltic Sea (Gajewski and Uscinowicz 1993 cited in Newell et al. 1998) and within 984 ft (300 m) of the dredge off the South Coast of Britain (Hitchcock et al. 2002).

Consideration of Effectiveness:

Turbidity generated during dredging operations is influenced by type of dredge and equipment operation, sediment characteristics, and existing conditions (Section 5.5.3). Turbidity monitoring data from the above thirteen offshore dredging projects of sandy sediments, including commercial aggregate operations, suggest that most deposition occurs over distances within 500 to 1,6400 ft (150 to 500 m) of the dredge. Because several of the reviewed reports did not include a sufficient number of sampling locations to demonstrate the full extent of the plume, it may be precautionary to use a buffer distance of 1,640 ft (500 m) between offshore dredging sites and sensitive aquatic resource areas during project design. Based on project- and site-specific conditions, a shorter buffer distance also may be protective. A more standardized approach to plume monitoring during project implementation would enable future refinement of appropriate buffer distances (see Section 7.4.3).

Embayment Dredging

Relevant Reports:

- Mean TSS concentrations ≥ 100 mg/L were measured within 300 ft (91 m) downcurrent of the dredge for some California harbor dredging projects, but in most of the reviewed projects the mean concentrations were similar at distances up to 2,000 ft (610 m) away both up and downcurrent, suggesting TSS concentrations were influenced by broader environmental conditions than dredging (Section 5.5.2, Figure 5.5-2). Mean turbidity levels sometimes were elevated within approximately 500 ft (150 m) downcurrent of the dredge (Section 5.5.2, Figure 5.5-6). Secchi disk depths also showed water clarity depressions within 500 ft (150 m) of the dredge (Figure 5.5-8). Monitoring at distances between 1,000 to 2,000 ft (300 to 610 m) upcurrent indicated values were outside the plume. Few data were collected at distances > 500 ft (> 150 m) downcurrent; measurements appeared to be outside the plume at distances > 1,000 ft downcurrent when measurements were taken. However, the downcurrent extent of the plumes was not demonstrated with most of the 18 reviewed projects.
- A slightly elevated TSS concentration of 50 mg/L was measured at distances up to 1,312 (400 m) during dredging in San Francisco Bay (MEC and USACE-ERDC 2004). Concentrations between 100 and 390 mg/L generally were < 1,000 ft (< 300 m) from the dredge.
- LaSalle et al. (1991) stated that a generalized worst-case plume of ≤ 500 mg/L will occur at distances ≤ 1,640 ft (≤ 500 m) with the maximum concentrations generally restricted to the lower water column within 164 to 328 ft (50 to 100 m).
- Germano and Cary (2005) reviewed that while measurable sedimentation during dredging could range from 656 to 3,281 ft (200 to 1,000 m) away from source, the strongest effects occur less than 984 ft (300 m) from the source.

Consideration of Effectiveness:

Turbidity plumes and sedimentation in embayments will be influenced by type of dredge and equipment operation, sediment characteristics, and existing conditions (Section 5.5.2). In addition, physical conditions (e.g., confined basins) in harbors may substantially influence hydrodynamics. Similar to the above discussion for offshore borrow sites, sampling designs of many harbor dredging projects do not measure the full extent of the plume. Available information suggests that turbidity and sedimentation effects mainly occur within 1,000 ft (300 m) of the dredge. Similar to considerations discussed above, a buffer distance of 1,640 ft (500 m) between dredge and sensitive aquatic resource areas may be precautionary. A more standardized approach to plume monitoring during project implementation would enable future refinement of appropriate buffer distances (see Section 7.4.3).

A shorter buffer distance also may be protective based on evaluation of project size, equipment, and site-specific conditions (i.e., sediment grain size characteristics, currents). Appropriate buffer distance considerations also vary depending on type of sensitive biological resource (Section 6.3.6).

6.3.5.2 Buffer to Minimize Sedimentation Impacts

Relevant Reports

- No discharge at the river mouth was specified for Ventura Harbor maintenance dredging and beach placement to avoid potential impacts to steelhead trout spawning migration and/or juveniles using the Santa Clara River (USACE 1998b).
- A beach receiver site was located 2,500 ft (762 m) downcoast of the inlet of Carpinteria Marsh to minimize sand migration impacts associated with placement of up to 50,000 cy with implementation of the BEACON South Central Coast program (Chambers 2001c, Moffatt & Nichol 2005a).
- Beach receiver sites for the 2001 San Diego Beach Sand Project were not located according to a standard buffer distance from intertidal tidepools, nearshore reefs, and kelp beds, but instead were evaluated based on placement volume, reef heights, biological resource development, and predicted sand thickness in excess of historical profiles (MEC 2000a, Moffatt & Nichol 2000). Reefs ranged from low to high relief with variable resource development. Sand placement volumes at receiver sites that had reefs and kelp beds in the vicinity ranged from 101,000 to 245,000 cy. No significant impacts to sensitive rocky intertidal, nearshore reef, or kelp bed habitats were reported after four years of monitoring compared to before project conditions using a BACI sampling design (AMEC 2005).
- A total of 97,600 cy was placed over two years at Goleta Beach, which had eelgrass habitat approximately >1,600 ft (> 500 m) offshore, kelp habitat > 1,969 ft (> 600 m) downcoast and offshore, and rocky intertidal with surfgrass approximately 6,500 ft (2000 m) downcoast. No persistent sedimentation impacts were observed in the habitats during the first year of post-construction monitoring (Chambers Group 2004).

Consideration of Effectiveness

Discharge of sediments in river mouths or other shallow-water inlets to coastal embayments may increase shoaling rates and risks of inlet closure and/or result in increased maintenance dredging and/or excavation requirements. Therefore, restriction of sediment discharge at river mouths is considered desirable not only to avoid potential interference with migration of salmonids, but other species that transit shallow-water inlets to use embayments (lagoons, sloughs) as nursery areas. Use of a buffer distance between sand placement location and inlets also should be effective for minimizing impacts associated with inlet closure. Factors such as project size, prevailing current direction, and distance from inlet are important considerations with respect to potential sedimentation impacts to inlets. Therefore, a standard buffer distance may not be effective across a range of project sizes. The importance of distance from embayment inlets increases with increased project volume.

The above relevant reports indicate that protection of sensitive reef habitats from indirect sedimentation after beach nourishment projects requires consideration of factors such as sand placement volume, reef heights, resource development, coastal processes, and predicted increase in sand thickness across beach profiles relative to pre-project conditions. Other factors such as receiver site dimensions and placement location also may be influential. Therefore, a standardized buffer distance may not be effective across a range of project sizes. The importance of distance from sensitive resources increases with increased project volume. Appropriate protective buffer distances may vary depending on type of sensitive biological resources (Section 6.3.6).

6.3.6 Buffer to Avoid and Minimize Impacts to Sensitive Species

Turbidity and/or sedimentation may be of concern for sensitive fishery spawning areas. Noise also may be of concern for sensitive fish species. Turbidity and/or noise may be of concern to sensitive bird species. Noise may be of concern near sensitive marine mammals.

Significance thresholds have been established for marine mammals. Significance thresholds have been established for sensitive bird species in San Diego County (2007), but otherwise have not been formally adopted in the state.

The following noise disturbance thresholds are recognized:

- 60 dB – Sensitive terrestrial birds, including snowy plover (San Diego County 2007). In areas where this level is exceeded under existing conditions, noise significance is defined relative to exceedance of ambient.
- 70 dB (terrestrial), 153 dB_{RMS} (underwater) – Seabird, marbled murrelet (WSDOT 2006).
- 150 dB_{RMS} (re 1 μPa) – Salmonids (WSDOT 2006).
- 120 dB_{RMS} (re 1 μPa) (underwater) 58 dB (terrestrial) – Cetaceans (Federal Register 2005).

The following subsections review buffer considerations for fish, birds, and marine mammals.

6.3.6.1 Buffer to Protect Fishery Spawning Grounds

This measure involves use of a buffer distance and/or barrier to minimize direct and/or indirect impacts to sensitive fishery spawning grounds. Relevant reports and effectiveness considerations are reviewed separately below for different species and/or types of fish.

Pacific Herring Spawning Sites

Consideration of Effectiveness:

Relevant reports and considerations of effectiveness discussed for sensitive habitats in Section 6.4.2.1 (embayments) are relevant to buffer considerations for protecting spawning grounds of Pacific herring. However, additional consideration should be given to the sensitivity of demersal eggs of Pacific herring to thin-layer sedimentation (Section 4.3.2). Evaluation of whether a buffer distance would provide adequate protection during the herring spawning season would require consideration of project and site-specific factors such as proximity to spawning sites, sediment characteristics of dredge material, and hydrodynamics.

Salmonids

Dredge noises may be less than disturbance thresholds for salmonids at distances > 100 to 1,312 ft (30 to 400 m) for hopper dredges and at distances closer than that for clamshell bucket dredges (Section 5.3.2.6). Turbidity may represent an adverse or beneficial effect to migrating salmonids depending on concentration. Based on these considerations, distance may represent an effective measure for minimizing impacts to migration of salmonids when indirect effects of noise and turbidity are minimized. Actual buffer distances should be based on project- and site-specific considerations, including equipment, substrate characteristics, and hydrodynamics. Width of water body where the sediment management activity would occur also may be an important consideration with respect to the effectiveness of this measure; the effectiveness may be less in confined areas. During times of migration, other effective measures may include operational controls for turbidity and entrainment (Section 6.4.3.2, 6.4.3.3).

6.3.6.2 Buffer to Avoid and Minimize Impacts to Sensitive Bird Species

California Brown Pelican

A buffer distance may be used to minimize impacts of sediment management activities near large roost sites of California brown pelican.

Relevant Reports:

- No dredging within 300 ft (91 m) of large roosts between July and September during the time period between one hour before sunset and sunrise is specified for San Francisco Bay by the USACE San Francisco District (http://el.erdc.usace.army.mil/tessp) and San Francisco Bay LTMS (USACE et al. 2001).
- A buffer distance of 115 ft (35 m) between dredge operations and breakwater where pelicans roost was specified during dredging of contaminated sediments

at Marina del Rey Harbor (USACE 1999b). The measure also included provision for increasing the buffer distance by 50 ft (15 m) increments up to a maximum of 270 ft (80 m) if substantial roost abandonment (50% reduction in birds) was observed at night. In addition, a temporary barge was used to provide additional potential roosting area. If abandonment of the breakwater roost was observed at a distance of 270 ft (80 m) and pelicans did not use the barge for roosting, further dredging of contaminated sediment was to be restricted.

- Varanus (1999) reported that pelicans displayed startle reaction to sudden and/or close approach disturbance (e.g., clamshell dredge start up, illumination of breakwater after long periods of inactivity, and movement of a tugboat between the dredge and breakwater), but otherwise were tolerant of dredging activities near the breakwater during the above-noted monitoring program at Marina del Rey. Startle responses to dredging activities included shifting of birds along the breakwater and/or brief departures (minutes).
- Jaques et al. (1996) reported that brown pelicans did not appear to be disturbed by heavy equipment operation and rip-rap installation within 328 ft (100 m) of a roost site.
- A distance of 164 ft (50 m) was specified as a buffer distance between pelican roosts and maintenance dredging at Moss Landing (USACE 2002c).

Consideration of Effectiveness:

A buffer distance of 300 ft (91 m) from large roost sites is supported by monitoring studies that indicate startle response behavior (shifting of position, brief flushing) of pelicans to sudden disturbance associated with dredging activities at distances within 270 ft (80 m) and no obvious disturbance to heavy equipment activities at a distance of 328 ft (100 m) (Jaques et al. 1996, Varanus 1999). No available information was identified during the literature review to support smaller buffer distances. Assuming dredge noise levels of 76 to 88 dB within 50 ft (15 m) (Table 5.3-1), noise levels of 61 to 73 dB may occur within 300 ft (91 m) based on a standard attenuation rate of 6 dB per doubling of distance (Section 5.3.3.6). These values are near or below the 70 dB disturbance threshold estimated for marbled murrelet (diving seabird) (WSDOT 2006). Average noise levels during dredging would be expected to attenuate to 60 dB at distances of 328 to 1,000 ft (100 to 200 m) depending on dredge equipment. Based on the above considerations, the 300 ft (91 m) buffer distance appears to be justified.

<u>California Least Tern</u>

Generally, sediment management projects in California require consultation with the USFWS if there is the potential for turbidity generating activities to occur within 1 to 2 miles of least tern nesting sites during their breeding season (Section 4.4.2). Projects located > 2 miles from least tern nesting sites do not require consultation. Review of available information suggests that a 1 to 2 mile threshold may be overly protective. Shorter buffer distances, particularly when combined with operational control of turbidity, may be protective.

Relevant Reports:

- RGP 67 specifies no beach nourishment activities shall be conducted within 3,000 ft (914 m) of least tern nest sites during the breeding season.

- Least terns may forage on small, schooling fish beyond the surf zone with 1 to 2 miles (1.6 to 3.2 km) of shore and in embayments and lakes near the coast (Atwood and Minsky 1983, Collins et al. 1979).
- Construction mitigation measures (e.g., dike or swale discharge) during beach nourishment generally limit turbidity to the surf zone, except in areas of rip currents (MEC 1997, AMEC 2002, Moffatt & Nichol 2004).
- Permit requirements that water clarity not be < 3 ft (1 m) over an area > 2.47 acre (> 1 hectare) to protect potential least tern foraging were met with few exceedances during the 2001 San Diego Regional Beach Sand Project (AMEC 2002).
- Monitoring did not detect any obvious effect on least tern foraging behavior during beach nourishment with diked discharge at Surfside-Sunset Beach (MEC 1997).
- Turbidity plumes during beach nourishment are mainly confined within the surf zone unless carried offshore by rip currents. Under rip current conditions, turbidity plumes may be visible downcurrent for > 2 mi (3.2 km) and extend outside the breaker zone (MEC 1997, Sherman et al. 1998, AMEC 2002). Under non-rip conditions, plumes may be < 1,000 ft (305 m) long and within the surf zone (MEC 1997, AMEC 2002, Moffatt & Nichol 2003, other data files reviewed in Section 5.5.3.5).
- Turbidity generally dissipates to near background levels within approximately 1,000 ft (300 m) of hydraulic dredges during offshore dredging and mechanical and hydraulic dredges during maintenance dredging in embayments (Sections 5.5.2, 6.4.2.1).
- Turbidity plumes during dredging may range up to 2,297 ft (700 m), but a generalized worst-case plume is considered ≤ 500 mg/L at distances ≤ 1,640 ft (≤ 500 m) (LaSalle et al. 1991).

Consideration of Effectiveness:

Least terns are visual foragers that require adequate water clarity to see prey (small, near surface schooling fish). In the Biological Opinion for the 2001 San Diego Regional Beach Sand Project, a conservation measure to avoid and/or minimize impacts to visual foragers (California least tern and California brown pelican) was specified as surface turbidity of not less than 3 ft (1 m) over a 328-ft^2 area (100-m^2, 1 hectare), as measured by Secchi disk (USFWS 2000). Few exceedances of that criterion were measured during implementation of that project (AMEC 2002).

Available information indicates that turbidity during beach nourishment is largely confined within the surf zone unless there are rip currents (Section 5.5.3.5). Monitoring during periods with and without rip currents suggests that rip currents are not persistent; reports of very large plumes represented a small percentage of the monitoring observations (MEC 1997, AMEC 2002). Turbidity plumes during 19 California and 1 East Coast beach nourishment project reported turbidity plume lengths generally < 2,500 ft (762m) and often less than <1,000 ft (300 m) in length Section 5.5.3.5).

Available reports indicate turbidity plumes during offshore dredging and in embayments may reach 2,297 ft (700 m), but generally are much less than ≤ 1,640 ft (500 m) (LaSalle et al. 1991).

As noted above for California brown pelican, average noise levels during sediment management projects would be expected to attenuate to ≤ 60 dBA at distances of 328 to 1000 ft (100 to 328 m) from dredging operations depending on dredge equipment. Noise levels associated with equipment use during beach nourishment may range up to 96 dBA with average levels expected to be less than 85 to 90 dBA at 50 ft (15 m) (Section 5.3.2.6). Average noise levels over flat terrain would be expected to attenuate to 60 dBA within distances of 1,000 to 1,600 ft (328 to 487 m).

Based on the above considerations, the 3,000 ft (914 m) buffer specified by RGP 67 appears to be supported by available data. The data suggest that shorter buffer distances also may be protective, particularly combined with operational controls that limit turbidity.

Snowy Plover

A buffer may be used to minimize impacts to snowy plover nesting sites, which are stationary after establishment during the breeding season. Buffers are not considered a feasible measure for minimizing impacts to snowy plovers foraging in the intertidal zone because of their mobility. In addition, other measures such as single-point surf zone discharge within a small, restricted zone of operations may be used to minimize impacts to snowy plover foraging (Section 6.4.1.2).

Relevant Reports

- A vehicle use restriction to near the pipeline and construction of one or more fenced corridors between the dunes and surf were specified to protect snowy plovers if beach placement activities extended beyond March 15 near Ventura Harbor (USACE 1998b).
- Dredging and surf zone disposal has been conducted during the snowy plover breeding season at Morro Bay with no documented adverse effects on breeding (USACE 2001).
- Chambers Group (2001a) reported that snowy plovers foraged in the vicinity of surf-zone discharge of dredged material from Santa Barbara Harbor.
- Worden and Smith (2004) reported short-term disturbances to snowy plovers from vehicles and pipeline installation activities during surf zone discharge of dredged materials from Ventura Harbor.
- Chambers Group (2005) noted that snowy plovers avoided the immediate vicinity of inlet dredging and disposal on the upper intertidal near Talbert Channel, Huntington Beach, but foraged undisturbed nearby.
- Protective measures recommended for piping plovers during beach nourishment on the Atlantic coast of the United States include a 300 ft (91 m) buffer from nests or chicks, and seasonal restriction of placement activities, pipeline storage, and pipeline removal between April 1 and August 31, unless work will enhance habitat (Melvin 2005).

Consideration of Effectiveness:

Average noise levels during beach nourishment projects would be expected to attenuate to 60 dBA within distances of 1,000 to 1,600 ft (328 to 487 m). Therefore, nesting sites of snowy plovers would not be expected to be adversely affected at distances > 1,640 ft (500 m) from beach nourishment activities.

Available literature indicates that few disturbances occur to snowy plovers at distances greater than 98 ft (30 m) (Lafferty 2000). Therefore, potential impacts to snowy plover foraging and/or resting may be more a function of how much of the beach area is affected by vehicles and equipment rather than distance from activities. Therefore, project- and site-specific considerations likely will influence the applicability of a buffer distance as an effective mitigation measure to minimize impacts to snowy plover foraging and/or resting activities. Site conditions should be evaluated on a case-by-case basis in coordination with the USFWS to develop appropriate mitigation measures for snowy plover if the project is within critical habitat.

Peregrine Falcon

Peregrine falcons may nest on cliff ledges and/or man-made structures (e.g., bridges) in harbors. The also nest and roost on Morro Rock at Morro Bay (USACE 2001). Average dredge noise levels would be expected to attenuate to 60 dBA at distances of 328 to 1,000 ft (100 to 328 m), depending on equipment (Section 5.3.2.6).

Average noise levels would be expected to attenuate to 60 dBA within distances of 1,000 to 1,600 ft (328 to 487 m) during beach nourishment, depending on equipment. Therefore, nesting sites of peregrine falcon would not be expected to be adversely affected at distances > 1,640 ft (500 m) from beach nourishment activities.

