Utilization and Recommendation Report
MCR Ocean Dredged Material Disposal Sites
For 2003-2004

1.0 PURPOSE AND SUMMARY

1.1 General The mouth of the Columbia River (MCR) is the ocean gateway for maritime navigation to/from the Columbia – Snake River navigation system. The U. S. Army Corps of Engineers is responsible for the operation and maintenance (O&M) of the federal deep-draft navigation channel at the MCR. The MCR channel is 2640 ft wide and nominally 55 ft deep (below MLLW). Each year, the Portland District dredges 3-5 million cubic yards (MCY) of sand at MCR to maintain the 5-mile long deep draft navigation channel. The dredged material is fine-medium sand (0.17-0.27 mm) and fine-grained material content is less than 4%. The MCR channel is dredged using 2 hopper dredges; a government dredge and a private industry (contract) dredge. The dredged sand is placed at ocean dredged material disposal sites (ODMDS) or at sites permitted through Section 404 of the Clean Water Act (404 site). Figure 1 shows the regional bathymetry of MCR and dredged material disposal sites. Figures 2-4 show a detailed view of each disposal site available for 2004.

Although the navigation channel is the primary Corps project feature at MCR, suitable open water dredged material disposal sites are necessary features and require a rationale for design, utilization, and designation. Management of an ODMDS is predicated on the need to efficiently utilize the site while minimizing impacts to navigation and environment outside the ODMDS. The *ultimate* capacity of an ODMDS is the volume (or height and area) of dredged material that can accumulate within a site's boundaries without adversely affecting navigation or the environment. MCR ODMDSs are managed to an *operational (or target)* level of accumulation that is below the ultimate capacity of the site. The target accumulation is based on the desire to limit dredged material accumulation such that mounded dredged material does not amplify waves, due to shoaling and refraction. The objective of managing an ODMDS to the target level of accumulation is to avoid adversely affecting navigation. The target accumulation can be different for each disposal site.

As part of the management plan for an active ODMDS, the bathymetry of the site is monitored during the dredging/disposal season to determine the extent of dredged material dispersion and accumulation on the seabed. If a given disposal site is at or near its target capacity, then site management changes accordingly. This report:

1) Describes observed bathymetric change at mouth of the Columbia River (MCR) dredged material disposal sites utilized during 2003, based on the comparison of hydrographic surveys;
2) Examines the relative usability of each disposal site based on observations made during 1997 to 2004;
3) Highlights the disposal sites availability for 2004; and

4) Presents recommendations for utilization of ODMDS E and the North Jetty site during 2004. In some cases, recommendations represent a departure from previous site utilization practices.

1.2 Dredging-Disposal during 2003. During the 2003 dredging season (June-October), 3.29 MCY of sand was dredged from the MCR navigation channel and placed in two in-water disposal sites: The North Jetty (404 site, formally known as site C), and ODMDS E. Although the Deep Water Site (the 103 sub-area) was available during 2003, it was not used. Approximately 2.85 MCY of dredged sand was placed at ODMDS E, and 448,800 cy (448 KCY) was placed at the North Jetty site.

The North Jetty site (404 site) was first used in 1999 and is located along the southern side of the MCR north jetty, in water depths of 40–70 ft. Use of the North Jetty (NJ) Site is intended to protect the foundation of the north jetty from additional scour.

The site now known as ODMDS E has been used since 1973 under different names and configurations, i.e., Site E and "Expanded Site E". EPA final designation of a Shallow Water Site (SWS) in the vicinity of ODMDS E is pending at the time of this report. Throughout this report the term, ODMDS E, is used consistently to represent the area that may soon become known as the SWS. ODMDS E has become the primary location for dredged material disposal at MCR and is located on the ebb tidal delta of the Columbia River, about 1/4 mile seaward of the MCR north jetty, in water depth of 45-70 ft.

ODMDS E and the North Jetty (NJ) site are considered to be within the active littoral zone of MCR and are highly dispersive: A sizable fraction of the dredged material placed at these sites is transported out of the site by waves and currents and reintroduced into the littoral system of MCR and the adjacent coast. For this reason, the NJ site and ODMDS E are used to the maximum extent possible.

If the Deep Water (DW) Site had been used during 2003, dredged material would have been placed in a confined manner within the available placement area (point dumping). The intent was to minimize the areal dispersal of dredged material placed within the DW Site (opposite to the SW and NJ Sites). The vertical limit for total dredged material accumulation (on the seabed) with the DW site is 40 ft.

The detailed strategy for managing the MCR dredged material disposal sites during 2003 is described in the document "MCR Dredged Material Disposal Site Annual Use Plan for 2003" USACE [2003b] http://www.nwp.usace.army.mil/issues/mcr/utilization.htm. To improve the utilization of ODMDS E and the NJ Site during 2004, some general observations and recommendations are made in this report (see page 16 and 18). After the 2004 predisposal surveys for each disposal site are acquired (April-May 2004), specific actions for utilizing available MCR disposal sites will be described in the "MCR Dredged Material Disposal Site Annual Use Plan for 2004."

