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).

<u>Bucket Size</u>

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 <u>Dredging Operational Controls – Turbidity</u>

<u>Bucket Dredges</u>

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).

<u>Cutterhead Dredges</u>

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:
    - Strong currents (> 1 to 1 ½ knot are problematic). In high currents, silt curtains may be difficult to maintain and can easily become dysfunctional.

- 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.
- 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.
- Excessive wave heights (including ship wakes).
- High winds. Can lift curtains like a sail.
- 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 <u>Minimize Potential Hazardous Materials Leaks or Spills</u>

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