6.3.6.3 Buffer to Avoid and Minimize Impacts to Marine Mammals

Dredge noises (airborne) would be expected to attenuate to below marine mammal harassment levels at distances of 300 to 1,600 ft (91 to 488 m). Actual buffer distances should be based on equipment, sensitivity of marine mammal, and use patterns in the project area. For example, sea lions and harbor seals are relatively tolerant of disturbance (Section 5.3.2.6).

Pre-construction buffer distances cannot be specified for mobile marine mammals while in the water. Other measures such as limiting intentional approaches and using slow vessel speeds are appropriate during construction (Section 6.4.1.5).

6.3.7 Environmental Coordination and Notifications

Several measures may be implemented as part of final design, permitting, and/or just prior to construction that include coordination and/or final planning activities relevant to environmental protection. These may include preparation of a hazardous materials management plan, inlet monitoring and response plan, notice to mariners, and/or environmental training. Each of these coordination activities has relevance to biological resource protection.

6.3.7.1 Prepare Hazardous Materials Management Plan

This measure includes preparation of a Transport and Discharge Operations Plan, including a Spill Prevention, Containment and Countermeasures Plan (SPCCP) that specifies fueling, equipment maintenance procedures to prevent spills and leaks, and containment and cleanup measures to be followed in the event of a spill.

Relevant Reports:

- RGP 67 (USACE 2006) specifies that (1) a Transport and Discharge Operations Plan shall include a Spill Prevention, Containment and Countermeasures Plan (SPCCP) that specifies fueling, equipment maintenance procedures to prevent spills and leaks, and containment and cleanup measures to be followed in the event of a spill.
- Preparation of a SPCCP that addresses (1) on- and offshore activities and use and refueling equipment, (2) handling and storage of construction and maintenance fluids, and (3) control, containment, and cleanup of released fluids was specified as a mitigation measure in the EIS/EIR for the Imperial Beach Shoreline Protection Project (USACE 2002).

Consideration of Effectiveness:

Accidental leaks and/or spills are of concern because of potential impacts to water quality and/or biological resources. Therefore, preparation of a SPCCP should be effective for minimizing the potential for adverse impacts from accidental spills or leaks.

6.3.7.2 Prepare Inlet Monitoring and Response Plan

Relevant Reports:

- The implementation guidelines for the BEACON South Central Coast Beach Enhancement Program specifies monitoring during, immediately after, and for six months following construction to determine if inlet closure occurs due to sedimentation. If closure is observed, then material will be removed as necessary until the inlet area has stabilized (Moffatt & Nichol 20005a).
- Monitoring and opening inlet if closure occurs was specified as a mitigation measure for the Goleta Beach Nourishment Demonstration Project (Chambers Group 1992).

Consideration of Effectiveness:

This type of planning has been conduced for several opportunistic sand programs. In addition, beach profile monitoring was conducted to determine inlet status and shoaling in lagoons during the 2001 San Diego Regional Beach Sand Project. Commitments for monitoring, response action, and/or funding have been specified with these project examples. The mitigation measure formalizes this process. Monitoring during construction is reviewed in Section 6.4.5.3.

6.3.7.3 Conduct Environmental Training Program

This measure involves conducting a pre-construction meeting and/or environmental training program with contractors, environmental monitors, and other agencies, as appropriate to ensure compliance with construction mitigation measures.

Relevant Reports:

- Implementation of an environmental training program to communicate environmental concerns and appropriate work practices, including spill prevention and response measures was specified as a mitigation measure in the EIS/EIR for the Imperial Beach Shoreline Protection Project (USACE 2002).
- A pre-project meeting with contractors, monitors, Corps, resource agencies, USACE, and local and federal lead sponsors (SANDAG, and U.S. Navy) to understand the roles and responsibilities of monitoring was specified in the biological opinion for the 2001 San Diego Regional Beach Sand Project (USFWS 2000).

Consideration of Effectiveness:

Sediment management projects occur in and/or in close proximity to marine and/or estuarine waters and may be implemented in proximity to sensitive biological resources, and/or habitats. Several types of monitoring and/or protective measures may be required during construction. An important element of successful environmental compliance is adequate coordination among contractor field personnel and monitors with respect to roles of individuals, monitoring requirements, safety issues, and communication protocol. At a minimum, a pre-construction field meeting may be adequate. When sensitive species are an issue, a pre-construction training program for field personnel may be effective to ensure successful compliance with mitigation.

6.3.7.4 Conduct Coast Guard Notification to Minimize Environmental Hazards

This measure addresses notifying the U.S. Coast Guard of planned in-water sediment management activities to minimize the potential for environmental hazards associated with collisions and oil spills.

Relevant Reports:

- Publication of dredge locations via a U.S. Coast Guard Notice to Mariners, written notices to local fishing representatives, and posted notices in local harbors was specified to avoid conflicts and fishing gear loss of commercial fishermen (SANDAG and USDN 2000).

Consideration of Effectiveness:

The U.S. Coast Guard Notice to Mariners provides up-to-date marine safety information (http://www.navcen.uscg.gov/lnm/default.htm). Therefore, notifications should be effective for minimizing potential for collisions and hazardous materials spills. In addition, the measure should be effective for minimizing interference with commercial fishing activities.

6.3.8 Mitigation and Monitoring Plan

The mitigation and monitoring plan generally is prepared as part of the requirements for a MND or EIR/EIS. The following measures include finalization of the plan prior to construction to include any relevant updates during final design, and briefly review types of monitoring that may be conducted during the pre-construction phase. Pre-construction monitoring is described further in Section 7.3.

6.3.8.1 Finalize Mitigation and Reporting Plan

This measure involves preparing a final mitigation, monitoring, and reporting program prior to construction.

Relevant Reports

- RGP 67 requires conducting a Sensitive Aquatic Resource (SAR) survey, including preparation of a MMRP for turbidity plumes in ASBSs, Pismo clam, and grunion monitoring and protective measures if activities are scheduled between March 1 and August 31. A Biology Report that specifies how impacts to threatened or endangered species are avoided also is to be prepared (USACE 2006).
- A final MMRP addressing pre- and post-project monitoring of sensitive habitats and construction monitoring of sensitive resources was required for the 2001 San Diego Regional Beach Sand Project (USACE 1999-15076-RLK, AMEC 2002, 2005).
- A final MMRP was prepared for the Goleta Beach Nourishment Demonstration Project (USACE 200200666-JCM, Moffatt & Nichol 2003).

Consideration of Effectiveness:

The effectiveness of this measure will depend in part on the detail provided in the plan. Ideally the plan should include description of the monitoring objectives, methods, field communication and agency notification protocol, and reporting schedule and contents. The decision process during construction and description of types of additional protective types that may be implemented during construction should be described, as appropriate. Plans that include pre- and post-project impact significance verification monitoring should specify significance criteria, detection level requirements, sampling design, data analysis methods, and reporting schedule.

6.3.8.2 Pre-Construction Surveys and Monitoring

Pre-construction surveys may be specified as mitigation measures to provide updated information on sensitive habitat boundaries, species occurrence, and/or invasive species occurrence to support logistic decisions with respect to project implementation. Results of pre-construction surveys may be used to determine whether additional protective measures and/or monitoring may be warranted during construction. Results also will support decisions with respect to minor adjustments to construction boundaries to avoid direct impacts to sensitive resources, if necessary, and will approval by resource and regulatory agencies.

Pre-construction surveys may be appropriate in areas where sensitive resource occurrence varies within and/or between years. They also may be appropriate in areas where sensitive habitats have patchy occurrence and detailed boundary information is not needed until construction and/or access plans are finalized.

The following types of pre-construction monitoring mitigation measures may be conducted to facilitate impact avoidance and/or minimization. The mitigation measures assume an environmental review process that includes preparation of a MMRP that is submitted to resource and regulatory agencies for comment and approval as part of informal coordination and/or the permitting process prior conducting surveys (Section 6.3.8.1). Monitoring considerations and effectiveness are reviewed in greater detail in Section 7.3.

- Sensitive aquatic resource (SAR) survey – Conduct SAR survey and submit results to resource agencies according to requirements specified in the MMRP. This measure is applicable to project footprints, access routes, pipeline routes, and/or vessel anchorages.
- Grunion habitat suitability survey – Conduct grunion habitat survey if project is scheduled between March 1 and August 31 and submit results to resource agencies according to requirements specified in the MMRP. If habitat is suitable, implement construction monitoring and protective measures specified in the approved MMRP or reschedule project.
- Pismo clam survey – Conduct Pismo clam survey in areas where there is potential for direct impacts (e.g., nearshore placement or borrow site dredging) and submit results to resource agencies according to requirements specified in the MMRP.
- Local Important Fishery Grounds – Conduct survey for other locally important fishery grounds (e.g., Dungeness crab) if project is located in an area of identified potential concern and the project schedule overlaps seasonal period of vulnerability.
- Snowy plover occurrence survey – Conduct snowy plover survey if site is within critical habitat, within 1 mile of known nesting sites, and/or is known to support a substantial wintering population and submit results to resource agencies according to requirements specified in the MMRP. If nests, chicks, or substantial wintering population are observed, implement construction monitoring and protective measures specified in the approved MMRP or reschedule project.
- *Caulerpa* survey – Conduct *Caulerpa* survey of dredge locations and submit results to resource agencies according to established protocols. If *Caulerpa* is found, eradication will be conducted prior to dredging to avoid spread of this invasive species.
- Conduct pre-project baseline monitoring of sensitive habitats – Conduct monitoring to establish existing conditions at adjacent sensitive habitats and at reference sites to support post-project impact significance verification and submit results to resource agencies according to requirements specified in the MMRP. The MMRP will include description of criteria and methods for determining impact, including thresholds of significance.

6.4 Construction Phase Mitigation Measures

Several different methods may be used to avoid direct and/or minimize indirect impacts to biological resources from equipment, burial, sedimentation, and turbidity related impacts during construction. These measures may include location controls, schedule restrictions, construction method and operational controls, best management practices, and monitoring (Table 6.4-1). These measures are briefly reviewed in the following sections.

6.4.1 Location Controls

6.4.1.1 <u>Avoid use of equipment, pipelines, and construction materials in sensitive habitats</u>

This measure involves specification of areas where construction activities are prohibited and/or restricted to avoid and/or minimize impacts to sensitive resources.

Relevant Reports:

- Establishment of no work zones, restriction of pipeline alignment and transportation corridors outside vegetated areas, where possible, and restriction against use of all-terrain vehicles in vegetated habitat were identified as environmental commitments for sediment management projects at Morro Bay Harbor and Ventura Harbor, California (USACE 1998b, 2001).
- At Morro Bay, pipeline placement was restricted to within a 50-ft (15-m) corridor if complete avoidance was not possible to minimize impacts to vegetation (USACE 2001). Avoid placement of pipelines and/or use of equipment in sensitive habitat areas.
- Use of aggregates (sand, gravel, asphalt, concrete) to support pipeline placement during maintenance dredging and beach nourishment Is prohibited in eelgrass beds in Morro Bay (USACE 2001). Use of concrete sleeves, heavy steel, or steel pipe casing for protecting, anchoring, or stabilizing sections of pipeline are allowed when placed and removed with pipeline.

Consideration of Potential Effectiveness:

Restriction of equipment in sensitive habitats is considered the most effective method to avoid direct impacts. Effectiveness of the measure may be improved on land by clearly marking restricted areas (e.g., visible flagging, temporary snow fencing).

When temporary pipeline placement is necessary in a sensitive habitat, restriction of introduction of materials that may change substrate characteristics should be effective for avoiding a change in habitat quality in sensitive habitat areas. Before and after construction monitoring may be necessary to assess direct damage effects, if any. For example, pre- and post-project eelgrass surveys for the area of pipeline placement, with mitigation of loss according to the Southern California Eelgrass Mitigation Policy are specified as an EFH conservation measure for 2001 to 2007 maintenance projects at Morro Bay (USACE 2001).

Table 6.4-1. Types of construction phase mitigation measures to reduce direct and indirect impacts during sediment management projects.

Construction Mitigation Measures	Equipment	Burial	Sedimentation	Turbidity/ Water Quality
Location Controls				
Avoid use of equipment, pipelines, and construction materials in sensitive habitats	X			
Avoid anchoring and/or operation of dredges, drill rigs, and/or barges in or above SAV habitats	X			
Surf-zone discharge location	X	X		X
Upper beach discharge location			X	X
Limit intentional approaches within 300 ft (91 m) and use slow vessel speed around sensitive marine mammals	X			
Schedule and/or SeasonalRestrictions				
Environmental windows	X	X		X
Avoid repetitive disturbance in same year[1]	X	X		
Avoid peak recruitment and productive period	X	X	X	X
Dredge Equipment and Operational Controls				
Dredge equipment selection			X	X
Use dredge controls - entrainment	X			
Use dredge controls - turbidity			X	X
Construction Equipment, Methods, and Best Management Practices (BMPs)				
Use silt curtains or gunderbooms to minimize turbidity				
Use dikes or swales to minimize turbidity			X	X
Minimize potential hazardous materials leaks or spills	X			X
Reduce noise levels below sensitive wildlife harassment or disturbance thresholds	X			
Minimize artificial lighting in sensitive wildlife areas	X			
Barrier reduction	X			
Environmental Training	X	X		X
Construction Monitoring				
Sediment compatibility inspections and testing		X		
Water quality compliance				X
Inlet status			X	
Sensitive species, as necessary	X	X		

6.4.1.2 Avoid anchoring and/or operation of dredges, drill rigs, and/or barges in or above SAV habitats

Relevant Reports:

- Dredging within specific limits has been used to minimize impacts to eelgrass habitat during required maintenance dredging at Agua Hedionda Lagoon, San Diego County (USACE Permit 87-171-SK). Permit requirements specify mapping of eelgrass before and after dredging and mitigation of any eelgrass removal outside prescribed dredge limits.
- WSDOT (2006) specifies that construction barges will not be anchored in or above eelgrass or kelp beds, and drill rigs will not operate in or above eelgrass or kelp beds to prevent damage to eelgrass and kelp beds as a result of shading or disturbance by anchors or drilling equipment.

Consideration of Effectiveness:

The effectiveness of prescribed dredge limits to minimize impacts to eelgrass is considered effective with use of navigational aids (e.g., GPS coordinates) and permit requirements that require pre- and post-dredge eelgrass mapping and mitigation for removal outside prescribed limits according to Southern California Eelgrass Mitigation Policy.

Restriction of anchoring and/or operating of vessels and/or dredges over eelgrass or kelp beds should be effective for avoiding direct impacts and minimizing indirect impacts to these SAV habitats. Sediment management projects may not span durations sufficient to result in decline of vegetation from vessel shading; however, restriction of operation of vessels above eelgrass and kelp canopies should reduce impacts associated with propeller entanglement and/or turbidity as a result of sediment resuspension from propeller wash.

6.4.1.3 Single-Point, Surf-Zone Discharge

Surf-zone discharge of hydraulic dredged materials has been used to avoid direct impacts to grunion spawning and/or snowy plover nesting habitats. Sometimes, the activity is restricted within a specified length of beach to minimize disturbance associated with pipeline operations. Pipeline placement and removal operations generally are restricted to outside spawning and/or breeding seasons if sensitive resources are present to avoid potential direct impacts to these species.

Relevant Reports:

- The use of a single-point surf zone discharge has been specified for beach placement disposal operations associated with maintenance dredging projects at Channel Islands/Port Hueneme Harbors, Marina del Rey Harbor, Morro Bay Harbor, Oceanside Harbor, Santa Barbara Harbor, and Ventura Harbor, California (USACE 1993, 1994a, 1994b, 1998a, 1998b, 1999b, 2000a, 2000b, 2001).
- Pipeline and discharge activities have been limited within a 500 ft (150 m) wide corridor associated with Marina del Rey Harbor and Santa Barbara Harbor

maintenance dredging and surf-zone disposal projects (USACE 1993, 1998a, 1999b).

- A 50-ft (15-m) wide corridor was specified for surf-zone disposal at Morro Strand State Beach near snowy plover nesting sites (USACE 2001).
- A five-year study by the Corps during March-April surf zone discharge at Santa Barbara did not detect significant differences in grunion spawning distribution or hatching success within project and reference areas (USACE 1998a). However, a limitation noted by that study was the lack of information later in the season when larger spawning runs may occur.
- The USACE (2001) reviewed that surf-zone disposal during fall-winter did not appear to affect subsequent nesting success of snowy plovers at Morro Strand State Beach after 1993, 1995, and 1997 maintenance dredging projects or successful nesting after the 1992-1993 beach disposal at Ventura. Successful nesting also was reported during and after surf-zone disposal at the Morro Bay sand spit in 1987.
- Chambers Group (2001a) reported that snowy plovers foraged in the vicinity of surf-zone discharge of dredged material from Santa Barbara Harbor.
- Worden and Smith (2004) reported short-term disturbances to snowy plovers from vehicles and pipeline installation activities during surf zone discharge of dredged materials from Ventura Harbor.

Consideration of Effectiveness:

Available information, although largely qualitative, suggests that single-point, surf zone discharge does not adversely affect grunion egg hatching or snowy plover nesting success, which occur at higher elevations of the beach. Placement and removal operations outside the spawning and/or breeding seasons are considered effective for avoidance of direct impacts to these species.

Single-point, surf zone discharge may be unnecessary for grunion if habitat conditions (e.g., beach width and/or sand depth) are unsuitable for spawning. The measure may be effective during the grunion season since grunion spawn higher on the beach (i.e., near spring high tide line). Limited information suggests that grunion spawning is not precluded by turbidity associated with single-point surf zone discharge and/or after storms. Relationships between turbidity and grunion spawning are not well understood. Insufficient information is available to assess to what extent confinement of turbidity plumes mainly to the surf zone (Section 5.5.3.5) lessens potential turbidity effects on grunion spawning behavior.

Snowy plovers forage in the swash zone; therefore, single-point surf zone discharge has the potential to interfere with their foraging behavior. Restriction of pipeline operations within corridors ranging from 50 to 500 ft (15 to 152 m) in beach length have been specified for several of the above-noted USACE sediment maintenance projects. Available literature indicates that few disturbances to snowy plovers occur at distances greater than 98 ft (30 m) (Lafferty 2000). Therefore, small corridors that confine operations are considered more protective than larger corridors.

Whether this measure is appropriate to implement should not only consider schedule and potential habitat suitability for grunion spawning and occurrence of snowy plover nesting activity, but also proximity to sensitive resources in the surf zone and/or nearshore. Surf zone discharge may be expected to produce greater turbidity than diked beach placement. Project volume and duration may be important factors to consider with respect to this placement method depending on existing conditions.

6.4.1.4 <u>Hydraulic Discharge on Upper Beach</u>

Hydraulic discharges sometimes are placed high on the beach to allow a more gradual migration of the pumped slurry seaward. This measure also may be used to control turbidity associated with minor changes in sediment characteristics of dredged materials.

Relevant Reports:

- This measure was identified to minimize impacts to Pismo clams during beach nourishment at Surfside-Sunset and West Newport beaches in Orange County, southern California (USACE 1995a).
- Greene (2002) stated that this measure may minimize impacts to sandy beach invertebrates because it allows more time for animals to move away and/or burrow through overburdens.
- Moving the location of hydraulic discharge from the swash zone to upper beach has been used to control turbidity from sand placement of sands during maintenance dredging of Aqua Hedionda Lagoon in Carlsbad, California (B. Dyson, dredge contractor, personal communication 2000).

Consideration of Effectiveness:

This operational control method may be a common practice of experienced dredge contractors; however, limited information is available on the effectiveness of this measure. Beach width may be important consideration. When beach width is limited other measures such as slower discharge volume rates may be more effective for reducing turbidity and/or migration rates associated with hydraulic discharges (Section 6.4.3.3).