1.3 ODMDS E ODMDS E is located along the southern flank of Peacock Spit within 2,000 ft north of the MCR navigation channel in a water depth of 45-70 ft (figure 1 and 2). Detailed assessments of ODMDS E are illustrated in figures 6-14. ODMDS E is the principal disposal site for MCR dredged material. Since 1997, 67% of all MCR dredged material (sand) has been placed in ODMDS E. As of March 2003, waves and currents had dispersed 93% of all dredged material placed within the site (17.7 MCY since May 1997) in a north-northwesterly direction onto Peacock Spit. Typically, less than 5% of the dredged material placed at the site has been transported southward into the MCR navigation channel. The lack of southward transport at ODMDS E is due to the predominate influence of ebb tidal currents that affect the site. The eastern half of the site has experienced net erosion since 1997. Based on monitoring conducted during 1997-2004 (see table 1), about 40% of the dredged material placed at ODMDS E has been dispersed during the dredging/disposal season (June-October). The dispersion rate within the site during the ensuing winter (November-May) has averaged about 53% of the volume placed at the site. The site's average annual dispersive rate has been about 93% of the volume of dredged material placed each year during 1997-2003.

Beginning in 1997, efforts had been made to place dredged material uniformly within ODMDS E. Yet prior to 2003, only 50-80% of the area within ODMDS E had been used in any given year. In some cases, dredged material placement within ODMDS E (and deposition on the seabed) was concentrated within small areas. When localized mounding occurred within ODMDS E, less than 10% of the dredged material placed during the dredging/disposal season had contributed to an accumulation that was greater than the management target [USACE 2001 and 2002a-c]. If the same "10%" of dredged material had been placed in the area of ODMDS E that was not used (20-50% of the site), the potential for mounding would have been greatly reduced if not eliminated. A new approach for utilizing "all" of ODMDS E was initiated in 2003.

In short, using 100% of the site for the placement of dredged material will reduce the occurrence of localized mounding and maximize the placement volume; not doing so will result in localized mounding of placed dredged material regardless of the volume placed. The presence of a navigation buoy (#7) within the middle of ODMDS E (prior to 2003) had contributed to the lack of complete site area utilization.

Due to critical nature of successfully managing dredged material disposal at ODMDS E, an independent Federal Review Team was convened in 2001 to review site management practices and make recommendations for improved future site management. Results can be found at: http://www.nwp.usace.army.mil/issues/MCR/reports/site_e/report.pdf. The USACE-Portland District and EPA-Region 10 produced a report in March 2003 that investigated the interaction of waves, currents, and dredged material disposal and sediment transport at ODMDS E. The Corps-EPA report also addressed the Federal Review Team's recommendations to improve management of ODMDS E, and developed a systematic procedure for optimally using ODMDS E given operational constraints. The improved procedure for using ODMDS E is described below. The entire USACE-EPA report can be viewed at: http://www.nwp.usace.army.mil/issues/MCR/reports/mcrfinal03/MCRdraftffinalreport10mar03final.pdf

1.4 Regimented Dredged Material Placement. To avert excessive mounding of dredged material placed within ODMDS E and the NJ site during 2003, a significant effort was made to achieve full utilization of capacity by promoting even deposition of dredged material throughout the entire site boundaries. To accomplish this, dredged material was placed though out the entire site, both in space and time, using a regimented procedure to produce a uniform continuous layer on the seabed, avoiding the formation of any localized mounding. The sites were partitioned into a system of cells (about 500 x 500 ft) and initial dump assignments were made for each cell within a given site. Cell assignments were determined using the pre-disposal survey for 2003, the site's baseline survey, and target mound heights (elevations) for dredged material accumulation. The cell assignments (dumps per cell) were periodically refined as a given site is "filled" and re-surveyed. As areas of a site were filled; filled cells were either minimally used or were restricted from use. To facilitate coordination of site assessment, the same placement grid was used by the contractor and government dredges. Figure 5 shows general cell layout for ODMDS E and the NJ Site. Initial cell assignments for ODMS E is shown in figure 8a. During 2003, placement of dredged material within ODMDS E and the NJ Site was conducted according to the following specification. The SW Site sand NJ Site were filled uniformly with no more than one load difference between any two cells: All cells were filled with one load before placing a second load in any cell; all cells designated for two loads were filled before placing a third load in any cell, etc. When recording the placement location, material shall was credited to the cell in which the disposal operation was started regardless of the number of cells disposed in. Each load was distributed across no less than 2 cells. Refer to USACE [2003b], for additional details of 2003 disposal site management: http://www.nwp.usace.army.mil/issues/mcr/utilization.htm

The volume of dredged material annually placed at MCR disposal site (for 1956-2004) is summarized in table 2. During June-September 2003, about 2.9 MCY of dredged sand was placed within ODMDS E. By November 2003, waves and currents had transported 40% of the dredged material placed within ODMDS E during 2003 out of the site (table 1). As of 13 November 2002, the level of dredged material mounding in ODMDS E was 4 ft or less, with respect to (w.r.t.) the 1997 baseline condition. About 30% of the area within ODMDS E was covered by 4 ft of dredged material, w.r.t. the baseline condition. As of 16 March 2004, waves and currents had transported an additional 53% of the dredged material placed within ODMDS E during 2003 out of the site (table 1). Less than 5% of the of the seabed area within ODMDS E was covered by 4 ft of dredged material, w.r.t. the baseline condition.