6.4.1.5 <u>Limit Intentional Approaches Within 300 ft (91 m) and Use Slow Vessel Speed Around Sensitive Marine Mammals</u>

This measure involves use of a buffer distance and vessel operational controls to minimize direct and/or indirect impacts to marine mammals.

Relevant Reports:

- A buffer distance of 164 ft (50 m) between dredge operations and sea otters was established for maintenance dredging at Moss Landing (USACE 2002c).
- Monitors are required year round to avoid injury from hopper dredges in areas where sea otters occur (<u>http://el.erdc.usace.army.mil/tessp</u>).
- Limiting intentional approaches within 300 ft (91 m) and reducing vessel speed to 4 kn has been specified by some Corps Districts to limit the potential for vessel strikes with marine mammals (Reine et al. 1998).

Consideration of Effectiveness:

Studies indicate sea otters are relatively tolerant of vessel activity (Richardson et al. 1995). However, Bodkin and Rathbun (1988) noted a temporary decrease in sea otters in Morro Bay during maintenance dredging that they thought might have been due to increased human activity. Average noise levels during dredging would be expected to attenuate to 60 dB at distances of 328 to 650 ft (100 to 200 m) depending on dredge equipment.

Seals and sea lions are sensitive to disturbance on land, but are relatively tolerant of vessels while in water (Richardson et al. 1995). Disturbance to pinnipeds is of primary concern at haul-out areas (Section 4.5.2). Therefore, a buffer distance between sediment management activities and haul out and/or rookeries areas may be an effective measure to minimize potential disturbance effects on land. Important considerations for determining an appropriate buffer distance on land includes proximity to human activities and noise. Sea lions rarely react unless a vessel approaches within 328 to 656 ft (100 to 200 m) (Bowles and Stewart 1980). Average noise levels during dredging would be expected to attenuate to 60 dB at distances of 328 to 650 ft (100 to 200 m) depending on dredge equipment. Average noise levels during beach nourishment may be expected to attenuate to near ambient levels within distances of 1,000 to 1,600 ft (328 to 487 m) depending on equipment used and existing noise levels (Section 5.3.3.6). Therefore, the distance over which noise is reduced to ambient may be a more conservative buffer. A buffer restriction is considered unnecessary for pinnipeds while in the water.

Whales may be affected by disturbance associated with noise and approach of vessels, and ship strikes may result in injury particularly at high vessel speed (Section 4.5.3). Whales may display avoidance behavior by changing course from vessel approach within 656 to 984 ft (200 to 300 m) (Richardson et al. 1995). Protection from vessel disturbance has been legislated for whales in areas where high numbers may occur and there is greater likelihood of disturbance. For example, it is unlawful to intentionally approach humpback whales off Alaska and Hawaii within 300 ft (91 m) (FR 2001). This distance also may be relevant to sediment management projects given that underwater noise levels from dredges generally attenuate below Level B harassment levels within 328 to 500 ft (100 to 150 m) (Section 5.3.3.6). A buffer distance of 300 ft (91 m) and slow vessel speed has been specified to reduce potential adverse impacts to whales in some Corps districts, but have not been specified for California districts (Reine et al. 1998).

California gray whales may follow a nearshore migration route within 5.7 mi (9 km) of the mainland; therefore, disturbance is a possibility for sediment management projects involving offshore dredge and/or disposal operations (e.g., Chambers Group 1992, SANDAG and USDN 2000). NOAA whalewatching guidelines to protect California gray whales specify that vessels should do nothing to cause a whale to change direction, maintain a constant vessel speed and not move faster than the whale(s) when paralleling within 300 ft (http://swr.nmfs.noaa.gov/psd/watching.htm). Limiting intentional approach of dredges and/or dump scows within 300 ft (91m) of gray whales and/or maintaining a constant vessel speed that is not faster than movement of whales may be effective for reducing potential disturbance effects during migration if whales are present in the project vicinity.

6.4.2 Schedule and/or Seasonal Restrictions

Schedule and/or seasonal restrictions often are permit requirements to protect sensitive species during dredging and discharge projects throughout the United States (Reine et al. 1998). Regional long-term sediment management plans may specify environmental windows based on site-specific consideration of sensitive species occurrence and use patterns (e.g., LTMS for San Francisco Bay region, USACE et al. 2001).

Reine et al. (1998) reviewed that environmental window restricted periods create logistical challenges and increase costs of sediment management projects. They noted that this is particularly so for waterbodies which support sensitive species with life stage and/or spawning/recruitment periods that cumulatively span most if not the entire year. Compliance with environmental windows based on rigorous technical evidence was not viewed as an issue; however, they noted that conflicts often arise during project coordination because data used to justify certain environmental windows are limited, subjective, or nonexistent. Environmental windows based on fish entrainment and/or migration were specifically questioned because of low observed entrainment rates for all examined fish species, including anadromous fish, and lack of conclusive evidence that turbidity plumes interfere with migration of anadromous adult and juvenile fishes.

The USACE Threatened, Endangered, and Sensitive Species Protection and Management System (http://el.erdc.usace.army.mil/tessp) lists the following environmental window restricted periods for California Corps districts (Table 6.4-2). Environmental windows may vary within a Corps district by life stage, habitat, and/or geographic location within large embayments. For example, several site specific differences in restricted periods are detailed in the San Francisco LTMS (USACE et al. 2001, http://swr.nmfs.noaa.gov/overview/sroffice/2Disposal_windows.html).

Table 6.4-3 lists seasonal periods for California habitats and species reviewed in this document. The seasonal periods generally reference reproductive periods, although for anadromous fish the migratory periods for adults and juveniles are also listed. Superimposed on this table are environmental work window restricted periods from Table 6.4-2. This comparison suggests that restricted periods generally overlap sensitive reproductive and/or migratory periods.

Coastal habitats are productive year-round, but display some seasonal differences in productivity depending on habitat and resources. Spring-summer seasonality is most pronounced for resources that use sandy beach as reproductive habitat (invertebrates, grunion, least tern, snowy plover) (Table 6.4-3).

Table 6.4-2. Environmental window restricted periods specified by the USACE for California sensitive species that have the potential to be affected by sediment management projects associated with beach nourishment.

Species	Los Angeles District	Sacramento District	San Francisco District
Submerged Aquatic Vegetation (SAV)			
Eelgrass	Year round		Year round
Invertebrates			
Dungeness crab			May 1 – Jun 30*
Fish			
California grunion	Mar 15 - Sep 15		
Chinook salmon		Sep 30 – Jun 1	Sep 30 – Jun 1*
Coho salmon			Sep 30 – Jun 1*
Delta smelt		Annual	Jan 1 – Dec 31*
Longfin smelt			Dec 1 – Aug 31*
Pacific herring			Nov 1 – Mar 1*
Sacramento splittail		Jun 1 – Aug 31	Feb 1 – Oct 30*
Steelhead trout	Winter - Spring	Sep 30 – Jun 1	Sep 30 – Jul 31*
Tidewater goby	Apr 1 – May 31		
Recreational finfish			May 1 – Oct 31*
Birds			
California brown pelican			Jul 1 – Sep 30
California clapper rail			Jan 1 – Dec 31*
California least tern	Apr 1 – Sep 15		Mar 15 – Sep7*
Peregrine falcon	May 1 – Jun 30*		
Western snowy plover	Mar 1 – Sep 15		Jan 1 – Dec 31*
Mammals			
Sea otters	Monitors year round		

Note: * Restricted period varies geographically

Lobsters display onshore migration in spring and offshore migration in fall. Winter-spring characterizes spawning periods for many fish species, and several reef fish coincide with kelp occurrence. Several fish species display seasonal onshore movement in summer-fall and offshore in winter. Migratory salmonids have different seasonal spawning runs that help minimize hybridization, and depending on river may include several runs per year (Johnson et al. 1999, CDFG 2001). Most coastal birds that breed in California do so at estuaries and/or the offshore Channel Islands. Coastal areas also provide important stopover and/or overwintering grounds for several migratory bird species. Beaches are primarily used by shorebirds and gulls in summer though early spring and less in May and June. Marine mammals are present year-round.

The topic of environmental windows is reviewed further below for relevant species.

Table 6.4-3. Seasonal recruitment, breeding, and/or spawning periods for representative and high interest California marine resources.

TAXA	J	F	M	A	M	J	J	A	S	O	N	D
Submerged Aquatic Vegetation (SAV)												
Eelgrass (growth)	1	x	x	x	x	x	x	x	x	x	x	31
Surfgrass												
Giant Kelp												
Invertebrates												
Abalone												
California Lobster			i	i	i							
Dungeness Crab	H	H	H	S	1 S	30 S					H	H
Pismo Clam												
Sea Urchin												
Beach Invertebrates												
Subtidal Sand Inverts												
Intertidal Rock Inverts												
Subtidal Reef Inverts												
Fish												
California Grunion			15	x	x	x	x	x	15			
Pacific Herring	x M	x M	1 M				J	J	J	J,M	1 M	x M
Salmonid Migration Chinook	x M,J	x M,J	x M,J	x M,J	x M,J	1 M,J	M,J	M	30 M	x M	X M,J	x M,J
Coho	x M	x M	x J	x J	x J	1			30	x	x M	x M
Steelhead	x M,J	x M,J	x M,J	x M,J	x M,J	x M,J	31 M,J	M,J	30 M,J	x M,J	x M,J	x M
Demersal Fish												
Pelagic Fish						i	i	i	i	i		
Subtidal Reef Fish												
Tidepool Fish												
Birds												
CA Brown Pelican							1	x	30			
CA Least Tern			15	1	x	x	x	x	15			
Western Snowy Plover	x	x	1	x	x	x	x	x	15	x	x	x
Gulls	W	W	W							W	W	W
Terns												
Shorebirds	W	W	M	M			M	M	M	M	W	W
Wading Birds												
Waterfowl	W	W	W							W	W	W
Marine Mammals												
Sea Otters	x	x	x	x	x	x	x	x	x	x	x	x
Pinnipeds												
Cetaceans		M	M	M	M	M					M	M

Sources: Abbott and Hollenberg 1976, Morris et al. 1980, Phillips 1984, Foster and Schiel 1985, Stewart 1989, Cross and Allen 1993, Ware 1993, Williams 1995, Love 1996, CDFG 2001

Notes:

A = adult, J = juvenile; H = eggs hatch, S =larvae settle,

I = inshore distribution, M = migration (only salmonids, shorebirds, and gray whales shown), w = overwinter

Darker Shading represents peak reproductive and/or occurrence period in nearshore coastal zone. Lighter blue shading indicates non-peak reproductive period. Lighter green shading indicates when pelicans congregate in northern California.

Numbers indicate start and end dates of existing environmental window restricted period; x = period between start and end date.

6.4.2.1 Eelgrass

Eelgrass has a year round environmental window restriction in northern and southern California.

Relevant Reports:

- The San Francisco Bay LTMS specifies that resource agency consultation is required year round for eelgrass beds in Central San Francisco Bay, Richardson Bay, South San Francisco Bay, South Central San Francisco Bay, and Waters of Marin (USACE et al. 2001).
- USACE, Los Angeles District and San Francisco District require monitors year round for any dredge type and disposal activities in areas with eelgrass to avoid impacts associated with turbidity, sedimentation, burial and physical removal of plants (http://el.erdc.usace.army.mil/tessp/).

Consideration of Effectiveness:

Eelgrass may exhibit seasonal growth and die-back of blades, but is a highly persistent habitat as a result of buried rhizomes. Eelgrass habitat supports numerous ecological functions and values and is regulated to avoid any net loss (NMFS et al. 2005, Section 3.3.8). A year round environmental window restriction is considered effective for highlighting habitat sensitivity and necessity of resource agency coordination as part of permitting process.

6.4.2.2 Invertebrates

Few seasonal restrictions have been used to minimize impacts to invertebrates.

Dungeness Crab

Relevant Reports:

- Dredging is restricted between May 1 through June 31 for shallows in San Francisco Bay/Delta Estuary and San Pablo Bay to protect against entrainment of early life stages (http://el.erdc.usace.army.mil/tessp/) (Table 6.4-2).
- Dredging has been scheduled during late August to late September in Crescent City Harbor to avoid direct impacts to mating Dungeness crabs (USACE 1998c).

Consideration of Effectiveness:

The use of environmental window restricted periods to protect this species is supported by relevant reports of increased vulnerability to dredge impacts (physical and/or entrainment) in areas where the species may congregate (Section 4.2.3). Most larval settlement occurs between April and June (Wild and Tasto 1983) and mating occurs from February to June (CDFG 2001). Therefore, restrictions from May through June may minimize (not fully avoid) entrainment during larval recruitment and potential physical disturbance of adult crab mating congregations. The environmental window does not address when berried females are more sedentary.

In contrast, other Northwest Pacific UCACE districts have longer duration environmental window restricted periods to protect Dungeness crabs from entrainment and physical disturbance (http://el.erdc.usace.army.mil/tessp/). The prolonged environmental windows cover most of the time period associated with mating, berried females, and larval recruitment.

Differences in level of protection associated with environmental window restrictions among USACE Districts in California, Oregon, and Washington suggest that appropriate application of environmental window restrictions should consider existing conditions in the area of potential effect; e.g., if and at what life stage Dungeness crabs concentrate in the area. Generally, environmental window restrictions have been applied in embayments. Dungeness crabs also may congregate in the nearshore (Section 4.2.3), therefore, this measure may be a relevant consideration for projects involving nearshore dredging and/or disposal depending on existing conditions.

Invertebrate Community

Relevant Reports:

- Avoidance of peak recruitment periods has been suggested to minimize recovery times of sandy beach invertebrate communities (Parr et al. 1978, Reilly and Bellis 1983, Peterson et al. 2000a, Greene 2002).
- Small, opportunistic sand placement projects in San Diego County that are conducted between March 1 and May 31 are required to not exceed 25,000 cy per month, be scheduled no less than two weeks apart, spaced at least 150 ft (46 m) apart, and not involve disturbance of previous placement locations to minimize impacts to invertebrate recruitment; placement is restricted during summer (Moffatt and Nichol 2006b).

Consideration of Effectiveness:

No environmental work window restrictions have been specified for invertebrate communities. The recommendation that impacts may be minimized by project schedule is supported by monitoring studies that have documented rapid invertebrate recovery when projects were completed prior to the onset and/or early in the spring recruitment period (Parr et al. 1978, Gorzelany and Nelson 1987, Versar 2004) or later in the season coinciding with natural seasonal decline with primary recruitment the following spring (Burlas et al. 2001, Versar 2004). Depending on beach type, sandy beach invertebrate populations may be highly seasonal with recruitment and growth over spring and summer and decline over winter, although this is less so for beaches with less sand mobility (Section 4.2.6).

Extent of recovery within the first year after beach nourishment is influenced by project timing. For example, populations have more time to recover when disturbance ends prior to spring recruitment and less time if a project is completed later in the season. This may be an important consideration for beaches that support wintering snowy plovers and/or overwintering populations of shorebirds since invertebrate biomass represents primary prey for those species.

A mitigation to avoid repetitive placement of the same area during the same year and to minimize placement volume during spring and summer is described in Section 6.3.3.1.

6.4.2.3 Fishes

Programmatic EFH Conservation Recommendations for adverse effects of dredging (turbidity and loss of benthic organisms) include time-of-year restrictions; avoidance of SAV and shellfish beds; post-dredging restoration of gravel spawning beds and other provisions in the 1996 NOAA Fisheries National Gravel Extraction Policy (NOAA 2004). Table 6.2-3 lists schedule restrictions to protect fish species.

California Grunion

Relevant Reports:

- RGP 67 normally restricts beach deposition between March 1 and August 31, but specifies that that deposition outside that period may be conducted when the following conditions are satisfied: consultation with CCDFG, approval of a monitoring and reporting program including approved contingency measures, limited to 24 to 72 hours prior to a predicted run (based on grunion calendar produced by CCDFG), and restricted immediately following a documented run (USACE 2006).
- Dredge discharge on the beach may be restricted from March 15 through September 15 by the USACE, Los Angeles District to avoid physical disturbance of spawning (http://el.erdc.usace.army.mil/tessp/) (Table 6.4-2).
- Sand placement restriction from March 30 to September 30 for Surfside-Sunset Beach Nourishment Project (USACE 1995a).
- Sand placement restriction from March 15 and August 15 recommended for BEACON Beach Nourishment Demonstration Project (Chambers Group 1992).
- Sand placement restriction from March 1 to Aug 31 recommended for Bolsa Chica Lowlands Restoration Project (Chambers Group 2000a).
- Sand placement restriction on the beach from May through August and allowance for single-point surf zone discharge in March and April has been specified for several harbor maintenance dredging and beach disposal projects at Oceanside, Santa Barbara, and Ventura (USACE 1994b, 1998a, 1998b, 2000b).
- Sand placement restriction on the beach from May through September with allowance for surf-zone discharge and monitoring in March and April was specified for harbor maintenance and beach disposal at Santa Barbara (USACE 1993).
- Sand placement restricted or allowed with monitoring between March 15 and September 15 was specified as implementation guidlines for the BEACON South Central Coast Beach Enhancement Program (Moffatt & Nichol 2005a).

Consideration of Effectiveness:

Avoidance of the grunion spawning season precludes any potential impacts to spawning activities as a result of beach nourishment activities that disturb the upper intertidal zone. The above-noted relevant reports indicate there has been some variability in specification of environmental window restricted periods; i.e., March 1, 15 or 30 specified for the start and August 15 or 31 or September 1, 15, or 30 for the end of the restricted period. The spawning season may begin as early as late February or March and extend as late as August or September, with heaviest runs from April through June (Martin 2006). Therefore, any of the above-noted restricted periods would be effective at protecting most of the grunion season and the majority of spawning activity. A standardized environmental window restricted period of March 1 though August 31 is recommended to simplify environmental documentation and consistency among permitted projects; that period coincides with the predicted run schedule posted by the CDFG (http://www.dfg.ca.gov/mrd/gruschd.html).

The effectiveness of this measure is directly associated with whether or not grunion spawn during the period of planned beach nourishment activities. This may be related to time of year, habitat suitability, and/or local variation in grunion behavior. A schedule restriction may be unnecessary at erosive beaches early in the grunion season due to unsuitable habitat, which may be determined with a habitat suitability survey (Section 6.3.3.3). Sand placement during the grunion season with monitoring and coordination with resource agencies is further discussed in Section 6.4.5.4

Pacific Herring

Relevant Reports:

- Dredging may be restricted between November 1 through March 1 by the USACE, San Francisco District to avoid disturbance to spawning, fishing, and roe collecting industries (North Coast) (http://el.erdc.usace.army.mil/tessp/) (Table 6.4-2).
- Dredging may be restricted between December 1 through February 28 by the USACE, San Francisco District to avoid entrainment and interference with spawning activities and habitat in historical spawning areas in San Francisco Bay/Delta Estuary (http://el.erdc.usace.army.mil/tessp/, USACE et al. 2001).

Consideration of Effectiveness:

The above-noted environmental window restricted periods apply to the four commercial fishing areas in the state (Crescent City Harbor, Humboldt Bay, Tomales Bay, and San Francisco Bay). The open fishing seasons for those areas range from December/January through February/March depending on location (http://www.CDFG.ca.gov/mrd/_herring/index.html). For example, 2007 open fishing seasons (start and end dates vary by location) range from December through March (San Francisco Bay), December through February (Tomales Bay), and January through March (Humboldt Bay, Crescent City Harbor). The above-noted relevant reports of dredging restricted periods may be longer (e.g., Humboldt Bay, Crescent City Harbor) or shorter (San Francisco Bay) than the allowed open fishing seasons. Therefore, the environmental window restricted periods may be overly restrictive or not fully effective at minimizing potential interference with fishing and roe collection activities depending on project location and existing conditions.

Pacific herring spawning may occur from late October through April; however, most spawning occurs from December through March and peaks in January–February (Section 4.2.3). Eggs hatch after 10 days and juveniles may remain in estuaries until summer, adults leave shortly after spawning. The environmental window restricted periods cover most (not all) of the potential spawning season and all of the peak spawning period, and therefore, may be effective at minimizing potential impacts to spawning. The CDFG conducts Pacific herring spawning assessments, which summarize detected spawning events at the regulated embayments (http://www.CDFG.ca.gov/mrd/herring/index.html). The assessments indicate that the dredging schedule restrictions may exceed actual spawning events depending on year and geographic location. Therefore, the environmental window restricted periods may be overly restrictive depending on location and existing conditions. The CDFG maintains a Herring Hotline for San Francisco Bay that provides information on location of herring schools and spawning events (http://www.CDFG.ca.gov/mrd/herring/sf_bay.html). The Hotline may be effective for review of dredging schedules in that embayment in the event of project delays affecting potential construction start and/or end dates.

The environmental window restricted periods may be effective at minimizing potential entrainment impacts during the spawning season. However, young herring remain in estuaries until summer to early fall. Therefore the above-noted environmental window restricted periods may not be fully effective at minimizing potential entrainment impacts, which may have higher risk during the day when herring may congregate near the bottom and less risk at night when herring are near the surface to feed (Section 4.2.3).

LFR (2004) summarized that limited information is available on spatial and temporal distribution of herring larvae and juveniles in San Francisco Bay, and such information could contribute to refinement of environmental windows and enable more effective (i.e., focused) protection of populations. This concern also may apply to other embayments used as nursery areas. Therefore, operational controls to reduce entrainment risk (Section 6.4.3.2) may be appropriate in embayments used as nursery habitat by Pacific herring.

Salmonids

Relevant Reports:

- Dredging may be restricted from September 30 to June 1 by USACE, San Francisco and Sacramento Districts to avoid disturbance of migrating adults and smolts (http://el.erdc.usace.army.mil/tessp/) – Chinook, Coho, steelhead.
- Dredging may be restricted during different time periods (e.g., October 1-May 31, October 15-July 31, November 1-May 15, or December 1-May31) by USACE, San Francisco District based on geographic location to avoid interference with migration, degradation of water quality, direct habitat loss or degradation, interference with foraging or food resources, entrainment (juveniles) ((http://el.erdc.usace.army.mil/tessp/, USACE et al. 2001) – Chinook and/or Steelhead.
- Dredging may be restricted during winter-spring by USACE, Los Angeles District to avoid detrimental impacts on migration (http://el.erdc.usace.army.mil/tessp/) – steelhead.

Consideration of Effectiveness:

LFR (2004) summarized that limited information is available on spatial and temporal distribution of juvenile Chinook and Coho salmon and steelhead in San Francisco Bay, and such information could contribute to refinement of environmental windows and enable more effective (i.e., focused) protection of populations. This concern also may apply to other embayments with tributary streams used by migrating individuals and/or used as nursery areas.

Generally, entrainment of salmonids is not an issue because dredging occurs below the depth where salmonids migrate (Larson and Moehl 1990, Carlson et al. 2001, NMFS 2002). However, entrainment rates are of concern in constricted waterways, river channels, and/or shallow depths where it may be difficult for juvenile salmonids to avoid the dredge operation (LaSalle et al. 1991, Reine and Clarke 1998). Therefore, environmental window restrictions may be effective for minimizing impacts to migrating salmonids in narrow waterways, shallows, and/or mouths of rivers and/or estuaries where effects of entrainment and/or turbidity may be more pronounced. In open expanses and/or deeper water, operational controls to reduce entrainment and turbidity effects (Sections 6.4.3.2, 6.4.3.3) also may be effective for minimizing impacts to migrating salmonids.

<u>Other Species</u>

Relevant Reports:

- Dredging may be restricted by USACE, Los Angeles District between April 1 and May 31 to avoid physical disturbance of breeding and spawning of tidewater goby (http://el.erdc.usace.army.mil/tessp/).
- Dredging may be restricted by USACE, Sacramento and San Francisco Districts during different time periods (January 1-December 31) depending on geographic area to avoid entrainment, degradation of spawning habitat, and/or direct habitat loss of Sacramento splittail (http://el.erdc.usace.army.mil/tessp/, USACE et al. 2001).
- Dredging may be restricted by USACE, Sacramento and San Francisco Districts during different time periods (January 1-December 31) depending on geographic area to avoid entrainment and degradation of spawning habitat for Delta smelt (http://el.erdc.usace.army.mil/tessp/, USACE et al. 2001).
- Dredging may be restricted by USACE, San Francisco District during different time periods (December 1-August 31) depending on geographic area to avoid entrainment and degradation of spawning habitat for longfin smelt (http://el.erdc.usace.army.mil/tessp/, USACE et al. 2001).
- Disposal is minimized at SF-10 and SF-11 between May and October by USACE, San Francisco District to minimize impacts to recreational finfish (USACE et al. 2001).

Consideration of Effectiveness:

The effectiveness of environmental window restrictions on other sensitive fish species depend on project location and existing conditions (occurrence of species). Similar to salmonids, constricted waterways and/or shallows may be important considerations with respect to the effectiveness of this measure. Tidewater goby may inhabit shallow estuaries and lagoons. Delta smelt may inhabit rivers and sloughs.

An environmental window restricted period applies to disposal at sites in San Francisco Bay (SF-10 and SF-11) to minimize potential interference with recreational fishing. This restriction is based on minimizing interference with other uses rather than a biological criterion.

6.4.2.4 Birds

Appendix Table 6.4-2 lists schedule and prohibition zones used to protect sensitive bird species during beach nourishment. Schedule restrictions have been used to avoid and/or minimize potential impacts to sensitive bird species during sediment management projects. In most cases, the restrictions have coincided with breeding seasons of endangered and/or threatened species. In the case of California brown pelicans, a seasonal period is associated with a buffer distance restriction.

California brown pelican

Relevant Reports:

- Dredging and disposal activities are restricted within 300 ft (274 m) of large communal roosts one hour before sunset to sunrise by USACE, San Francisco District between July 1 and September 30 to avoid disruption of brown pelicans at large roost sites (http://el.erdc.usace.army.mil/tessp, USACE et al. 2001) (Table 6.4-2).
- In southern California, environmental windows specified for least tern (e.g., April through September) generally have been considered protective of brown pelican (e.g., USACE 1995a, 2000b).

Consideration of Effectiveness:

Mainland roost sites are essential to brown pelicans since they must come ashore to dry their plumage. Large communal roosts are considered essential habitat throughout their range (American Trader Trustee Council 2001). The July through September restricted period in northern California is supported by the migratory pattern of the species. Post-breeding pelicans disperse to central and northern California beginning in May, with peak numbers in July through September (Small 1994). Monitoring studies suggest brown pelicans become habituated to repetitive activities, but startle to sudden loud noises and/or spot lighting (Jaques et al. 1996, Varanus 1999). This suggests that a buffer distance should be an effective mitigation measure.

California least tern

Relevant Reports:

- Dredging and disposal activities may be restricted by USACE, San Francisco District from January 1 to December 31 to avoid turbidity effects on foraging activities and degradation of eelgrass beds, which represent important foraging habitat (http://el.erdc.usace.army.mil/tessp/).

- Dredging and disposal activities may be restricted by USACE, Los Angeles District from April 1 to September 15 to avoid impacts on nesting and foraging activities (http://el.erdc.usace.army.mil/tessp/).
- An environmental work window restricted period of April 1 to September 15 has been used for several dredging and/or beach nourishment projects (e.g., USACE 1999b, Batiquitos USACE permit); however, in areas where both least tern and snowy plover occur, one environmental window restriction that covers both species (e.g., March 15 to September 15) has been specified (e.g., USACE 1995a, 1998b, 1999b, 2000b, Chambers Group 2001).

Consideration of Effectiveness:

A fall-winter environmental window (restricted during months of April - September) has been used to avoid disruption of nesting activities of least terns. This measure is effective because of the migratory behavior of least terns, which do not occur in California during the non-breeding season.

Sometimes sediment management activities during the breeding season of least tern have been approved in coordination with resource agencies with implementation of other mitigation measures such as construction monitoring (e.g., MEC 1997). Review of available information suggests that use of a buffer and operational control of turbidity may be effective measures to protect California least tern during sediment management activities (Sections 6.3.6.2, 6.4.3.2, 6.4.4).

Snowy Plover

Relevant Reports:

- Dredging and disposal activities may be restricted by USACE, Los Angeles District from March 1 to September 15 to avoid disruption of nesting activities (http://el.erdc.usace.army.mil/tessp/).
- Dredging and disposal activities may be restricted by USACE, San Francisco District from January 1 to December 31 to avoid degradation of mudflat foraging habitat (http://el.erdc.usace.army.mil/tessp/).
- The environmental work window restricted period has varied among sediment management projects, for example:
    - March 1 to September 15 (USFWS 2000, USACE 2001).
    - March 1 to September 30 (USACE 1995a, 1999a)
    - March 15 to September 15 (USACE 1994a, 1994b, 1998b, 2000, Chambers Group 2001).
    - March 15 to August 15 (Chambers Group 1992).
    - Year round for San Francisco Bay (USACE et al. 2001).
- Protective measures recommended for piping plovers during beach nourishment on the Atlantic coast of the United States include a seasonal restriction of placement activities, pipeline storage, and pipeline removal between April 1 and August 31, unless work will enhance habitat (Melvin 2005).

Consideration of Effectiveness:

Because snowy plovers may occur throughout the year on California beaches, the environmental window restricted period has been used to avoid disruption of nesting activities of snowy plovers. Human disturbance of nesting has been considered a primary contributing factor to the decline of the species (Bruce et al. 1994). Therefore, avoidance of the breeding season in areas where snowy plovers nest is considered effective for minimizing impacts to populations.

Similarly, a seasonal restriction during the breeding season is used to minimize impacts to endangered piping plover on the East Coast of the United States, unless work will enhance habitat. Temporary benefits to snowy plover habitat from beach nourishment also is recognized (SAIC 2006, USFWS 2001).

Sometimes sediment management activities that have extended into the breeding season of snowy plover have been approved in coordination with resource agencies with implementation of other mitigation measures such as surf zone or single-point, diked discharge (Sections 6.4.1.3), construction monitoring (Section 6.4.5.5), and/or additional predator control (USFWS 2000).

<u>(4) Peregrine Falcon</u>

Relevant Reports:

- An environmental window restriction period from May 1 to June 30 is specified by the USACE, Los Angeles District to avoid the sensitive nesting period. (http://el.erdc.usace.army.mil/tessp).
- The May 1 to June 30 environmental window restriction has been applied to sediment management projects at Anaheim Bay Harbor, Los Angeles Harbor, Morro Bay Harbor, Newport Harbor, Port Hueneme Harbor, and Ventura Harbor (http://el.erdc.usace.army.mil/tessp).

Consideration of Effectiveness:

Peregrine falcons may nest on cliff ledges and/or man-made structures (e.g., bridges) in urban areas. They feed on other birds (Hunt 1994); therefore, no impacts to food resources are expected from dredging activities. The primary impact concern is from noise and activity disturbance during their nesting season. This suggests that a buffer distance may be as effective a measure to minimize impacts. The effectiveness of this measure relates to project location and existing conditions, which may be more effectively addressed by use of a buffer distance. Average noise levels would be expected to attenuate to 60 dBA at distances of 328 to 650 ft (100 to 200 m) depending on dredge equipment (Section 5.3.3.6). Therefore, peregrine falcon nesting activities would not be expected to be adversely affected by dredging activities at distances > 650 ft (200 m).

6.4.2.5 Marine Mammals

Relevant Reports:

- The USACE, Los Angeles District specifies that monitors are required year round to avoid injury/mortality to sea otters from collisions (http://el.erdc.usace.army.mil/tessp).

Consideration of Effectiveness:

Available information suggests that sea otters are relatively tolerant of vessel activity, but may avoid heavily used areas (Richardson et al. 1995). A temporary decline in sea otters abundance was observed during maintenance dredging in Morro Bay (Bodkin and Rathbun 1988).

Vessel strikes of sea otters and pinnipeds have been associated with fast moving vessels (Carretta et al. 2004, Harvey 2004). Generally, no effects occur when vessels travel between 4 and 6 kn (Laist et al. 2001). Dredge vessels generally operate at a relatively slow speed while dredging. Risk of collision from support work boats may be minimized by limiting vessel speed in areas near pinniped haul-outs and areas where sea otters congregate. This may be as or more effective than use of monitors.

6.4.3 Construction Equipment and Operational Controls

Several impact minimization measures involve methods associated with construction. These may include selection of certain types of equipment, operational controls, use of best management practices (BMPs), and/or modification of discharge locations. Many of the construction method minimization measures seek to reduce indirect impacts to biological resources associated with turbidity, entrainment, discharges, and/or noise. Examples of types of construction method mitigation measures are given below.

The review of water quality monitoring data in Section 5.5.3 suggests that contractors are effective in controlling the spatial extent of turbidity plumes. However, the specific effectiveness of any particular measure is difficult to evaluate because water quality reporting requirements do not require specification of what control measures were in place at the time monitoring measurements were collected, and few monitoring reports include that information.

6.4.3.1 Dredge Equipment Selection

Dredges vary in operational characteristics, which result in differences in suspended sediment plumes and concentrations (Sections 5.5.2). Generally, turbidity plumes and suspended sediment concentrations range from smallest to largest for the following types of dredge equipment:

- Cutterhead dredge, Hopper dredge without overflow, closed bucket dredge.
- Open clamshell bucket dredge, hopper dredge with overflow.

Dredge equipment has been modified to increase operational performance and/or effectiveness in minimizing environmental impacts. Use of closed buckets to reduce turbidity and use of larger bucket size to reduce duration of impact exposure are two of the more commonly referenced modifications, which are reviewed below.

Closed bucket dredge

Turbidity is minimized because there is less overflow spillage from closed bucket relative to conventional bucket dredges.

Relevant Reports:

- Turbidity levels up to 79% less than observed with a conventional bucket were reported for the Cable Arm closed bucket when dredging soft sediments (USACE 2001b cited in Anchor Environmental 2003).
- Analyses indicate that closed buckets may generate 30 to 70% less turbidity (Palermo and Pankow 1988 cited in Chambers Group 2001b).
- The effectiveness of a closed bucket may be reduced if air is trapped in the bucket at impact. Collins (1995) reported TSS concentrations of 150 mg/L with a closed bucket and 250 mg/L with a conventional bucket for one project. However, TSS concentrations were 150 mg/L for a closed bucket compared to 55 mg/L for a conventional bucket in another study. Air trapped in the bucket possibly contributed to greater bucket impact in the second study.
- Sediment type may influence effectiveness. Closed buckets have been reported to be ineffective and/or less effective at dredging consolidated material (Anchor 2001, Chambers Group 2001b).

Consideration of Potential Effectiveness:

The above noted report indicates a closed bucket is effective at reducing turbidity. Available reports indicate that turbidity plume extent and TSS concentrations generally are greater with a conventional bucket dredge than with a closed bucket dredge (Section 5.5.3.1).

Bucket Size

Bucket size may influence project schedule as a result of differences in sediment capacity. Bucket size also may influence generated turbidity as a result of differences in weight impacting the bottom.

Relevant Reports:

- Anchor Environmental (2003) reported that larger than normal dredges provide fewer disturbances due to less traffic and fewer dumps.
- Chambers Group (2001b) statistically determined that there was significantly less turbidity generated by a 10-cy bucket compared to a 14-cy bucket during the 1998 Marina del Rey, California maintenance dredging project (Chambers Group 2001). The small bucket released less water as it was raised through the water column. Chambers Group (2001b also considered that environmental impacts may be less in situations where larger buckets can remove more sediment per load than smaller buckets and reduce overall length of project schedule.

- Less sediment resuspension appears to result from small versus large bucket dredges (Collins 1995).

Consideration of Potential Effectiveness:

The effectiveness of bucket size as an impact minimization measure may vary depending on project and site specific environmental conditions. Some situations may favor selection of a small bucket, while others may favor a large bucket. For example, a small bucket may be preferred to reduce sediment resuspension near areas with sensitive resources. Use of a larger dredge may be effective in reducing overall impacts if the construction schedule is substantially shortened (e.g., weeks to days, months to weeks), but would not substantially minimize impacts if the project only realized a small incremental difference in construction duration (e.g., days).

6.4.3.2 Dredging Operational Controls – Entrainment

The following types of measures may be appropriate considerations for reducing entrainment impacts based on the following relevant reports and consideration of behavior of resources of concern:

- Restrict operation of suction pumps when dredge cutterhead and/or draghead are above the sediment surface.
- Use bucket dredge in confined and/or shallow water work areas for limited footprint and duration projects during periods when ecologically sensitive resources are concentrated in consultation and with approval from resource agencies.
- Alter daily dredge cycle (day, night operations) to minimize impacts near ecologically sensitive areas where resources of concern undergo daily vertically migration in the water column.

Relevant Reports:

- Maintain, to the extent possible, the cutterhead or draghead below the substrate surface, and stop pumping if cutterhead or dragarm is raised more than 3 ft (1 m) above substrate (NMFS 2002).
- Restrict use of suction dredges in waters that are < 15 ft (4.6 m) deep during the migratory period of salmonid fry, and restrict activation of suction pumps to when cutterhead or draghead is < 5 ft (1.5 m) from the bottom (Arseneault 1981 cited in LaSalle et al. 1991).
- Use dredge types that are less likely to entrain fish in areas where there is a high risk of entrainment. It may also be possible to moderate inflow velocities of the [suction] dredge, although this would also stretch out the required dredging time (IMG-Golder 2004).
- Studies have shown little correlation between entrainment rates and bottom depth, hopper dredge speed or cutterhead rates of advance, flow-field velocities generated at the draghead or cutterhead, or volume of dredge material (Reine and Clarke 1998).
- Direction of dredging relative to tidal flow, with higher entrainment rate while dredging against ebb tide was reported during one study, but was not duplicated

in three years of follow-up studies (Larson and Patterson 1989 cited in Reine and Clarke 1998).

- Modified dragheads produce similar entrainment rates as conventional dragheads (McGraw et al. 1988 cited in Reine and Clarke 1998).

Consideration of Potential Effectiveness:

Entrainment results when dredge operations remove animals along with water (Section 5.3.2.3). Entrainment concerns mainly are associated with suction dredges when the suction field is still in operation above the sediment surface (LaSalle et al. 1991, Reine and Clarke 1998). For example, a mean entrainment rate of shrimp was 0.69 shrimp/cy when the suction field was at or near the bottom, but reached 3.38 shrimp/cy when the cutterhead or draghead was raised and clean water was pumped to wash out the system (Armstrong et al. 1982 cited in Reine and Clarke 1998). Therefore, a restriction on the depth above the bottom at which the pumps are allowed to operate should be effective for minimizing entrainment effects. Of the above-noted relevant reports, the recommendation by NMFS (2002) is most protective; i.e., maintain the suction dredge below the substrate surface to the extent possible and stop pumping if the suction head is more than 3 ft (1 m) above the sediment surface.