Depending upon the approach for utilizing of ODMDS E during 2004 (which will be specified in the 2004 Annual Use Plan, scheduled for May 2004), the site may be able to accept 3 to 4 MCY.

Utilization of ODMDS E is intended to (re-) introduce dredged sand into the littoral zone of Peacock Spit and points north of north MCR. It is widely recognized that Peacock Spit is the reservoir of sand that maintains the littoral budget for the shoreline north of MCR. By maintaining Peacock Spit, the littoral budget of the Long Beach Peninsula will be maintained. Use of ODMDS E is believed to replicate the process of sand discharge from

the MCR to Peacock Spit. At least 85% of the material placed at ODMDS E has been transported out to of the site onto Peacock Spit. Given that the small size of ODMDS E with respect to the present size of Peacock Spit (1 mi^2s vs. 25 mi^2), use of ODMDS E has been an effective method for supplying sand to the littoral budget of Peacock Spit. Continued use of ODMDS E is strongly recommended. See page 16 of this document for specific recommendations that will facilitate the avoidance of excessive mounding in 2004.

1.5 North Jetty (NJ) Site Much of the dredged material placed at the NJ site has abated a destabilizing scour area along the southern toe of the MCR North jetty. This was the justification for using the NJ site. However, the target capacity of the NJ site is difficult to fully utilize due to the site's small areal size, proximity of the north jetty, and limited water depth on the site's east/south side (see figure 1). It is difficult to maneuver a ship the size of a medium-class hopper dredge through the entire site. The capacity of the NJ site to handle large volumes of dredged material is limited and requires care in operational planning and use. The NJ site is illustrated in figures 1 & 3 and 23-24. During 2003, dredged material placement within NJ Site was controlled using the same protocols as ODMDS E (see Section 1.4 of this report).

As of 12 September 2003, about 40% (or 1.0 MCY) of the material placed in the site during 1999-2002 had remained within the site. Sand transport from the NJ site appeared to be in several directions; some of the placed sand has moved south toward the MCR navigation channel and some has moved toward the toe of the north jetty. The accumulation of dredged material along the toe of north jetty is most desirable. Unless the volume of channel shoaling attributable to the NJ site becomes excessive, the value of protecting the toe of the North Jetty from destabilizing scour offsets minor channel shoaling. As of October 2003, about 65% (290,000 cy) of the material placed in the site during late September 2003 remained within the site, and a total of 1.3 MCY was present within the NJ site when compared to the baseline condition (June 1999). The NJ site has been moderately dispersive w.r.t. the volume of dredged material placed there; about 43% of the material placed within the site since 1999 was on the seabed as of 6 October 2003. However, a 31 March 2004 survey of the NJ site indicates that 700 KCY was deposited within the site during the winter. This was not a normal occurrence.

Based on the vertical extent of dredged material accumulation observed on 31 March 2004, it is recommended the NJ site not be used until the present accumulation (w.r.t June 1999) has been reduced to 8 ft or less. Based on prior years' observed dispersion during spring-summer, the NJ site may be able to receive 100-200 KCY in 2004. Use of the NJ site during 2004 will be predicated based on review of the pre-disposal survey (to be acquired in July-September). See page 16 for additional recommendations.

1.6 Disposal Sites No Longer Used. The regions of ODMDS A, B, and F which were temporarily expanded under "section 103" of MPRSA (in 1993) had expired in 2003. This left only the original EPA-designated areas of ODMDS A, B, and F (originally designated in 1986, under "section 102" of MPRSA) available for use. The boundaries for the "section 102" ODMDS are shown in figure 1 and 22. The restrictive size of the present ODMDS A, B (2,000 ft x 5,000), and F(1,800 ft x 1,800 ft) is compounded by the

mounding of dredged material that was previously placed at these sites and limits future use. This decision is also predicated on EPA's proposed rule to designate the SWS and DWS and de-designate MCR ODMDSs A, B, and F as described in http://edocket.access.gpo.gov/2003/pdf/03-5743.pdf.

1.7 Outlook for Present MCR Dredged Material Disposal Sites In-water disposal sites which are planned for use in 2004 include ODMDS E, the DWS ("section 103" area), and the NJ Site. Each of the MCR dredged material disposal sites available for use in 2004 is affected by a unique physical environment and presents unique challenges for site management. See figure 1 for the location of MCR dredged material disposal sites available for 2004.

At present, ODMDS E and the NJ site are expected to have a combined target capacity of 3-4 MCY for the 2004 dredging-disposal season. An improved estimate for the 2004 disposal (target) capacity of ODMDS E and the NJ will be ascertained when a pre-disposal survey for each site is acquired in May-June 2004. In the event that ODMDS E and the NJ site do not have the capacity to handle all 2004 MCR dredging disposal volume, the "section 103" area of the Deep Water Site could be used. Clarification for availability and potential use of the DWS during 2004 will be presented in the "2004 Annual Use Plan" for MCR disposal sites (scheduled for May 2004).

2.0 MANAGEMENT PROTOCOLS FOR ODMDS E

2.1 Management Goal for 2003 Successful management of ODMDS E is predicated on the requirement to avoid modification of the site's bathymetry (via dredged material mounding) such that the modification could potentially result in adverse wave amplification with respect to the May 1997 baseline condition [USACE 1998a, USACE 1999a]. With this criterion in mind, a target value of 5 ft was selected for managing the vertical accumulation of dredged material (with respect to the *baseline* condition of 1997) within ODMDS E during 2003 based on the water depth dependent thresholds discussed in USACE 2003 & 2003a.

2.2 Management Target for 2003 The 5-foot target height for dredged material accumulation within ODMDS E during 2003 was based on a mound feature that would occupy an area of 2,000 x 2,000 ft (with respect to the *baseline* condition of 1997). For smaller mound features that exceed the target height, there would be little or no wave amplification. A case-by-case examination of wave amplification potential is warranted only when dredged material accumulated to levels that far exceeded the "limiting mound height" and/or covered an area larger that 2,000 x 2,000 ft. A contingency plan for managing dredged material placement within ODMDS E during 2003 was based on 6 action levels (USACE 2003b). The objective of the 2003 Annual Use Plan was to avoid any action level above "Level 4." Action Level #4 was defined as: Limited Management Level = dredged material exceeds target mound height by 1-2 ft within an area greater than 500 x 500 ft. ACTION: Avoid placement in the affected location of accumulation and in adjacent areas. Continue to use areas not affected; adopt early exit strategy for site.

ODMDS E is typically managed in two parts, a western half and an eastern half. Each half of the site exhibits different physical characteristics; the eastern half is geometrically smaller but is 2x more dispersive than the western half. Demarcating ODMDS E in terms of two parts facilitates clear communication about site utilization and improves site management. It is noted that since 2000, the western half of ODMDS E has been accumulating about 200,000 cy/yr of sediment; not all of the placed dredged material is transported out of the site on an annual basis. Depending upon annual conditions, the western half of ODMDS E is managed differently than the eastern half of the site to account for net deposition.

3.0 UTILIZATION OF ODMDS E DURING 2003

3.1 Objective The management objective for ODMDS E was to fully utilize the site for the disposal of MCR dredged material, while limiting the average vertical accumulation of placed dredged material so as to avoid adversely affecting navigation at or near the site. The 2003 management target for the vertical accumulation of dredged material placed within ODMDS E was 5 ft, w.r.t. the site's *baseline* condition (9 May 1997) [USACE 1998b and 2003b]. Uniform distribution of dredged material within ODMDS E was achieved through a systematic procedure outlined in Section 1.4 of this report. The preference for continued use of ODMDS E is due to:

The dispersive nature of the site - dredged material placed at ODMDS E is quickly transported to the littoral (coastal) environment of MCR. This allows for the renewal of disposal (target) capacity at ODMDS E while using the process of dredged material disposal as a method to place or retain dredged material within the nearshore littoral environment of Washington and abate erosion of Peacock Spit and locations north. The State of Washington, thru issuance of water quality certification for MCR O & M dredging, urges Portland District to maximize use of ODMDS E, for the beneficial littoral aspects of the site.

The proximity of the site with respect to the MCR navigation channel – haul distance from MCR dredging to ODMDS E is short, making ODMDS E cost-effective to utilize and allows more dredging to be accomplished within the limited operational window at MCR.

"Fully utilizing" ODMDS E while not negatively affecting navigation (by limiting the accumulation of dredged material placed within the site) could be inferred as conflicted objectives. Management of conflicted objectives is problematic: This is why prudent management of ODMDS E during 2003 was essential. A critical element that allowed full utilization of ODMSD E during 2003, was the relocation of buoy #7 (see figure 6a). Previous to 2003, buoy #7 had prevented full use of the site due to the buoy's location within the middle of the site. The US Coast Guard relocated the buoy in May 2003 at the request of USACE, Portland District after full coordination with all MCR navigation interests. Partial validation of a "new" approach for managing ODMDS E during 2003 was supported through computer modeling of dredged material placement within the site. Disposal scenarios ranging from 1 to 6 MCY, were modeled using the uniform method of placement (described in Section 1.4), and indicated that ODMDS E could be used without

significantly affecting the wave environment at/near the site. Figure 17 shows a comparison between predicted dredged material accumulation within ODMDS E and observed accumulation during 2003. Additional details concerning the strategy for utilizing ODMDS E are described in USACE [2003] and can be viewed at: http://www.nwp.usace.army.mil/issues/MCR/reports/mcrfinal03/MCRdraftffinalreport10mar03final.pdf.

3.2 Pre-disposal Condition of ODMDS E for 2003 Figures 5 and 8a show the distribution of the 87 disposal cells that were used to guide the placement of dredged material within ODMDS E during 2003. Figure 5 (upper R.H. corner) lists the protocol for dredged material placement within ODMDS E, as does Section 1.4 of this report. The May 1997 *baseline* bathymetry for ODMDS E is shown in figure 2. Figure 6a shows the bathymetry at ODMDS E as of 29 April 2003 and documents the pre-disposal condition of ODMDS E for 2002. Note the new location of entrance buoy #7. Figure 6b shows the difference between the surveys of 1 Dec 2002 and 29 April 2003 and highlights the erosion of dredged material (placed within ODMDS E during 2002) that had occurred during the winter of 2002-2003. About 1.7 MCY of sediment was eroded from ODMDS E during the winter 2002-2003 (2-4 ft of erosion); much of the eroded sediment moved north of the site (onto Peacock Spit).