Use of bucket dredges instead of suction dredges in areas where entrainment is more of a concern (e.g., confined waterways, shallows) may be effective for minimizing impacts. Two factors may contribute to reduced entrainment with clamshell dredges: avoidance of low-frequency vibrations produced by lowering the bucket through the water, and increased turbidity when the dredge hits the bottom (Stevens 1981 cited in Reine and Clarke 1998). A bucket dredge often is the dredge of choice in situations where small volumes of material in spatially restricted areas need to be removed (LaSalle et al. 1991). However, a bucket dredge may be less effective for channel maintenance projects requiring removal of large sediment volumes, unless a large capacity bucket dredge is used (LaSalle et al. 1991). The overall benefit of this measure also should be considered in balance with turbidity impacts, which may be higher for mechanical than hydraulic dredges (Section 5.5.3.1).

Limited available information suggests that other operational controls designed primarily to address turbidity issues (e.g., dredge speed or rates of advance, suction velocities, volume of dredge material) do not appear to affect entrainment rates (Reine and Clarke 1998). Insufficient information is available to assess whether entrainment rates may be influenced by tide stage.

Altering the daily dredge cycle (day, night operations) to the time when resources of concern are above the bottom may be another consideration for minimizing entrainment effects. For example, Pacific herring congregate near the bottom or mid-water schools during the day, but migrate towards the surface to feed at night (Section 4.3.2). Therefore, it is possible that conducting dredging at night may minimize entrainment concerns in areas nearby and after major spawning events. Although distribution of juvenile herring may not be well known, there is some evidence that larvae and young juveniles concentrate near their spawning sites and/or in shallows and older juveniles are more dispersed (CDFG 1992 cited in LFR 2004). Therefore, This measure may be more effective within 90 days of major spawning events. The overall benefit of this measure should be considered in balance with potential night-time light attraction and increased predation.

In areas where there is more risk and/or concern for entrainment (e.g., constricted waterways, shallows, adjacent to spawning and/or nursery areas), operational controls may not be fully effective for minimizing impacts. In such situations, environmental window restrictions may be more effective (Section 6.4.3).

6.4.3.3 Dredging Operational Controls – Turbidity

Bucket Dredges

Several factors contribute to sediment resuspension by bucket dredges, including sediment impact, penetration, and withdrawal, and loss of sediment during bucket ascent, removal from the water, and as the bucket is swung to the point of bucket release (Hayes et al. 1988, Collins 1995). Operational controls address each of those steps of bucket operation.

Relevant Reports:

The following operational controls have been reported for bucket dredges (LaSalle et al. 1991, Collins 1995, Chambers Group 2001, Anchor Environmental 2003):

- Slow the cycle time – This measure reduces the velocity of the bucket hitting the bottom and may reduce sediment wash out as the bucket is raised through the water column.
- Eliminate multiple bites – The practice of multiple bites involves repetitive lowering, raising, and reopening the bucket to obtain a fuller sediment load. Eliminating multiple bites reduces the number of times an impact wave of suspended sediment travels along the bottom away from the dredge and reduces sediment loss in the water column associated with reopening the dredge.
- Eliminate bottom stockpiling – Stockpiling of silty dredge material on the bottom increases sediment resuspension; therefore, restricting this practice may reduce suspended sediment concentration.
- Bucket Wash – Rinsing the bucket out at the barge to clean off excess sediment between loads may reduce sediment release in the water column.
- Waterline Pause – Briefly stopping the bucket at the waterline allows excess water to drain before raising the bucket from the water.

Consideration of Effectiveness:

The above-noted measures may be effective at reducing turbidity because they address limiting bottom disturbance, sediment resuspension, and sediment leakage and/or washout of the bucket. Some measures are more applicable to conventional than closed buckets, however, measures applicable to both include slowing the cycle time to reduce physical disturbance of the bottom and washing of the bucket. The applicability of both these methods likely depends on sediment characteristics and hydrodynamics in the project area; being more effective for fine sediments than sands. A potential disadvantage with slowing the cycle time may be an increase in project duration. Slowing the velocity of the bucket may reduce the volume of sediment obtained by the bucket during each bite (Chambers Group 2001, Anchor Environmental 2003).

Cutterhead Dredges

Sediment resuspension from a cutterhead dredge results when the suction does not keep pace with sediment agitation/slurry, resulting in sediment resuspension or release (Collins 1995). The operational controls primarily address slowing sediment slurry production to the speed the suction pump can handle and/or keeping the cutterhead at or near the sediment surface.

Relevant Reports:

The following operational controls have been reported for cutterhead dredges (LaSalle et al. 1991, Collins 1995, Anchor Environmental 2003):

- Reduce cutterhead rotation speed – Reducing the rotation speed reduces the potential for side casting of sediment away from the cutterhead and slows production rate.
- Reduce swing speed of dredge head (ladder) – Reducing the swing speed ensures the dread head does not move through the cut faster than it can hydraulically pump the sediment. Typical swing speeds are 5 to 30 ft/minute (Anchor Environmental 2003).
- Increase pump rates – Increasing the suction rate will tend to reduce the amount of resuspended sediments around the cutterhead.
- Operate cutterhead below sediment surface – Maintaining, to the extent possible, the cutterhead just below the substrate surface minimizes sediment resuspension turbidity associated with partial cutting (some blade exposure) and fully buried cutting (sediment cave-in).
- Eliminate bank undercutting – Removal of sediment in lifts ≤ 80% of cutterhead diameter reduces cave-ins and sloughing.

Consideration of Effectiveness:

Collins (1995) provides a comprehensive review of the factors and effectiveness of most of the above-noted operational controls. That reference is the primary basis for the following summary of effectiveness considerations. The rotation speed of the cutterhead and swing speed of the dredge head are primary factors that influence the amount of sediment resuspension and may be optimized by dredge operators to control turbidity. The direction of the ladder swing relative to cutterhead blade rotation also is important, with greater resuspension when the cutterhead is overcutting (shear velocity higher) than undercutting (shear velocity lower). This generally is more pronounced with cohesive than non-cohesive sediments. Increasing the rate at which the slurry is drawn into the suction pipe may reduce the amount of sediment around the cutterhead.

Maintaining the cutterhead below the sediment surface has been shown to significantly reduce resuspension compared to partial burial (exposure of blades above the mudline allows more opportunity for wash off) and deep burial (results in slouging and cave-in along the dredge path). Maintaining the cutterhead below the sediment surface also reduces entrainment rate (Section 6.4.3.2).

Hopper Dredges

Sediment resuspension from a hopper dredge results when hoppers are intentionally overfilled so excess water runs overboard while greater density is achieved in retained sediment-laden slurry; this practice is used to maximize sediment load. Spillage also may occur while the vessel is underway if hoppers are too full. Operational controls address minimizing intentional overflows and/or unintentional spillage. In addition, a water recirculation system may be used to return overflow waters to the draghead.

Relevant Reports:

The following operational controls have been reported for hopper dredges:

- Eliminate Overflow – Minimizing sediment overflow spillage from the vessel reduces turbidity plumes and suspended sediment concentration (LaSalle et al. 1991, Collins 1995, Anchor Environmental 2003).
- Reduce Fill Level – Lowering the hopper fill level minimizes overflow spillage during rough sea conditions (Anchor Environmental 2003).
- Use a Recirculation System – Recirculation of overflow water to the draghead may increase sediment load in hopper (Anchor Environmental 2003).
- Equip with morning glory spillway – This conveys overflow water subtidally.

Consideration of Effectiveness:

Hopper dredge overflow produces substantially higher (e.g., an order of magnitude) suspended sediment concentrations than the dredging action itself (reviewed in LaSalle et al. 1991, Section 5.5.2.2). This results from the high suspended sediment concentration of slurry waters only having a short retention time in the hoppers (Collins 1995). Therefore, elimination of intentional overflows should be effective for reducing turbidity. A reported disadvantage of this operational control is increased costs and project duration due to less efficient production rates (Anchor Environmental 2003).

Use of a morning glory spillway that conveys overflow water 15 to 20 ft (4.5 to 6 m) below the water surface to reduce surface turbidity was listed as a conservation measure in the biological opinion for the 2001 2001 San Diego Regional Beach Sand Project (USFWS 2000), which was specified as requirement in the 404 permit for that project (USACE No. 1999-15076-RLK). Monitoring showed that depression of water clarity was primarily within 500 ft (152 m) of the dredge (Section 5.5.3.5, Figure 5.5-7) and turbidity plumes complied with permit requirements (i.e., ≤ 1 hectare, 2.47 acres) with few exceptions (AMEC 2002). Therefore, this measure appears to be effective at controlling surface water turbidity.

Other measures such as recirculating overflow water near the draghead and/or discharge of overflow water to mid-depth or deeper water enable more efficient production rates and reduce surface turbidity, which may be effective for meeting water quality Receiving Water Limitations. Those measures may increase suspended sediment concentrations at depth beyond that without overflow, which should be taken into consideration if sensitive habitats (e.g., reefs, SAV, spawning grounds) are in the vicinity.

Limiting the hopper fill level addresses unintentional overflows during rough seas, which may be more or less effective depending on existing conditions

Halt operations

Relevant Reports:

- Anchor Environmental (2003) reported that halting dredging can be an effective measure for reducing turbidity during periods of extreme tidal fluctuation when currents are strongest.
- RGP 67 specifies that if turbidity is greater than one-half mile from discharge site (either upcoast or downcoast) for five (5) consecutive days, the discharge shall be halted or modified to reduce turbidity.

Consideration of Effectiveness:

Halting construction operations may be necessary to stop significant and/or unpermitted adverse impacts, if necessary, until operations can be modified to reduce turbidity to acceptable levels or until environmental conditions moderate. This measure may be effective when implemented infrequently, but may increase project duration and costs if frequent halts to construction are required.

Inspection and Repair of Pipeline Leaks

This measure involves pipeline inspection and repairs to avoid and/or minimize sediment loss from hydraulic pipelines.

Relevant Reports:

- Leaky hydraulic pipeline connections may increase turbidity (LaSalle et al. 1991).
- Leaky hydraulic pipeline connections pose a threat to snowy plover nest sites, if present (Hutchinson et al. 1987).

Consideration of Effectiveness:

Sediment loss from pipeline leaks or breaks has the potential to increase suspended sediment concentrations and/or sediment burial in unwanted locations. This may be of particular concern in areas where pipelines are placed in close proximity to sensitive reef, SAV, and/or coastal strand habitats. Pipeline leaks deposit fine aprons of sand, making the area homogenous and unsuitable for snowy plover's, which require the sand surface to be heterogeneous to camouflage their nests (Hutchinson et al. 1987).

Periodic inspections of above water pipelines should be effective for early problem identification and repairs. This is of particular importance in areas where snowy plovers may be nesting. In areas lacking nesting activity, increased turbidity is the primary concern. Monitoring of the discharge should be effective for detection of a drop in production rate that may signal a pipe break. Turbidity monitoring may be effective for detection of a substantial change in surf zone or nearshore turbidity characteristics that may signal pipeline leakage.

6.4.4 Construction Methods and BMPs

Best management practices (BMPs) may be implemented during dredging and/or discharge activities to control turbidity and/or other discharges.

6.4.4.1 <u>Use Silt Curtains or Gunderbooms to Minimize Turbidity</u>

Turbidity sometimes is controlled by use of silt curtains, which are flexible, vertical barriers, constructed of permeable or impermeable materials. Francinques and Palermo (2005) reviewed that there are three types of devices that have been used to control turbidity, which sometimes are generically referred to as "silt curtains":

- Silt/turbidity curtain – Impermeable barrier to contain turbidity. Usually deployed from surface to within 1 to 2 ft (0.3 to 0.6 m) of the bottom.
- Silt/turbidity screen – A permeable barrier that allows water flow-through and retains suspended sediment.
- Gunderboom – A turbidity screen modified by addition of adsorbent geotextile material to control oil spills. Usually deployed from surface to bottom.

Francinques and Palermo (2005) reviewed that silt curtains are generally constructed of polyester-reinforced thermoplastic (vinyl) fabric that is maintained in a vertical position by floatation material at the top and a ballast chain along the bottom. The Depending on water depth and type of sediment management activity, silt curtains may or may not extend to the bottom substrate. Silt curtains are designed to control the dispersion of turbidity and facilitate suspended sediment settlement, but do not prevent turbidity outside the area of deployment. When there is hydraulic discharge, a gap between the bottom of the curtain and substrate is maintained to allow escape of fluid mud, which otherwise could accumulate and bury the curtain.

Silt curtains may be deployed in several different configurations (e.g., circular, elliptical, semicircular, U-shaped, maze of two or more curtains) (Francinques and Palermo 2005). Generally, deployment configurations are based on physical, hydrodynamic, and vessel traffic considerations.

Relevant Reports:

- Francinques and Palermo (2005) reviewed that silt curtains are most effective in areas with slow to moderate currents, stable water levels, and relatively shallow depths. The effectiveness of silt curtains is reduced under the following conditions:
    - o Strong currents (> 1 to 1 ½ knot are problematic). In high currents, silt curtains may be difficult to maintain and can easily become dysfunctional.

- o Fluctuating tide levels. Anchoring on both sides of the curtain is recommended prevent the curtain from overrunning the anchors and pulling them out when the tide reverses. Extra curtain length (10 to 20 %) and depth (slack) should be included to allow for tidal fluctuations and exchanges of water within the curtain.
- o Water deeper than 10 to 15 ft (3 to 4.5 m). At greater depths, loads or pressures on curtains and mooring systems become excessive and could result in curtain failure.
- o Excessive wave heights (including ship wakes).
- o High winds. Can lift curtains like a sail.
- o Drifting debris and/or ice.

- Anchor Envioronmental (2003) reviewed that silt curtains, if deployed properly, can protect adjacent resources and control surface turbidity, but have no effect on bottom turbidity (where turbidity is highest). They also reviewed that gunderboom advantages included surface to bottom turbidity control and water exchange, but greater expense and potential clogging by silt were considered disadvantages.
- Chambers Group (2001) reviewed that silt curtains can be effective under calm conditions, but they require substantial maintenance, can be difficult to hold together, may become fouled, and storms can dislodge anchors.

Consideration of Effectiveness:

Use of silt curtains appears to be effective at containing turbidity within localized project areas in embayments where current speed and water depth

6.4.4.2 Use Dikes or Swales to Minimize Turbidity

This measure involves construction of temporary sand dikes or swales where hydraulically pumped materials would be discharged to slow the rate of release to the swash zone. This measure is designed to settle sands on the beach and minimize turbidity in the nearshore.

Longitudinal Dikes

Temporary earthen berms (dikes) may be created parallel to shore during beach nourishment to reduce turbidity of return water from hydraulic pumping of sands to the beach.

Relevant Reports:

- This method and/or single-point surf zone discharge has been widely applied to projects to minimize potential impacts to snowy plovers and/or California grunion (USACE 1993, 1994a, 1998a, 1998b, 2000a, 2001), to minimize turbidity effects on least tern foraging (USACE), and/or to minimize turbidity (U.S. Navy 1997a, b).

- This method was used during the 2001 San Diego Regional Beach Sand Project, and apparently was effective since turbidity was largely restricted to the surf zone (AMEC 2002).
- This method also was used during the Surfside-Sunset beach nourishment project; least tern monitoring showed no apparent influence between turbidity plumes and least tern foraging behavior (MEC 1997).

Consideration of Potential Effectiveness:

Limited data indicate diked discharges may be effective in lessening turbidity plume effects outside the surf zone. Data also suggest that resulting turbidity plume characteristics do not result in obvious alteration of least tern foraging behavior; although, catch success rates within and outside plume areas have not been compared.

<u>Swales</u>

Temporary earthern swales may be created during beach nourishment to reduce turbidity associated with pumping sands to the beach.

Relevant Reports:

- This method was employed during the Goleta Beach Nourishment Demonstration Project, and apparently was effective based on turbidity being localized and restricted to the surf zone (Moffatt & Nichol 2003).

Consideration of Potential Effectiveness:

Monitoring information indicates that use of dikes and/or swales are effective in lessening turbidity plume effects outside the surf zone (AMEC 2002, Moffatt & Nichol 2003). Data also suggest that resulting turbidity plume characteristics do not result in obvious alteration of least tern foraging behavior (MEC 1997); although, catch success rates within and outside plume areas have not been compared.

6.4.4.3 Use Dikes to Protect Sensitive Resources

<u>Temporary protective dike</u>

Construction of temporary dikes (berms) sometimes has been identified as a measure to protect sensitive resource areas.

Relevant Reports:

- This measure was identified as a measure to prevent creek blockage, if necessary, at Morro Bay (USACE 2001).
- Protective dikes were identified as a measure to protect grunion spawning areas and/or eggs during beach nourishment, as necessary (Tekmarine and Analytic Planning Service 1990, Chambers 2001c).
- Monitoring during construction with specification of a diked buffer (100 feet up and downcoast of spawning area and 65 feet shoreward of highest high water

mark) if spawning was observed was specified as a mitigation measure for a planned beach nourishment project in San Diego County, California (U.S. Navy 1997a) .

Consideration of Potential Effectiveness:

Temporary dikes may be effective at providing a temporary barrier to block undesired impacts. Use of a dike to prevent creek blockage by discharged material is considered less effective than placement of material sufficient distance away and downcurrent of entrance channels to minimize potential blockage. Furthermore, construction of a temporary sand dike in a creek channel could contribute to shoaling as the dike erodes.

Use of diked discharges during grunion season requires careful design consideration. An important consideration is suitable access for construction equipment to the area to construct and then remove the temporary dikes without disturbing spawning areas. Removal of dikes is necessary to permit egg hatching and to prevent fish stranding during subsequent grunion runs. Placement of a longitudinal dike between the swash line and spring high tide line could strand grunion and is not recommended. Dikes constructed above the high tide line to provide a visible barrier between construction activities and spawning sites may be effective for avoiding impacts.

6.4.4.4 Minimize Potential Hazardous Materials Leaks or Spills

Accidental leaks and/or spills are of concern because of potential impacts to water quality and/or biological resources.

Mitigation Measures:

- All equipment shall be inspected for leaks (especially hydraulic lines, fittings, and cylinders) and the equipment cleaned each day or shift that the equipment is to enter the water. Equipment will be cleaned and repaired (other than emergency repairs) at least 500 ft (152 m) from the high tide line. No equipment with leaks will be allowed on the beach or to operate in waters.
- All contaminated water, sludge, spill residue, or other hazardous compounds will be disposed of at a lawfully authorized designation.
- Use biodegradable, nontoxic, vegetable-based hydraulic oil rather than petroleum-based hydraulic oil when practicable.

Relevant Reports:

- RGP 67 (USACE 2006) specifies that all equipment shall be inspected for leaks immediately prior to start of beach operations and regularly inspected thereafter until project completion, and vehicles with leaks shall not enter the beach area; and equipment shall be cleaned and repaired (other than emergency repairs) at least 500 ft (152 m) from the high tide line, and all contaminated water, sludge, spill residue, or other hazardous compounds will be disposed of at a lawfully authorized designation.

- NMFS (2002) recommended in the biological opinion for Columbia River Federal Navigational Channel Improvements Project that the contractor, where possible, use or propose for use, materials that may be considered environmentally-friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal of this material shall be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.
- Vegetable oil or other biodegradable, acceptable hydraulic fluid substitute may be recommended for all equipment entering waters containing sensitive fish species (WSDOT 2006).
- Prior to entering the water, all equipment will be checked for leaks and completely cleaned of any external petroleum products, hydraulic fluid, coolants, and other deleterious materials. Washwater will not be discharged to any water body without pretreatment to state water quality standards (WSDOT 2006).