Figure 7a shows ODMDS E bathymetry change that had occurred between the time of the *baseline* condition (May 1997) and 29 April 2003. Note the erosion within the eastern quarter of the site; the bathymetry in eastern half of the site was 2-8 ft lower in 2003 than in 1997. As of 29 April 2003, there was some material remaining within the western half of ODMDS E from preceding years' disposal operations: Accumulation w.r.t. the site's *baseline* condition ranged from 1-4 ft high and contained about 0.83 MCY.

Figure 7b shows the spatially varying target capacity of ODMDS E in terms of target accumulation levels within the site, based on the 29 April 2003 survey. A "limited capacity zone" is where dredged material had accumulated 3-4 ft with respect to the baseline condition and additional disposal was to be minimized. An "Avoidance Zone" is where dredged material has accumulated to 4 ft or greater, and additional disposal is prohibited. Note that the total target capacity within Site E was 4.9 MCY, but the effective target capacity was 4.1 MCY. The effective target capacity of Site E is based on: The *vertical threshold* for which dredged material can accumulate within the *usable* area of Site E. The vertical threshold for accumulation in 2002 was 5 ft with respect to the baseline condition. The usable area of Site E was calculated as: The site's **total area** - "**Avoidance Zones**" – non-**use along the site's margins** (-20% of the total site area). This means that about 80% of ODMDS E can be relied upon to fully accept dredged material assuming that there were no "avoidance zones." The site's target capacity estimate for 2003 did not account for the dispersive nature of Site E (ie dynamic capacity), which would increase the effective site's capacity. Based on past observation (table 1), about 40% of all material placed in Site E during a dredging/disposal season is dispersed out of the site during the dredging/disposal season. In summary, the 2003 ODMDS E target capacity estimate of 4.1 MCY (based on the 29 April survey) and was subject to change depending upon the

amount of natural deposition or erosion that occurred within the site during the course of the 2003 dredged material disposal season (June-October).

Figure 8a shows the layout for the initial cell assignment that was used to distribute dredged material within ODMDS E, at the beginning of the 2003 dredging-disposal season. The initial cell assignment (figure 8a) was based on the capacity available within the site as of 29 April (figure 7b). As areas of the site were filled, the respective cells would be specified as not available for use or as "Limited Capacity Zones." The grid system was used to adaptively manage ODMDS E by cumulatively tracking individual disposal events and communicate site utilization strategy between Portland District and dredges. Cell assignments were modified as site monitoring dictated. Refer to figure 5 and Section 1.4 of this report.

3.3 Dredged Material Placement During 28 June – 26 Sept 2003, the contract hopper dredge (*Sugar Island*) placed 1,542,000 CY within ODMDS E. During 28 August - 15 Oct, the government hopper (*Essayons*) dredge placed 1,306,000 CY within ODMDS E. The total volume of dredged material (sand) placed within ODMDS E during 28 June – 15 October 2003 was 2.85 MCY. During 2003, the government was responsible for monitoring the level of dredged material accumulation with ODMDS E and making corrections to the site utilization plan to ensure compliance with the criteria as described in Section 1.4. Both ODMDS E and the NJ Site were managed in "real-time" and a high degree of coordination was established and maintained between various government offices (EC-C,EC-HY,EC-HR,OP-NW, PM-PM, OP-DE, EPA Region 10) and the contract dredge. Decisions for directing dredged material placement were supported by disposal site bathymetry surveys (conducted weekly during active site use) and active tracking of disposal vessel location during individual load placement (assessed daily). Figure 8b shows the beginning and ending coordinates for the first 83 loads of dredged material placed within ODMDS E by the contract dredge, according the initial placement plan (figure 8a). As of 6 July, 208,000 cy of sand had been placed within ODMDS E. for 2003.

Figure 9a shows the target capacity of ODMDS E and dump-cell assignment plan #2, based on the 8 July survey. Figure 9b shows the beginning and ending coordinates for 77 loads of dredged material placed within ODMDS E by the contract dredge, according the placement plan #2 (figure 9a). As of 12 July, 164 loads (or 410,000 cy of sand) had been placed within ODMDS E for 2003. Figures 10-13a show similar results for subsequent cell assignments, dredged material, disposal and accumulation within ODMDS E during 21 July – 22 September. The cells within the eastern 1/3rd of the site were assigned a high number of dumps due to large capacity of this area. The eastern half of the site is typically 2 times more dispersive than the western half [UASCE 2003]. Toward the end of the 2003 dredging season, this area of the site was targeted for enhanced disposal (see figure 12b).

3.4 Placement Summary for 2003 In summary, dredged material accumulation with ODMDS E did not exceed 5 ft at any time during 2003. More than 98% of the site's area had been used for dredged material disposal during 2003, resulting in uniform distribution of dredged material through out the entire site. Throughout 2003, placement of dredged

material was modified to minimize new accumulation at areas with accumulation from previous years' use. This contingency made the management of the western half of the site more intensive than the eastern half of the site. The eastern 1/3rd of ODMDS E could have been used for at least 500,000 cy additional dredged material disposal, if the need had arisen during 2003 (due to the high rate of dispersion observed at this area of the site). The accumulation of dredged material placed within ODMDS E during 2003 did not exceed the "Action Level 4," an objective that was specified in the 2003 Annual Use Plan.

3.5 Dredged Material Accumulation and Dispersal During Placement The year-to-year management of *total* dredged material accumulation within ODMDS E is exercised w.r.t. the site's baseline (9 May 1997) condition. However, additional insight of the site's capacity can be gained by viewing the intra-annual bathymetry change. Several surveys conducted during 2003 are compared, to assess the accumulation and dispersion of dredged placed within the site. The two intermediate time periods examined are:
29 April-4 August and 4 August-13 November, 2003.

Figure 13b shows the bathymetry change that occurred within ODMDS E during 29 April - and 4 August 2003. As of 4 August, 1.1 MCY of sand had been placed within ODMDS E during the 2003 dredged disposal season. Approximately 840 KCY had deposited uniformly on the seabed within the site. About 25% of the material placed during 28 June – 4 August was dispersed out of the site (by waves and currents), shortly after placement. Maximum vertical accumulation was about 2 ft, and was located within the eastern half of the site, along the northern boundary.

Figure 14a shows the bathymetry change that occurred within ODMDS E during 4 August – 13 November 2003. During this time, 1.75 MCY of sand was placed within ODMDS E, with approximately 1.1 MCY being deposited on the seabed within the site. This means that 37% of the material placed during this time had been dispersed out of the site (by waves and currents), shortly after placement. Maximum vertical accumulation was about 3 ft, and was located near the center of the site. Placement (and deposition) of dredge material during 4 Aug-15 Oct was not as uniform as the preceding time period. This was primarily to avoid adding additional material within the western half of the site, where capacity was near the target threshold. However, the area of 3-ft accumulation near the center of the site was the result of excessive disposal track crossing that had occurred during 7-9 August. Using the daily disposal track plots provided by the contractor (as required by contract), the localized accumulation issue was observed and resolved by 9 August. Without timely access to this type of data and a well-oiled team, the target threshold would have been exceeded in this high-use area of the site and ODMDS E utilization would have been serious affected for the remainder of 2003. Bathymetry surveys would have isolated the problem, but at some time after the exceedance condition.

3.6 Post-Disposal Condition of ODMDS E for 2003. Figure 14b shows the post-disposal condition of ODMDS E on 13 November 2003, about 4 weeks after the completion of MCR dredging-disposal. Figure 15 shows the difference between the 29 April and 13 November 2003 surveys and documents the net bathymetry change that occurred within ODMDS E during 2003. Approximately 2.85 MCY of sand had been

placed within ODMDS E during 2003 and 1.9 MCY remained on the seabed within the site. About 900,000 cy (32%) of the material placed during 28 June – 15 October had been dispersed out of ODMDS E (by waves and currents) shortly after placement. Note the asymmetric distribution of dredged material accumulation within ODMDS E during 2003.

If ODMDS E had no accumulation within the site prior to 2003, with respect to the baseline condition, a uniform coverage of dredged material throughout the site would have been desirable. However, this was not the case due to prior accumulation of dredged material within the western half of the site. An asymmetric distribution of dredged material was achieved within the site, to avoid adding additional accumulation to the western half of the site (and exceeding the target threshold, see Section 3.1). Improvements that could have been made to utilization of the site as shown in figure 15 include: A) Reducing the level of accumulation northwest of buoy #7, B) increasing the level of accumulation within the eastern 1/3rd of the site.

Figure 16 shows the difference between the 9 May 1997 and 13 November 2003 surveys and documents the total accumulation of dredged material placed within ODMDS E as of 15 November 2003, w.r.t the baseline condition. As of 15 November 2003, the level of dredged material mounding in ODMDS E was less than the target threshold (5 ft). More than 80% of the material that has accumulated with the site since 1997, was contained within the western half. Much of the eastern half of ODMDS E has experienced 2-6 ft of erosion since 1997, despite the annual placement of dredged material. Since 1997, approximately 17.7 MCY has been placed within ODMDS E. As of 15 November 2003, 93% of all dredged material placed within the site since 1997 had been dispersed out of the site. Typically, less than 5% has been attributed to shoaling within the MCR navigation channel. Use of ODMDS E during 2003 was highly successful; with respect to the stated accumulation threshold, annual use plan, the volume of material placed (and dispersed) within the site, and the degree of cooperation among stakeholders using, managing, and regulating ODMDSs at MCR.