Consideration of Effectiveness:

Preparation of a SPCCP should be effective for minimizing the potential for adverse impacts from accidental spills or leaks. Daily inspections for leaks and routine cleaning of equipment will prevent pollutants from entering natural water bodies and affecting fish or habitat. Additionally, the use of environmentally-friendly materials may be effective for further minimizing potential impacts from equipment use on the beach and in waters.

6.4.4.4 Reduce Noise Levels Below Sensitive Wildlife Harassment Thresholds

Noise may be of concern near areas with sensitive biological resources such as bird nesting colonies, pinniped rookeries and substantial haul-outs, and migratory routes of sensitive fish and cetaceans (Section 5.3.2.6). Significance thresholds have been established for marine mammals. Significance thresholds of 60 dBA have been established for sensitive bird species in San Diego County (2007), but otherwise have not been formally adopted in the state. Disturbance thresholds for salmonids were recommended by Hastings (2002) and have been generally adopted by the USFWS (WSDOT 2006).

Buffer distances during the design phase may be effective for minimizing potential impacts to known sensitive bird nesting sites (Section 6.3.6.2). Noise mitigation measures may be appropriate during construction to meet effective buffer distance criteria and/or to minimize impacts to mobile sensitive wildlife.

The following noise disturbance thresholds are recognized:

- 60 dBA – Sensitive terrestrial birds, including snowy plover (San Diego County 2007). In areas where this level is exceeded under existing conditions, noise significance is defined relative to exceedance of ambient.
- 70 dBA (airborne), 153 dB_{RMS} (underwater) – Seabird, marbled murrelet (WSDOT 2006).
- 150 dB_{RMS} (re 1 μPa) – Salmonids (WSDOT 2006).
- 120 dB_{RMS} (re 1 μPa) (underwater) 58 dB (airborne) – Cetaceans (Federal Register 2005).

Relevant Reports:

- Helicopters are prohibited for use to place or remove sand delivery pipelines to avoid potential noise impacts to peregrine falcons nesting on Morro Rock, Morro Bay, California during the nesting season (USACE 2001).
- Construction BMPs may include specification that equipment be properly maintained to minimize unsafe and nuisance noise effects (e.g., USACE 2001).
- Final EA on Issuance of an Incidental Harassment Authorization for the Take of marine Mammals During Dredging Operations at Pier 39, San Francisco, California (www.nmfs.noaa.gov/pr/pdfs/permits/pier39_ea.pdf).

Consideration of Potential Effectiveness:

Buffer distances based on attenuation are considered precautionary. Behavior of animals and existing conditions with respect to use patterns are important considerations with respect to avoiding and minimizing harassment. The following distances may be precautionary based on review of available information. However, actual buffers should be based on project-specific equipment and site-conditions.

Average noise levels on land would be expected to attenuate to ≤ 60 dB at distances of 328 to 1,000 ft (100 to 328 m) during dredging operations, depending on dredge equipment, and 1,000 to 1,600 ft (328 to 487 m) during beach nourishment (Section 5.3.2.6).

Average underwater noise levels would be expected to attenuate to 120 dB_{RMS} at distances of 400 to >3,281 ft (150 to >1,000 m) and to 150 dB_{RMS} at approximately 50 to 984 ft ft (300 m) depending on dredge equipment.

Dredge noises would be expected to be less than disturbance thresholds for salmonids at distances > 100 to 1,312 ft (80 to 400 m) for hopper dredges and at closer distances for clamshell and cutterhead dredges (Section 5.3.2.6).

Dredge noises (airborne) would be expected to attenuate to below marine mammal harassment levels at distances of 300 to 1,600 ft (91 to 488 m). Underwater noise levels would be expected to attenuate to 120 dB_{RMS} at distances of 400 to >3,281 ft (150 to >1,000 m), depending on dredge equipment.

6.4.4.5 Minimize Artificial Lighting in Sensitive Wildlife Areas

Artificial lighting may be of concern near areas with sensitive biological resources such as bird nesting colonies, wildlife corridors, and migratory routes (Section 5.3.2.7). Types of measures that may be applied to avoid and/or minimize effects of artificial lighting during construction include:

- Shield and direct lights away from sensitive bird nesting sites.
- Avoid spot lighting and/or sudden changes in illumination of large communal roosts.

- Minimize use of lights in areas of salmon migration.

Relevant Reports:

- The use of downward-directed shields on lights in less sensitive areas was recommended as a mitigation measure to minimize potential night-time lighting impacts to aesthetics for the BEACON Beach Nourishment Demonstration Project (Chambers Group 1992).
- The Biological Opinion for the 2001 San Diego Regional Beach Sand Project specified that all construction lighting at receiver sites shall be shielded and oriented to the ocean away from back beaches in order to ensure no measurable increase in light levels at tern and plover nesting colonies from March 1 to September 15 (USFWS 2000). In addition, monitoring before and at least once per night during night-time construction at receiver sites near nesting colonies was required to ensure no measurable increase in pre-project light levels.

Consideration of Effectiveness:

Artificial lighting may disturb, increase predation rates, and/or mortality rates of a number of wildlife (Section 5.3.2.7). This is of particular concern during spawning runs of sensitive fish species, breeding seasons of sensitive birds, and/or near substantial roosts or rookeries. Several of these resource concerns are seasonal; therefore, the effectiveness of the measures will depend on time of year and proximity to sensitive resource considerations.

Limited studies indicate light attraction and increased predation for several species of salmonids (Section 5.3.2.7). However, Nightengale and Simenstad (2002) reviewed that additional study was warranted because of the limited number of available studies to better understand the extent of night lighting on fish distribution changes.

Artificial lights from vessels or other temporary sources are of concern near least terns and snowy plover nesting sites because of attraction and increased predation by gulls (CCDFG 2003b). Therefore, use of light-shields and directing lighting away from nest site locations should be effective when ambient light levels are not exceeded (USFWS 2000). Proximity of project area to nesting sites and project schedule relative to sensitive bird breeding seasons (Section 6.4.2.4) are important considerations to the applicability of this avoidance measure.

Lights from night-time dredge operations are of concern if operations are conducted near sensitive bird nesting and/or roosting sites. Buffers used to protect sensitive nest sites from noise disturbance also may be effective at minimizing potential lighting impacts.

California brown pelican roosting may be disturbed by a sudden change in night-time lighting conditions. Pelicans displayed brief disturbance to dredge illumination and/or engine start up after long periods of inactivity within 270 ft (80 m) of a breakwater roosting location in Marina del Rey Harbor, but otherwise showed little response (Varanus 1999). Use of downward-directed shields on lights of stationary dredge platforms and/or maintaining a buffer may be effective for minimizing potential artificial lighting impacts.

6.4.5 Construction Monitoring

Two types of monitoring may be conducted during construction: verification of permit compliance, and to ensure no significant impacts to sensitive resources during construction. Types of construction monitoring are listed below. Construction monitoring considerations are reviewed in 7.4.

6.4.5.1 Conduct Sediment Compatibiltiy Inspections and Testing to Ensure Substrate Characteristics Match Permit Requirements

This measure involves conducting regular inspections of substrate quality during sand placement to ensure substrate characteristics match permit requirements.

Relevant Reports:

- Inspection of the beach at the end of construction to determine if undesirable sediment size differences and shell fragment content occur and whether a sand sweeper (or alternative mechanical separation device) should be used to alleviate problem was specified as a mitigation measure in the EIS/EIR for the Imperial Beach Shoreline Protection Project (USACE 2002). This measure also included follow up monitoring at one month intervals, as warranted, until potential impacts are considered less than significant.
- Periodic visual observations and sampling to verify proper quality of source sands is specified in the implementation guidelines for the BEACON South Central Coast Beach Enhancement Program (Moffatt & Nichol 2005a).
- Peterson et al. (2000b) recommended that substrate characteristics by inspected during construction to ensure no substantial change in characteristics than planned. Rehabilitation of substrate after placement was considered impracticable

Consideration of Effectiveness:

Several examples of ecologically “bad” beaches resulting from beach nourishment placement of substrate with substantial shell hash, limestone cobbles, and/or mud on beaches in Florida and North Carolina have been identified (Peterson et al. 2000b, Pilkey and Coburn 2005). Once placed, no action was taken to remedy substrate problems.

Post-project remediation of undesirable substrate surface may result in disturbance to biological resources and be problematic from logistic and/or cost considerations. A program of sand remediation to remedy undesirable substrate surface has the potential to result in disturbance of biological resources that may reduce recovery rates and functional use of habitat.

Based on the above considerations, regular inspection of substrate quality during sand placement to ensure substrate characteristics match permit requirements may be more effective than a post-project inspection.

6.4.5.2 Conduct Water Quality Compliance Monitoring and Modify Activities if Necessary to Meet Turbidity Requirements

This measure includes monitoring and reporting consistent with requirements specified in a WDR or project-specific 401 Water Quality Certification.

Relevant Reports:

- Applicants for federal permits that involve dredge or fill activities in surface waters (including wetlands) are required to obtain certification from the state (401 Certification) verifying that the activity will comply with state water quality standards (ADD WEB).
- Turbidity monitoring for beach nourishment and dredging projects vary among WDRs and Water Quality Certification requirements in California (Section 5.5.2.1).

Consideration of Effectiveness:

Compliance with Basin Plan water quality objectives is effective for protection of ecosystem values and other beneficial uses of marine and estuarine waters where sediment management activities occur.

However, the effectiveness of compliance monitoring may be improved by a more standardized approach to monitoring requirements. The effectiveness of operational controls during project implementation may be improved by use of monitoring methods with increased relevance to biological resource concerns in areas where sediment management projects occur. Addition of more complete documentation of operational controls used during project implementation would increase the usefulness of data to support evaluations and adaptive improvement in operational control strategies.

6.4.5.3 Monitor Inlet Status and Take Action if Necessary to Maintain in Open Condition

Relevant Reports:

- The implementation guidelines for the BEACON South Central Coast Beach Enhancement Program specifies monitoring during, immediately after, and for six months following construction to determine if inlet closure occurs due to sedimentation. If closure is observed, then material will be removed as necessary until the inlet area has stabilized (Moffatt & Nichol 20005a).
- Monitoring and opening inlet if closure occurs was specified as a mitigation measure for the Goleta Beach Nourishment Demonstration Project (Chambers Group 1992).
- Monitoring to determine whether sand was transported into lagoons, and if so the volume and rate of transport, whether sedimentation increased the rate of shoaling, or altered the frequency or duration of lagoon mouth closings was a permit requirement for the 2001 San Diego Regional Beach Sand Project (USACE 1999-15076-RLK). SANDAG committed to provide funding for sediment removal or additional inlet opening in concert with other on-going maintenance efforts at each lagoon.

Consideration of Effectiveness:

Visual observations and beach profiles were used to monitor Goleta Slough was monitored during and after beach nourishment and the project did not close the inlet (Mofatt and Nichol 2005b). Coastal Frontiers (2004) used beach profiles to monitor inlets and shoaling in lagoons after the 2001 San Diego Regional Beach Sand Project. Results indicated response varied among lagoons, with some experiencing no measurable shoaling, minor additional shoaling, or substantial additional shoaling. Monitoring was effective for assessing sand level changes, change in frequency of open inlet status, and change in dredge rate.

Sand movement may vary considerably between years based on climatic and oceanographic variability. If source of sediment is an important consideration with respect to response to inlet closure and/or increased dredge volume, monitoring programs may require additional survey locations and/or use of other methods (e.g., tracers) (Section 7.4.4). Dredging and/or excavation to restore inlet function are demonstrated successful technologies. However, equipment access may be an important consideration to the feasibility of this measure in some areas.

Preparation of an Inlet Monitoring and Response Plan is described in Section 6.3.7.2.

6.4.5.4 <u>Monitor Grunion Spawning and Modify Activities if Necessary to Avoid Impacts</u>

This measure involves monitoring grunion to determine spawning activity and, if observed, to implement measures to avoid impacts to spawned eggs.

Relevant Reports:

- Construction monitoring and implementation of either diked beach or single-point, surf-zone discharge if construction extends into March and April has been specified for several USACE harbor maintenance projects with beach discharge of dredged materials (e.g., USACE 1993, 1994a, 1998a, 2000a, b).
- Construction monitoring and implementation of protective measures, as necessary to protect grunion, was specified as a mitigation measure for the 2001 San Diego Regional Beach Sand Project (SANDAG and USDN 2000).
- Monitoring during construction is specified for the SCOUP project if construction is scheduled during the spawning season and a pre-construction survey determines habitat is potentially suitable for spawning (Moffatt & Nichol 2006).
- RGP 67 specifies monitoring during construction if the project is scheduled between March 1 and August 31 and a pre-construction survey determines habitat is suitable for spawning (USACE 2006).

Consideration of Effectiveness:

Grunion monitoring was conducted during implementation of the 2001 San Diego Regional Beach Sand Project. Construction was redirected away from spawning sites when thousands of fish were observed, but no redirection was considered necessary when a few to a few hundred fish were observed (AMEC 2002). This result suggests a minimization rather than avoidance approach was taken with implementation of the mitigation measure.

The USACE monitored grunion spawning between 1993 and 1997 during March through April dredging at Santa Barbara Harbor and surf zone disposal at a nearby beach. Statistical analysis of the grunion data indicated that March-April dredging and single-point, surf zone disposal did not significantly affect grunion. They noted that all of the dredging and disposal operations occurred early in the spawning season when grunion spawning densities were low. No beach disposal occurred in May and June when a much greater number of grunion spawned. There was no significant difference in egg pod diameter, depth, or location between dredging and non-dredging periods. Ecologically, use of a single-point, surf zone discharge should be effective at avoiding impacts to spawned eggs because the discharge location (swash zone) is below that where spawning occurs (spring high tide zone). The effects of turbidity from surf-zone discharge on grunion spawning have not been tested; however, observations of grunion during monitored surf-zone disposal indicate spawning is not precluded (Section 6. 4.1.3).

The effectiveness of construction monitoring to avoid impacts to grunion spawning requires monitoring during appropriate time periods to detect grunion (Section 7.). In addition, effectiveness depends on the methods used to avoid impact should grunion be observed. The primary measure that will avoid impacts is to redirect construction activities above the high tide line until eggs hatch (i.e., after next spring high tide). A diked buffer (Section 6.4.2.2) between the spring high tide line and construction activities sometimes has been specified to clearly demarcate the avoidance zone. Halting of construction also would be effective, but would not be necessary unless the only work remaining was at and/or below the high tide line.

6.4.5.5 Monitor Sensitive Bird Species and Modify Activities if Necessary to Avoid Impacts

Relevant Reports:

- Surveys to detect nesting and/or snowy plover behavior have been specified if construction schedules extend into the breeding season for maintenance dredging projects involving beach discharge near Channel Islands/Port Hueneme Harbors, Marina del Rey Harbor, Morro Bay, Oceanside Harbor, Santa Barbara Harbor, and Ventura Harbor (USACE 1994a, 1998a, 1998b, 1999a, 1999b, 2000b).
- Surveys of least tern foraging and/or turbidity plumes have been conducted with a few beach nourishment and dredging projects (USDN 1996 cited in USFWS 2000, MEC 1997, AMEC 2002). were observed foraging in turbidity plumes during beach nourishment with diked discharge at Surfside-Sunset Beach (MEC 1997).

Consideration of Effectiveness:

Hutchinson et al. (1987) reported several types of coordination with the contractor and during monitoring of beach placement of dredged materials from Morro Bay to ensure impacts were avoided. Types of coordination activities included restriction of vehicle and foot traffic to a 20-ft (6-m) roadway adjacent to the sand delivery pipeline, creation of a temporary dike to contain runoff from leaky pipeline joints, day-by-day coordination regarding removal of pipeline segments. There were no reported adverse effects of sediment management operations on snowy plovers.

The USACE (2001) reported that surveys conducted following the 1993, 1995, and 1997 beach placement operations at Morro Bay documented snowy plover nesting. Successful nesting was reported during and after disposal at the Morro Bay sand spit in 1987.

Worden and Smith (2004) observed temporary disruption of foraging and resting snowy plovers during surf zone disposal of maintenance dredge materials from Ventura Harbor to McGrath State Beach. Birds were observed moving to avoid the heavy equipment and trucks driven on the beach during installation, pumping, and/or removal of the dredge pipe.

Chambers Group (2001a) observed snowy plovers foraging in the vicinity of the beach discharge of dredged material from Santa Barbara Harbor (Chambers Group 2001). The plovers did not react adversely to beach nourishment activities, but were flushed by joggers and people with dogs.

Limited available monitoring studies suggest that impacts may minimized when turbidity is controlled. Additional monitoring with respect to least tern foraging behavior, water clarity, and turbidity plumes would enable a more rigorous evaluation of potential impacts under different project conditions.

Based on the above considerations, construction monitoring combined with authority to redirect and/or halt operations may to be effective for protecting snowy plovers during sediment management projects.

6.4.5.6 Monitor Marine Mammals and Modify Activities if Necessary to Avoid Impacts

Relevant Reports:

- Monitoring of sea otters was conducted during dredging at Morro Bay (Bodkin and Rathbun 1988, 1989).
- The USACE, Los Angeles District specifies monitors are to be used during dredging when sea otters are present (http://el.erdc.usace.army.mil/tessp/info.cfm).

Considerations of Effectiveness:

Bodkin and Rathbun (1988, 1989) documented a reduction in the abundance of wintering male sea otters that coincided with a dredge cycle at Morro Bay. A small, resident population, including a pup was reported in subsequent years (USACE 2001). No other monitoring reports during sediment management activities were found from the literature review for California. Monitoring is recommended during offshore dredging on the East and Gulf Coasts (RPI et al. 2001). Monitoring considerations are further discussed in Section 7.4.5.4.

6.5 Post Construction Phase Mitigation Measures

6.5.1 Verify Impact Significance in Areas Where There is a Potential to Impact Sensitive Habitat Resources

Pre- and post-construction monitoring in areas with sensitive resources may be required to verify significance of impacts associated with sediment management projects.

Relevant Reports:

- A final MMRP addressing pre- and post-project monitoring of sensitive habitats (rocky intertidal, nearshore reefs, kelp beds) was required for the 2001 San Diego Regional Beach Sand Project (USACE 1999-15076-RLK, AMEC 2002, 2005).
- A final MMRP was prepared for the Goleta Beach Nourishment Demonstration Project addressing pre- and post-project monitoring of sensitive habitats (eelgrass, surfgrass, kelp beds) (USACE 200200666-JCM, Moffatt & Nichol 2003).
- Pre- and post-project mapping of eelgrass distribution and determination of eelgrass density is required for dredging projects that occur in proximity to this habitat (e.g., USACE permit 200100328-SKB).

Consideration of Potential Effectiveness:

The above-referenced monitoring plans included monitoring methods that addressed habitat reduction and quality issues. Monitoring to verify no loss of sensitive habitat are effective for ensuring that project implementation does not adversely impact ecosystems. Measures that include assessment of habitat quality are effective for ensuring ecosystem functions and values are protected. Monitoring in areas with sensitive resources is considered an effective measure to address uncertainties associated with sedimentation model predictions. For example, the sampling design of the 2001 San Diego Regional Beach Sand Project included stations that were located with respect to distance from receiver sites, within areas of predicted sand transport, and reference areas outside the influence of beach nourishment. Sand transport sedimentation was detected, but results did not suggest significant impacts to sensitive habitats (AMEC 2005).

6.5.2 Compensatory Mitigation

Example Mitigation Measures:

- Revegetate loss of coastal strand habitat.
- Replace eelgrass habitat loss according to Southern California Eelgrass Mitigation Policy.
- Compensate loss of nearshore reef habitat with creation of artificial reefs.
- Compensate for increase in dredge volume and/or frequency in dredging.