3.7 Simulation of Dredged Material Placed within ODMDS E. In March 2003, the USACE-Portland District and EPA-Region 10 produced a report that investigated the interaction of waves, currents, and dredged material disposal and sediment transport at ODMDS E. A major focus of analysis was to evaluate if dredged material could be placed such that uniform deposition could be achieved within the SWS. A disposal sequence and sediment fate model (MDFATE) was used to simulate dredged material disposal operations and estimate the bathymetric condition within the SWS. The MDFATE model defines an open water disposal site in terms of a numerical grid and simulates 2-dimensional bathymetry change resulting from a series of disposal events. The model accounts for all physical, environmental, and operational parameters that affect dredged material when it is placed in an open water site. The USAE-EPA report [USACE 2003] can be viewed at:
http://www.nwp.usace.army.mil/issues/MCR/reports/mcrfinal03/MCRdraftffinalreport10mar03final.pdf

The objective of the model simulations was to determine if a cell-based placement plan could be used to achieve optimal utilization of available site capacity (minimize the vertical accumulation of placed dredged material) within the SWS.
The successful utilization of ODMDS E during 2003 was based in part, on the MDFATE simulations described above. To provide a "reality-check" for the simulations discussed in USACE 2003, the post disposal condition of the ODMDS E observed at the end of the 2003 is compared to one of the simulated scenarios.

Figure 17 compares observed accumulation within ODMDS E during 2003 (April-November) to the modeled result, obtained in March 2003. The simulated results (figure 17b) were produced assuming both contract and government hopper dredges placed dredged material uniformly throughout the site. The actual disposal operation (in 2003) placed material asymmetrically within the site to avoid additional accumulation within the western half of the site (see Section 3.5). The observed vertical accumulation was 5 ft high (with respect to the 2003 pre-disposal condition) and the simulated accumulation was 3 ft high. The observed dispersion rate within the site during 2003 was 32% of the volume placed; the dispersion rate for the simulated condition was 21%. The observed post-disposal condition compares favorably with the simulated results, despite differences in how the dredged material was actually placed vs. modeled.

3.8 Pre-Disposal Condition of ODMDS E for 2004. Figure 18 shows the bathymetry for ODMDS E on 16 March 2004. Figure 19 highlights the bathymetry change that occurred within the ODMDS E and the adjacent channel during November 2003 to March 2004. Note the erosion within ODMDS E of the area that had exhibited pronounced accumulation in November 2003 (see figure 15). There was a net 940,000 cy of erosion within ODMDS E during Nov03-Mar04, and about 300,000 cy of shoaling along the northside of the navigation channel adjacent to ODMDS E. It is unknown if this shoaling is from material transported out of ODMDS E, but if it was, this material represents about 10% of the volume placed in ODMDS E during 2003. Although the depth of the shoal is greater than 75 feet, this occurrence will be closely reviewed and monitored.

Figure 20 shows the difference between the 9 May 1997 and 16 March 2004 surveys and documents the total accumulation of dredged material placed within ODMDS E as of 16 March 2004, w.r.t the baseline condition. Most of the material remaining within the site resides within the western half. Less than 8% of the material placed within the site since 1997 is present and less than 5% of the of the seabed area within ODMDS E was covered by 4 ft of dredged material, w.r.t. the baseline condition. Figure 21 shows the spatially varying target capacity of ODMDS E in terms of target accumulation levels within the site, based on the 16 March 2004 survey. As of 16 March 2004, the effective capacity for additional dredged material disposal within ODMDS E was 3 MCY (1.1 MCY within the west half and 1.9 MCY within the east half). It is noted that this capacity estimate defines a safe operational limit since it does not include the dispersive capacity of the site and discounts 20% of the site's area. In 2003, over 95% of the site was used and the dispersive capacity of the site was about 30% of the volume placed (table 1).

Depending upon the approach for utilizing ODMDS E during 2004 (specified in the 2004 Annual Use Plan, to be prepared in May-June 2004), the site should be able to accept between 2-4 MCY.

4.0 REGIONAL BATHYMETRY CHANGE AT MCR

4.1 Bathymetric Changes Figure 22 shows ***regional*** bathymetric changes observed at MCR during 1997 to 2004 (refer to figure 1 for location of regional bathymetry change). During 1997-2004, moderate bathymetry change had occurred throughout the MCR region. The tops of the dredged material mounds at ODMDS A and B were eroded by 6-8 ft and much of the eroded material (sand) has been deposited near the flanks of the dredged material mounds. The crest of Peacock spit (MCR ebb tidal shoal) was eroded by 2-4 ft; with the eroded sediment appearing to have been deposited along the northern and seaward flank of the spit. The western area of Clatsop Spit was eroded by 4-8 ft.

The cumulative effect of using expanded ODMDS E can be seen by the extension of the "0" ft deposition contour to the north, onto Peacock Spit. This subtle change in bathymetry occurred over a period of 7 years and indicates the effectiveness of using Site E, for the purpose of introducing dredged sand into the littoral budget north of MCR and to maintain Peacock Spit. The extension of the "0" ft deposition contour from ODMDS E south into the MCR channel may be an indication that some of the dredged material placed at Site E has being transported southward or that sediment eroded from Clatsop Spit has been transported northward. Deposition of 2-4 ft has occurred near the seaward end of the south jetty and extends into the MCR entrance channel, in the form of a 1,500-foot wide strand oriented north-south: This feature may be an indication of sand-bypassing the south jetty to the north. There appears to be a wide tongue of (2 ft thick) deposition about 1 mile south of ODMDS B and within ODMDS F. Note the remnant accumulation of dredged material placed at ODMDS F (103 boundary, not shown).