Relevant Reports:

- Fund if necessary for increased dredge volume and/or inlet opening of coastal lagoons. Artificial reefs if necessary to compensate for habitat loss (SANDAG and USDN 2000).

A disadvantage of compensatory mitigation is the high cost to replace lost ecosystem functions and values if post-project monitoring reveals significant impacts from project implementation. Mitigation requirements to compensate for losses in eelgrass habitat require mitigation according to the Southern California Eelgrass Mitigation Policy (Section 3.3.8). Mitigation requirements to compensate for significant loss of nearshore reef habitats (and/or kelp beds) may include construction of artificial reefs (e.g., Lindeman and Snyder 1998, Coastal Planning & Engineering 2004a, b).

6.6 Summary of Mitigation Measures

A variety of mitigation measures have been employed to avoid and/or minimize impacts during sediment management projects (Table 6.6-1). The measures span a variety of approaches ranging from project design to implementation restrictions, operational controls and BMPs during construction, and monitoring during and/or after implementation to verify permit compliance and/or the need for additional mitigation. Review of available information presented in previous subsections suggests that the range of mitigation approaches provides sufficient flexibility to address impacts issues likely to arise with most sediment management projects. In some situations more restrictive avoidance measures may be warranted whereas in other situations minimization measures may provide adequate protection of biological resources.

Several questions of interest to the CSMW with respect to mitigation measures relate to their effectiveness, particularly with respect to prohibition zones and seasonal restrictions. The following summary questions of interest to the CSMW are addressed in this section:

- *Has the effectiveness of any of these mitigation measures been demonstrated?*
- *What types of prohibition zones have been permit-required surrounding various sensitive bird nesting and foraging areas?*
- *What are the reported bases for these zones? Have the dimensions been based on scientific data, do they relate to potential foraging ranges or nesting territories, do they reflect measured impact ranges, are they based on professional judgment or uncertainty-based conservatism?*
- *Do typical bird breeding season limitations reflect the actual time that the area is used for breeding and nesting? Can historic lengths of time or areas under limitation be safely revised?*
- *What types of information and process are needed to objectively review and establish appropriate sediment management permit conditions associated with breeding season restrictions?*
- *Can an appropriate level of impact/mitigation measure be recommended for the species/habitat/ecosystem of concern?*

Four types of summaries are provided. Section 6.6.1 addresses the first five of the above-listed questions of the CSMW based on considerations of the effectiveness of mitigation measures that may be used during pre-construction, construction, and post-construction to avoid and/or minimize impacts. Section 6.6.2 presents an approach to facilitate effective project planning and coordination with resource agencies with respect to selection of appropriate mitigation measures to protect EFH and listed sensitive species. Section 6.6.3 provides further summaries of mitigation measures by impact of concern and habitats. The following summaries are not intended to be prescriptive. Selection of mitigation measures should be based on project features and existing conditions. This is considered particularly relevant to project size. For instance, measures appropriate to large projects may be overly restrictive for small projects of short duration.

6.6.1 Considerations of Mitigation Effectiveness

6.6.1.1 <u>Available Information on Effectiveness</u>

The literature review indicates that few reports are available that describe effectiveness of mitigation measures applied during sediment management projects. Notable exceptions are reviews or relevant information on controls for turbidity (e.g., silt curtains, gunderbooms, type of dredge equipment).

Many monitoring reports lack information on project implementation methods, operational controls, and mitigation activities and their effectiveness. This data gap, if filled could improve the usefulness of monitoring data to support adaptive decisions on how to improve mitigation effectiveness. Very few comparisons are available that permit evaluation of percent reduction in impact with respect to mitigation measures.

There may be notes and references to be gleaned from various reports relevant to mitigation effectiveness that perhaps could be compiled to a greater extent than was done for this review, but were outside the scope of this effort. Instead a substantial effort of this report section is associated with the discussions of considerations of effectiveness for the reviewed measures. These discussions are based on considerations of species biology, habitat ecology, physical processes, and mechanisms of potential impact so that the rationale and/or scientific basis of the measure can be examined. This approach was taken to provide some basic background information on mitigation measures to facilitate future application of measures to assist environmental design of projects and protection of resources during their implementation.

It is recommended that monitoring reports include in their introduction an abstract of the project description that includes information on implementation, including project volume, schedule (including hours of construction), equipment, and construction methods. Mitigation measures used during construction should be specified, and any measurements that are made during different operational conditions should be clearly identified. Additional actions taken to further minimize impacts should be described in sufficient detail that they may be repeatable, if successful. A summary of the effectiveness of the mitigation measure in meeting compliance objectives would be helpful.

6.6.1.2 Considerations Relevant to Prohibition Zones

Types of prohibition zones around sensitive bird nesting and foraging areas are reviewed in Section 6.3.6. The rationales have been based on sensitivity to close approach disturbance (California brown pelican, marine mammals), foraging range (California least tern), direct impacts and foraging interference (snowy plover), and harassment disturbance that affects migration, efficient capture of food, and/or reproductive success (marine mammals). With the exception of California least tern, buffer distances have been based on distance considerations associated with noise and proximity of activity-related disturbance.

While that is also true for California least tern, an additional consideration has been protection of the relatively large foraging range (2 mi, 3.2 km) of the species reported by available scientific literature. Least terns are visual foragers on schooling fishes, and may forage in the ocean, embayments, rivers, and lakes near the coast. A concern for turbidity interference with foraging has been addressed by buffer distances ranging from 1 to 2 mi (1.6 to 3.2 km) (Section 4.4.2). No available information was found with the literature review to suggest that buffer areas of this size were based on measured impact ranges.

Reviews presented in this document indicate that turbidity plumes may vary depending on type of project, equipment, sediment characteristics, and hydrodynamics. In addition, construction methods and operational controls during construction may lessen turbidity plumes. Consequently, large-scale buffer distances for least tern may be overly conservative in some circumstances depending on project- and site-specific considerations. There is evidence that least terns prefer to forage near their nesting sites to minimize time away from eggs and chicks. Therefore, buffer distances that minimize turbidity effects in water bodies near nesting areas may be an important consideration along with turbidity and noise controls.

6.6.1.3 Considerations Relevant to Environmental Windows

Although the primary questions of interest to the CSMW relate to the use of environmental windows with respect to birds, seasonal restrictions also have been used to protect other sensitive resources such as eelgrass, fish, and mammals. Seasonal restriction mitigation measures and their effectiveness are reviewed in Section 6.4.2.

Seasonal restrictions for birds primarily relate to breeding and nesting periods, which are scientifically supported by available literature (Section 4.4). There is no scientific basis for revision of critical seasonal reproductive periods. However, many of the impact concerns to sensitive bird breeding areas relate to direct impacts and/or proximity of disturbance issues, which should be avoidable with mitigation measures that address effectively address minimizing disturbance and interference with other critical functions such as foraging success below levels of concern.

Similar considerations apply to seasonal restrictions associated with protection of other sensitive wildlife. Protection of SAV habitats is a year round concern, which is reflected in the language of the environmental window.

The primary advantage of environmental windows is that species protection generally is assured by implementing a project during a period when the resource of concern is absent or less sensitive to impact.

The primary disadvantage is that environmental window restrictions reduce schedule flexibility and contingencies, which may contribute to substantially higher project costs (Reine et al. 1998). In some cases, other measures (e.g., buffer distances, operational controls) may be as effective in minimizing impacts. Sometimes sediment management projects are permitted during a restricted window in coordination with resource agencies, which may require monitoring and/or use of other measures to ensure adequate protection of populations.

The permitting process is effective at providing opportunity for informal coordination with resource agencies to identify and develop mitigation measures, when appropriate, based on project-specific and site-specific considerations. More effective use of this existing process is recommended. Based on review of several permits, it appears that environmental windows often are identified as the primary mitigation measure and other measures are then applied to further minimize potential impacts. The impression is that environmental windows have been used to simplify CEQA/NEPA documentation and streamline environmental review and permitting. This approach may be precautionary in areas where insufficient information is known about site-specific use patterns by sensitive resources. Site-specific data gaps may be addressed by conducting surveys and obtaining necessary information.

Another approach is to address potential impact risk factors for sensitive resources of concern. There are a number of aspects of project design and implementation that may be tailored to address impact issues of concern. Several types of information can be addressed to enable objective review and establishment of appropriate mitigation measures. Foremost are project- and site-specific impact risk factors, associated with the following considerations:

- Impact mechanism.
- Magnitude of impact.
- Exposure duration.
- Habitat suitability to support sensitive species.
- Proximity to sensitive resources.
- Historic use patterns.
- Unique site conditions.

Spatial and temporal scales of impact vary depending on a number of physical factors, including project size, equipment used, substrate characteristics, and hydrodynamics. This document review indicates that many aspects of mechanism, magnitude, and exposure duration associated with impacts can be controlled by distance (buffers), construction methods, and operational controls during construction. There also are examples of construction monitoring being used in combination with mitigation measures to ensure appropriate avoidance and minimization occurs.

Impact duration is an important consideration. The review suggests that most habitats and many coastal species are adapted to disturbance and can tolerate short-term and/or small-scale impacts. Therefore, common sense indicates that small projects that are completed on the order of days generally should be within tolerance thresholds of habitats and species provided critical impact thresholds are not exceeded.

However, environmental windows may represent the best management choice in areas where avoidance of impact otherwise is not possible. Of particular concern, are protecting reproductive success of sensitive species in areas where buffers or construction methods may not be effective; e.g., avoidance of direct impacts to sensitive nesting, spawning, and/or nursery grounds could not be prevented or impacts would occur in a confined area that may magnify the level of impact above critical thresholds.

6.6.2 EFH and Sensitive Species Coordination and Mitigation Measures

[NEPA and CEQA require pre-decisional evaluation of impacts and mitigation measures. All of the topics discussed in this section, as well as less damaging alternatives to the proposed action, would typically be addressed in the appropriate NEPA or CEQA documentation before there is any other formal permit processing.]

The California Endangered Species Act (CESA) requires that each state lead agency consult with the CDFG to ensure that any action authorized, funded, or carried out by that lead agency is not likely to jeopardize the continued existence of any species that is state listed as endangered, threatened, or rare. CESA consultation is conducted when there is both a State lead agency and an EIR. Otherwise, CESA section 2081 allows DFG to issue an incidental take permit for a State listed threatened or endangered species. Specific criteria for 2081 permits are found at Title 14 CCR, sections 783.4(a) and (b).

Section 7 (a)(2) of the federal ESA requires a federal agency (e.g., USACE), in consultation with the Secretary of the Interior (USFWS) and the Secretary of Commerce (NMFS), to ensure that any action authorized, funded, or carried out by that agency (e.g., issuance of 404 permits) is not likely to jeopardize the continued existence of any listed species. Additionally, the action cannot result in the destruction or adverse modification of the species habitat if that habitat is determined to be critical (by the Secretary after consultation, as appropriate, with affected States), unless the action agency is exempted under Section 7(h) of the ESA. Section 9 prohibits unauthorized take of federally listed threatened or endangered species. Federal action agencies obtain incidental take authorizations via the Section 7 consultation process. Where there is no Federal action, Section 10 provides for incidental take authorization following completion of a Habitat Conservation Plan.

If a proposed federal action may adversely affect a listed species or designated critical habitat, formal consultation is required (except when, through informal consultation, the USFWS and NMFS concur, in writing, that a proposed action “is not likely to adversely affect” listed species or designated critical habitat). A formal consultation concludes with the issuance of a biological opinion and an incidental take statement by either or both USFWS and NMFS, depending on the species affected

There also may be the need to consult with respect to species of special concern identified during the planning stage. Typically, the USFWS will provide a list upon request, of species of concern that could potentially occur in the project area. The list may include species that are listed, that are candidates for listing, or that have been recommended for listing as endangered or threatened by a state or federal agency under the ESAs.

Useful Online References Regarding Federal and State Endangered Species Consultation

http://www.fws.gov/endangered/consultations/s7hndbk/s7hndbk.htm

http://www.dfg.ca.gov/hcpb/ceqacesa/cesa/cesa.shtml

http://www.dfg.ca.gov/legal/879regs.htm

Federal and state resources agencies both recommend informal early coordination to avoid potential impacts to rare, endangered, and threatened species. Advantages of early consultation include appropriate mitigation planning to offset impacts to listed species and their essential habitats and a streamlined consultation process (USFWS and NMFS 1998).

Informal coordination may involve the following recommended steps:

- Request a list of species of concern and current information from the USFWS, as available
- Meet with appropriate resource agencies (depending on federal and/or state status of species) to review project design, current available information on species occurrence, and mitigation measures to avoid and/or minimize impacts to sensitive species. Depending on project complexity, more than one meeting may be necessary.
- If a federal action agency determines that the proposed action "is not likely to adversely affect" listed species or designated critical habitat, a concurrence is obtained, in writing, from resource agencies. The project description cannot change after this concurrence unless the federal action agency reconsiders the "not likely to adversely affect" conclusion.

If a proposed federal action may adversely affect a listed species or designated critical habitat, formal consultation is required under Section 7(b)(2) and (3) of the ESA. The USFWS and/or NMFS will provide to the federal action agency (e.g., USACE) and the applicant, a biological opinion (BO) detailing how the proposed action affects the listed species or designated critical habitat, a summary of the information on which the opinion is based, and reasonable and prudent alternatives that are believed to not violate subsection (a)(2) of the ESA if taken by the federal agency or applicant in implementing the action. A formal consultation concludes with the issuance of a biological opinion and an incidental take statement by either or both USFWS and NMFS. The CDFG may provide concurrence with a federal BO or if not consistent will issue a separate Incidental Take Permit.

The federal Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) requires federal agencies to consult with the NMFS regarding the potential effects of actions on "essential fish habitat" (EFH) and respond in writing to NMFS recommendations. State agency activities which would impact EFH also require NMFS comment.

The following sections summarize types of mitigation measures that appear to be effective and/or have the potential to be effective for avoiding and/or minimizing impacts to biological resources during implementation of sediment management projects. While some measures may have broad applicability in a variety of potential project situations, there may be project- and site-specific factors that should be considered to ensure appropriate application of a mitigation measure. Those considerations are best reviewed during informal resource agency coordination.

The Corps of Engineers administered Clean Water Act Section 404 permit (regulating discharge of dredge or fill material in waters or wetlands of the U.S.) or Rivers and Harbors Act of 1899 Section 10 permit (structures and dredging in navigable waters) process may include a public notice requirement. During the public comment period for such a permit application, the resource agencies may provide comments on the subject project under authority of the Federal Fish and Wildlife Coordination Act and ESA.

6.6.2.1 Essential Fish Habitat

Mitigation measures may include activities both during the pre-construction and construction phases. The measures listed below are described in greater detail in Section 6.3 (Pre-Construction Mitigation Measures) and Section 6.4 (Construction Mitigation Measures).

- Conduct informal consultation with CDFG and NMFS if proposed project area is within essential fish habitat.
- Prepare mitigation, monitoring, and reporting plan (MMRP) if sensitive aquatic resources are within project area. Obtain resource agency approval of plan prior to construction. Submit reports of monitoring results and effectiveness of implemented mitigation measures according to reporting schedule specified in the plan. Sensitive aquatic resources include SAV (eelgrass meadows, kelp forests and/or beds, surfgrass beds), perennial hard bottom, and areas of special biological significance (ASBS).
- Conduct pre-construction survey within 30 days of construction to finalize pipeline and vessel routes and/or anchorage plans, if proposed activities will occur in areas with sensitive aquatic resources. Survey results will be used to select areas that avoid direct impacts to SAV and perennial hard bottom habitats. Any significant direct impacts (i.e., habitat loss or substantial reduction in habitat quality) will require compensatory mitigation.
- Use construction methods and/or schedule to minimize recovery rates of benthic invertebrate forage base.
- Avoid repetitive beach nourishment disturbance in the same location in the same year.
- Use construction methods and/or BMPs to limit turbidity, reduction of water clarity, and elevated suspended solids during beach nourishment and/or dredging to below levels that result in loss of SAV.
- In project areas that may affect SAV, conduct construction monitoring of light transmission, light levels, and/or water clarity to verify that critical thresholds are not exceeded. Measurements within any turbidity plume over SAV habitat should

be within 20% of ambient. If > 20% deviation occurs, the following thresholds may be useful for determining potential for impact and need for additional operational controls or change in activities: In the event that ambient conditions are also below the following thresholds (e.g., storm conditions, red tides), conditions would be considered within natural variability. The following light level thresholds should be verified with the RWQCB and resource agencies before use.

  - Kelp forests and/or beds - Near bottom light levels < 10% of surface irradiance for a period > 1 week may affect juvenile growth and should be avoided.
  - Surfgrass beds – Near bottom light levels < 40% of surface irradiance for a period > 2 weeks may affect growth and should be avoided.
  - Eelgrass meadows – Near bottom light levels < 20% of surface irradiance for a period > two weeks may affect growth and should be avoided.

- Match project size and/or project location to environmental constraints to avoid burial and/or substantial sedimentation of sensitive aquatic resource habitats and/or reduction in habitat quality such as substantial thinning of vegetation, reduced species diversity, and/or loss of shelter functions.
- Any loss or substantial reduction in habitat quality of sensitive aquatic resource areas will require compensatory mitigation according to ratios specified in advance of the project in consultation with resource and regulatory agencies.
- Eelgrass, *Zostera marina*, as a significant marine aquatic resource is subject to a regional mitigation policy produced by NMFS and endorsed by USFWS and DFG.

6.6.2.2 Other Sensitive and/or Managed Fish

Mitigation measures may include activities both during the pre-construction and construction phases. The measures listed below are described in greater detail in Section 6.3 (Pre-Construction Mitigation Measures) and Section 6.4 (Construction Mitigation Measures).

<u>Grunion</u>

- Conduct informal consultation with CDFG and NMFS if proposed project would occur during the spawning season of March 1 through August 31.
- Prepare a MMRP and obtain resource agency approval on plan prior to construction. Submit reports of monitoring results and effectiveness of implemented mitigation measures according to reporting scheduled specified in the plan.
- Conduct pre-construction survey within 30 days of construction to determine habitat suitability for grunion spawning need for additional protective measures, as described below. If construction spans more than one predicted spawning run, conduct habitat suitability survey prior to each predicted run.
- Conduct construction monitoring by a qualified biologist if habitat is determined to be suitable for spawning (see Section 6.3.6.3). The biological monitor will have

authority to halt and/or redirect activities, as necessary to avoid impacts to spawning.

- Restrict placement and/or removal of any sediment delivery pipelines to outside the spawning season if spawning occurs in the project area during construction.
- Minimize interference with grunion spawning by use of construction methods such as single-point diked beach discharge within a confined work zone. The work zone limits will be determined on a project-specific basis in consultation with CDFG and NMFS, considering site-specific factors as beach length and receiver site dimensions.
- Use environmental window restricted period between March 1 and August 31 if mitigation measures will not be sufficient to reduce impacts below a below a level of concern by CDFG and NMFS.

<u>Pacific Herring</u>

- Avoid dredging during spawning runs in and/or near areas where spawning is known to occur or potential attachment sites for eggs occur (e.g., eelgrass, other SAV, shallows, rip rap, piles).

<u>Salmonids</u>

- Avoid interference with migration by ensuring that the project does not result in closure of stream inlets. If closure does occur, immediate action will be taken to mechanically open the inlet.
- Minimize interference with foraging and/or migration by use operational controls and/or BMPs (e.g., silt curtains) to limit turbidity reduction of water clarity during embayment dredging.
- Minimize night-time lighting in areas with active migration.
- Minimize potential entrainment from hydraulic dredging in depths less than 20 ft (6 m), dredge head must be maintained at or below substrate surface. Head may not be raised more than 3 ft (1 m) off the bottom for flushing and the pump will be turned off at the end of dredging when the head is no more than 3 feet off bottom.

6.6.2.3 Sensitive Bird Species

Mitigation measures may include activities both during the pre-construction and construction phases. The measures listed below are described in greater detail in Section 6.3 (Pre-Construction Mitigation Measures) and Section 6.4 (Construction Mitigation Measures).

<u>California Brown Pelican</u>

- Avoid dredging or other sediment management activities within 300 ft (91 m) of large, communal roosts during the time period from one hour before sunset to sunrise.

- In areas where sediment management activities are necessary at night within 300 ft (91 m) of large roosts, minimize disturbance by conducting engine start-ups father away than 300 ft (91 m), use slow speed to avoid sudden approach, and avoid direct lighting of roosts.

California Least Tern

- Informal consultation with CDFG and USFWS if proposed project area is within 1 mi (1.6 km) of least tern nesting sites and would occur during the breeding season of April 1 through September 15.
- Prepare a mitigation, monitoring, and reporting plan (MMRP) and obtain resource agency approval on plan prior to construction. Submit reports of monitoring results and effectiveness of implemented mitigation measures according to reporting schedule specified in the plan.
- Use buffer distance that attenuates noise to ≤ 60 dBA or ambient at active nesting sites to minimize potential noise and disturbance impacts. A distance of 1,000 ft (328 m) from dredging and 1,640 ft (500 m) from beach nourishment activities may be useful for planning purposes based on the assumptions that dredge noises do not exceed 88 dBA and average combined construction noise levels at the beach do not exceed 90 dBA at a distance of 50 ft (15.2 m) from the source. If the average noise level of equipment is more or less than these levels, then the buffer distance should increase or decrease as appropriate to meet attenuation guidelines.
- Minimize beach slope steepness (e.g., 10:1 horizontal: vertical) to enhance spawning habitat.
- Minimize interference with foraging activities by use of construction methods and/or BMPs to limit turbidity reduction of water clarity during beach nourishment and/or offshore borrow site dredging. Water clarity < 3.3 ft (1 m), as measured by Secchi disk, should not affect more than 1 hectare (2.47 acres) outside the surf breaker zone for beach nourishment projects or nearshore area in vicinity of dredge for offshore dredging projects.
- Use construction methods and/or BMPs to limit turbidity reduction of water clarity during embayment dredging. The amount of area that may be affected by water clarity reduction (< 3.2 ft, 1 m) in an embayment as a result of dredging, if any, will be determined on a project-specific basis in consultation with CDFG and USFWS, considering such factors as size of water body, proximity to other foraging locations, and nest site usage patterns.
- Use environmental window restriction between April 1 and September 15 if mitigation measures will not be sufficient to reduce impacts below a level of concern by CDFG and USFWS.

Western Snowy Plover

- Conduct informal consultation with CDFG and USFWS if proposed project area is within critical habitat and/or within 3,281 ft (1 km) of snowy plover nesting sites and would occur during the breeding season of March 1 through September 15.
- Prepare a mitigation, monitoring, and reporting plan and obtain resource agency approval on plan prior to construction. Submit reports of monitoring results and effectiveness of implemented mitigation measures according to reporting schedule specified in the plan.

- Conduct pre-construction survey within 30 days of construction to verify snowy plover occurrence within project area and need for additional protective measures, as described below.
- Use buffer distance that attenuates noise to ≤ 60 dBA or ambient at active nesting sites to minimize potential noise and disturbance impacts. A distance of 1,000 ft (328 m) from dredging and 1,640 ft (500 m) from beach nourishment activities may be useful for planning purposes based on the assumptions that dredge noises do not exceed 88 dBA and average combined construction noise levels at the beach do not exceed 90 dBA at a distance of 50 ft (15.2 m) from the source. If the average noise level of equipment is more or less than these levels, then the buffer distance should increase or decrease as appropriate to meet attenuation guidelines.
- Avoid direct impacts and minimize disturbance to snowy plovers with construction monitoring by a qualified biologist if snowy plovers are present in project area during the breeding season and/or the site supports substantial wintering populations. The biological monitor will have authority to halt and/or redirect activities, as necessary to ensure impacts are minimal.
- Restrict placement and/or removal of any sediment delivery pipelines to outside the breeding season if project area is within 500 ft (152 m) of known nesting sites.
- Minimize interference with snowy plover foraging by use of construction methods such as surf zone or single-point diked beach discharge within a confined work zone. The work zone limits will be will be determined on a project-specific basis in consultation with CDFG and USFWS, considering such factors as beach length, proximity to nesting sites, and/or any features that may represent barriers to movement.
- Shield and orient night-time lighting so that there is no measurable increase in light levels at least tern and/or snowy plover nesting sites during the breeding season.
- Use environmental window restricted period between March 1 and September 15 if mitigation measures will not be sufficient to reduce impacts below a below a level of concern by CDFG and USFWS.

<u>Migratory Birds</u>

Migratory Birds are protected from unauthorized take by the Federal Migratory Bird Treaty Act. Unauthorized take can occur when certain birds nest within a project area. Some examples of migratory birds that may nest in southern California wetland areas include, killdeer, black-necked stilts, American avocets, Forster's terns, Caspian terns, and several species of waterfowl.

- Avoid work during the breeding season, approximately March through August, when project boundaries are close to where breeding birds are present.
- Use buffer distance that attenuates noise to ≤ 60 dBA or ambient at active nesting sites to minimize potential noise and disturbance impacts. A distance of 1,000 ft (328 m) from dredging and 1,640 ft (500 m) from beach nourishment activities may be useful for planning purposes based on the assumptions that dredge noises do not exceed 88 dBA and average combined construction noise

levels at the beach do not exceed 90 dBA at a distance of 50 ft (15.2 m) from the source. If the average noise level of equipment is more or less than these levels, then the buffer distance should increase or decrease as appropriate to meet attenuation guidelines.

6.6.2.4 <u>Marine Mammals</u>

The following mitigation considerations were based on guidance provided by NOAA with respect to vessel distance and noise Level B harassment levels. Sensitivity to disturbance varies among species and existing noise conditions. In addition, NOAA is currently reviewing noise criteria. Therefore, site-specific information and current information from NOAA should be considered before use of the following guidelines.

- Avoid intentional vessel approaches within 300 ft (91 m) of sea otters and whales. Reduce and maintain a constant speed that is not faster than the whale(s) when paralleling within 300 ft (91 m).
- Use construction monitoring by qualified biologist in project areas where sea otters occur. The biological monitor will have authority to halt and/or redirect activities, as necessary to ensure impacts are minimal.
- Use buffer distance that attenuates noise to ≤ 58 dBA or ambient at pinniped rookeries and/or substantial haul outs areas when pups are present to minimize potential noise and disturbance impacts. A distance of 1,640 ft (500 m) from dredging and/or beach nourishment activities may be useful for planning purposes based on the assumptions that dredge noises do not exceed 88 dBA and average combined construction noise levels at the beach do not exceed 90 dBA at a distance of 50 ft (15.2 m) from the source. If the average combined noise level of equipment is more or less than these values, then the buffer distance should increase or decrease as appropriate to meet attenuation guidelines.
- Use buffer distance that attenuates noise to ≤ 60 dBA or ambient at active nesting sites to minimize potential noise and disturbance impacts. A distance of 1,000 ft (328 m) from dredging and 1,640 ft (500 m) from beach nourishment activities may be useful for planning purposes based on the assumptions that dredge noises do not exceed 88 dBA and average combined construction noise levels at the beach do not exceed 90 dBA at a distance of 50 ft (15.2 m) from the source. If the average noise level of equipment is more or less than these levels, then the buffer distance should increase or decrease as appropriate to meet attenuation guidelines.

6.6.3 Mitigation Measures by Sediment Management Activity, Impact of Concern, Habitats, and Species

A variety of mitigation measures may be used to avoid and minimize impacts to biological resources during sediment management activities. Some of the most effective are those that occur in the pre-construction phase, when impact avoidance and design may be incorporated in project design (Table 6.3-1). Construction measures are particularly useful for minimizing impacts during project implementation. The following sections summarize mitigation measures by sediment management activity (Section

6.6.3.1), particular impacts of concern (Section 6.6.3.2), and habitats and species (Section 6.6.3.3).

6.6.3.1 Summary of Measures by Sediment Management Activity

Several mitigation measures may be applicable to different types of sediment management activities depending on type of activity (beach nourishment, dredging) and location of activity (Tables 6.6-1 and 6.6-2). The list of measures is not intended to be prescriptive. Appropriate measures will depend on project- and site-specific considerations. Primary considerations may include project size, location, proximity to sensitive resources, and project schedule.

6.6.3.2 Summary of Measures by Impact of Concern

Specific summaries are listed below that address the following concerns identified in the literature. In addition, measures to minimize contaminant concerns are listed, many of which were identified from WSDOT guidance documentation (2006).

- Measures to minimize recovery rates of benthic invertebrate forage base for secondary consumers such as fishes and shorebirds.
- Measures to minimize maintenance frequency over time.
- Measures to avoid and minimize impacts to EFH and sensitive species.
- Measures to minimize potential for hazards.

Minimize Recovery Rates of Benthic Invertebrate Forage Base

- Minimize difference in grain size characteristics to existing beach unless change represents enhancement.
- Minimize change in surface substrate characteristics of beach and/or dredge areas unless change represents enhancement.
- Minimize shell and coarse substrate content of source sands.
- Conduct sediment compatibility inspections and testing.
- Minimize change in hydrodynamics and/or water quality unless change represents enhancement.
- Avoid repetitive disturbance at same location in same year.
- Avoid peak recruitment and productive time of year.
- Minimize project volume by use of multiple small sites rather than large site.
- Minimize project area by incorporating refuge areas into project design.

Table 6.6-1. Types of pre-construction phase mitigation measures to avoid and minimize impacts by type of sediment management project.

Pre-Construction Mitigation Measures	Beach Nourishment			Dredge	
	Dune	Beach	Nearshore	Off-shore	Bay
Maintain Sediment Compatibility and Quality					
Minimize difference in sediment characteristics unless enhancement is conducted	X	X	X		
Minimize change in surface substrate unless enhancement is conducted	X	X	X	X	X
Environmental Design					
Avoid direct impacts to sensitive habitats	X	X	X	X	X
Match project volume to environmental constraints		X	X	X	
Maintain hydrodynamics unless enhancement is conducted			X	X	X
Avoid steep scarps and slopes		X			X
Environmental Implementation Strategy					
Avoid repetitive disturbance in same year[1]		X	X	X	X
Use multiple small sites instead of one large site[1]		X	X		
Incorporate refuge areas[1]				X	
Reduce Maintenance Frequency Over Time					
Incorporate dune restoration[1]	X				
Use sedimentation basins and source control					X
Habitat Buffers					
Buffer to minimize turbidity impacts		X	X	X	X
Buffer to minimize sedimentation impacts		X	X		
Sensitive Species Buffers					
Buffer to protect fishery spawning grounds		X	X	X	X
Buffer to minimize impacts to sensitive birds	X	X			X
Buffer to minimize impacts to marine mammals		X			X
Environmental Coordination and Notifications					
Prepare hazardous materials management plan	X	X	X	X	X
Prepare inlet monitoring and response plan		X			
Conduct U.S. Coast Guard notification to minimize hazards and interference with other uses		X	X	X	X
Conduct environmental training program	X	X			
Mitigation and Monitoring Program					
Conduct EFH and/or sensitive species coordination, as appropriate	X	X	X	X	X
Finalize mitigation and monitoring plan	X	X	X	X	X
Conduct pre-construction surveys, as appropriate	X	X	X	X	X

Table 6.6-2. Types of construction phase mitigation measures to avoid and minimize impacts by type of sediment management project.

Construction Mitigation Measures	Beach Nourishment			Dredge	
	Dune	**Beach**	**Nearshore**	**OffShore**	**Bay**
Location Controls					
Avoid use of equipment, pipelines, and construction materials in sensitive habitats	X	X	X	X	X
Avoid anchoring and/or operation of dredges, drill rigs, and/or barges in or above SAV habitats			X	X	X
Surf-zone discharge location		X			
Upper beach discharge location		X			
Limit intentional approaches within 300 ft (91 m) and use slow vessel speed around sensitive marine mammals			X	X	X
Schedule and/or Seasonal Restrictions					
Environmental windows	X	X	X	X	X
Avoid repetitive disturbance in same year[1]	X	X	X	X	X
Avoid peak recruitment and productive period		X			
Dredge Equipment and Operational Controls					
Dredge equipment selection				X	X
Use dredge controls - entrainment				X	X
Use dredge controls - turbidity				X	X
Construction Equipment, Methods, and Best Management Practices (BMPs)					
Use silt curtains or gunderbooms to minimize turbidity					X
Use dikes or swales to minimize turbidity		X			
Use dikes protect sensitive resources		X			
Minimize potential hazardous materials leaks or spills	X	X	X	X	X
Reduce noise levels below sensitive wildlife harassment or disturbance thresholds	X	X			X
Minimize artificial lighting in sensitive wildlife areas	X	X			X
Construction Monitoring					
Sediment compatibility inspections and testing	X	X			
Water quality compliance		X	X	X	X
Inlet status		X			
Sensitive species, as appropriate	X	X			X
Post Construction Monitoring					
Verify impact significance, as appropriate	X	X	X	X	X

Minimize Maintenance Frequency of Impact Over Time

- Minimize frequency of beach nourishment by incorporation of dune restoration, where feasible.
- Minimize maintenance dredge frequency by use of over-dredge depths or advance maintenance dredging.
- Minimize sedimentation inputs from watershed using erosion control BMPs, sedimentation basins, and/or sand retention traps.
- Minimize sedimentation of embayment inlets and channels from beach nourishment by use of placement location downcurrent of inlet, buffer distance, and/or project volume controls.

Avoid and Minimize Impacts to EFH and Sensitive Species
Measures are reviewed in Section 6.6.2.

Minimize Potential for Hazards

- A Transport and Discharge Operations Plan shall include a Spill Prevention, Containment and Countermeasures Plan (SPCCP) that specifies fueling, equipment maintenance procedures to prevent spills and leaks, and containment and cleanup measures to be followed in the event of a spill.
- All equipment shall be inspected for leaks (especially hydraulic lines, fittings, and cylinders) and the equipment cleaned each day or shift that the equipment is to enter the water. Equipment will be cleaned and repaired (other than emergency repairs) at least 500 ft (152 m) from the high tide line. No equipment with leaks will be allowed on the beach or to operate in waters.
- All contaminated water, sludge, spill residue, or other hazardous compounds will be disposed of at a lawfully authorized designation.
- Use biodegradable, nontoxic, vegetable-based hydraulic oil rather than petroleum-based hydraulic oil when practicable.

6.6.3.3 Summary of Mitigation Measures by Habitats and Species

Mitigation measures applicable to coastal habitats and species are listed in Table 6.6-3.

Pre-construction project design is considered the most effective measure to avoid and/or minimize impacts to biological habitats. Important design considerations vary among habitats, as follows:

- Project location is relevant to all habitats, but is particularly important as an avoidance measure for sensitive hard bottom and vegetated habitats.
- Project size (volume) is an important consideration for minimizing impacts to sensitive hard bottom and SAV habitats located within distances that may be influenced by turbidity and/or sedimentation during and after beach nourishment and/or dredging projects.
- Sediment compatibility is relevant to beach nourishment projects and is particularly important for minimizing impacts to sandy habitats (i.e., coastal dune and/or strand, sandy beach, nearshore sands).

- A pre-construction survey to finalize construction plans is effective for avoidance of direct impacts to sensitive habitats in areas where site-specific information is limited or lacking. This measure may be relevant for coastal strand, hard bottom, and SAV habitats. This measure also may be relevant for dredging and/or nearshore placement project areas where sensitive spawning grounds and/or nursery areas of fishery species (e.g., Pismo clam beds, Dungeness crab breeding/brooding areas), have the potential to occur, but site-specific information is lacking.

Applicable mitigation measures during construction depend on habitat type.

- Buffers and/or prohibition zones, which may be verified with construction monitoring (e.g., turbidity, verification of buffers), may be applicable for projects conducted in proximity to sensitive hard bottom and/or vegetated habitats, and/or near entrances of shallow-inlet embayments.
- Construction methods and/or BMPs to control turbidity are applicable to all aquatic habitats. They also are applicable to all dredging projects and most beach nourishment projects (i.e., placement in intertidal and/or nearshore habitats).
- BMPs to control spills and/or leaks from equipment operation are applicable to all habitats and types of sediment management projects.
- Environmental windows, which are the most restrictive of construction mitigation measures, have been applied to protect sensitive or commercially important species rather than habitats, which support ecological functions year-round. Other mitigation measures such as buffers, equipment operational controls, and monitoring also may be protective and should be determined on a case-by-case basis.

Post-construction monitoring and/or compensatory mitigation measures may be relevant for sensitive hard bottom and/or vegetated habitats when there is uncertainty with respect to project impacts.

Table 6.6-3. Types of mitigation measures with demonstrated and/or likely effectiveness to protect biological resources during sediment management activities.

Resource	Pre-Construction				Construction Phase					Post Project	
	Sediment Compatibility	Project Design	Implementation Strategy	Buffers	Location Controls	Environmental Windows	Operational Controls	Construction Methods, BMPs	Construction Monitoring	Impact Verification Monitoring	Compensatory Mitigation
Impact Factor											
Equipment			X	X	X	X	X	X	X	X	X
Turbidity	X	X	X	X	X	X	X	X	X		
Burial	X	X	X	X	X	X	X		X	X	X
Sedimentation	X	X	X		X	X	X	X		X	X
Habitats and Species											
Coastal Dune and/or Strand	X	X	X	X	X		X		X	X	X
Sandy Beach	X	X	X				X	X	X		
Sandy Subtidal	X	X	X				X	X	X		
Rocky Intertidal		X	X	X	X		X	X	X	X	X
Rocky Subtidal		X	X	X	X		X	X	X	X	X
Kelp Forest and/or Bed		X	X	X	X		X	X	X	X	X
Surfgrass Bed		X	X	X	X		X	X	X	X	
Eelgrass Meadow		X	X	X	X	X	X	X	X	X	X
Embayment		X	X	X			X	X	X	X	X
Abalone		X	X	X			X				
California Lobster		X	X	X			X			X	
Dungeness Crab	X		X	X		X	X				
Pismo Clam	X	X	X	X	X		X				
Sea Urchins			X	X			X				
Beach Invertebrates	X		X				X	X			
Subtidal Sand Invertebrates	X		X				X	X			
Intertidal Rock Invertebrates		X	X	X			X			X	X
Subtidal Reef Invertebrates		X	X	X			X			X	X
California Grunion	X	X	X	X	X	X	X	X	X		
Pacific Herring			X	X		X	X	X			
Salmonids			X			X	X				
Demersal Fish	X		X				X				
Pelagic Fish			X				X	X			
Subtidal Reef Fish		X	X	X			X	X			
Tidepool Fish		X	X	X			X	X			
CA Brown Pelican			X	X		X	X	X			
CA Least Tern			X	X		X	X	X	X		
Western Snowy Plover	X	X	X	X	X	X	X	X	X		
Gulls and/or Terns	X		X				X				
Shorebirds	X	X	X				X				
Wading Birds, Waterfowl			X				X				
Sea Otters		X	X	X	X	X	X				
Pinnipeds		X	X	X	X		X				
Cetaceans			X	X	X		X		X		