Overall, the MCR ebb tidal delta has experienced net erosion during 1997-2003 with deposition occurring along the toe of the ebb tidal shoal. The above MCR bathymetry changes can be thought of as a "natural" occurrence, due to the process of waves and currents acting to re-distribute MCR sediment from the ebb tidal shoals that formed in response to jetty construction (1885 - 1917). Had ODMDS E not been used during this time, the erosion of Peacock spit would have likely been much greater.

5.0 RECOMMENDATIONS FOR 2004 UTILIZATION OF ODMDS E

Based on the results of managing ODMDS E during 1997-2002, a key observation was made in 2003. As predicted, minimizing the occurrence of dredged material mounding (above target levels) within ODMDS E is a matter of improving the management of less than 10% of the dredged material placed at the site. This observation was substantiated by computer simulation of dredged material behavior [USACE 2003] and recommendations to improve use of ODMDS E during 2003 were implemented [USACE 2003b]. Use of ODMDS E during 2003 was highly successful. Several recommendations are made below,

to continually improve use of ODMDS E for 2004 and beyond. Specific management and monitoring recommendations will be presented in the 2004 Annual Use Plan.

1) *Management of ODMDS E should be based on the usable target capacity of the site.* Areas of the site that cannot be easily accessed by hopper dredges will be identified within the 2004 Annual Use Plan, after procurement of the site's 2004 pre-disposal survey. The capacity associated with these areas should be subtracted from the site's total available (target) capacity. This would then define the site's effective target capacity for a given year. Based on the 2004 effective target capacity for ODMDS E, the methods and frequency for monitoring the site's bathymetry will be specified in the 2004 Annual Use Plan.

2) *Ensure that the MCR hopper dredges invoke active measures to avoid placement of dredged material on or near areas exhibiting remnant mounding.* This was accomplished in 2003 using a grid system for ODMDS E to identify areas requiring specific management action. It is also recommended that the use of "limited capacity" and "avoidance" zones again be employed, if needed in 2004. However, it is strongly recommended NOT to over restrict use of the site: "limited capacity" zones must be used if the full utilization of ODMDS E is to be achieved.

3) *Enforce Uniform placement of dredged material throughout the entire site, by all dredges using the site, throughout the entire dredging season.* It is recommended that all dredges using ODMDS E strive to continually distribute dredged material within the entire assigned disposal area. Assigned disposal areas within the site should be as large and contiguous as possible to enhance distribution of placed dredged material.

4) *For advance planning purposes, ODMDS E can be considered (at this time) for 3.0 to 4.0 MCY of dredged material disposal during 2004.* This is based on the 16 March 2004 survey of the site. This recommendation will be re-verified, before commencement of the 2004 dredging-disposal season, when ODMDS E is surveyed in May or June 2004.

5) *Track the placement of dredged material within ODMDS E by frequent plotting of disposal locations within the site.* The accurate plotting of disposal events should be used as a surrogate for assessing the local accumulation of dredge material placed within ODMDS E, as compared to directly monitoring the site's bathymetry and performing "survey differencing". Daily plotting of disposal locations (and vessel tracking) will provide a continuous knowledge of how placed dredged material is likely being depositing within the site and avoid mounding beyond the management target. A standardized procedure was developed by EC-C in 2003 and should be used in 2004.

6) *Implement several detailed improvements within the 2004 Annual Use Plan*. Limit the number of disposal dump-track crossings; Avoid dumping "on" ODMDS E boundary; Spend "up-front" time preparing NEW crew of the contract dredge for ODMSD E management and requirements. Review with government dredge crew.

For 2004, it is recommended that the contractor and government dredge continue reporting beginning-ending coordinates for each disposal event. The digital compilation of disposal coordinates should be sent to EPA Region 10, USACE-NWP (EC-R, EC-HR, and EC-HY) daily.

6.0 THE NORTH JETTY (NJ) SITE

6.1 General Figures 1 and 3 show the location of the NJ site. During 1990-1997, progressive lowering (erosion) of the seabed was occurring along the south side of the MCR north jetty, adjacent to the structure's toe. In many cases, rapid jetty deterioration of the north jetty has been attributed to the erosion of sediment at the structure toe. Placement of up to 1 MCY/yr of sandy dredged material at the NJ site is intended to replace sediment that has eroded from the southern toe of the north jetty, thereby protecting the structure from deterioration (caused by toe scour and related slope instability).

6.2 Dredged Material Placement during 2003. The NJ site was used during 12 September – 15 October and was essential to the 2003 O&M dredging mission at MCR, and successful management of ODMDS E. Other than the DWS, the NJ site was the only other disposal site available for use during periods when ODMDS E could not be used simultaneously by both hopper dredges. Had the DWS been used (instead of the NJ site) the sand dredged from MCR would have been placed in deep water where it would have no benefit to maintaining jetty stability or the littoral environment. The proximity of the NJ site to the MCR also reduced the time and cost of dredging at MCR for the volume of dredged material placed at the site, as compared to using the DWS. Use of the NJ site instead of ODMDS E provided a "buffer time" for surveying ODMDS E and planning subsequent use strategies for ODMDS E. The contract dredge *Sugar Island* used the NJ site during 21-27 Sept, placing 262 KCY. The government dredge *Essayons* used the NJ site during 12-17 Sept, placing186 KCY.

6.3 Bathymetry Change A total of 3 MCY has been placed within the NJ site during 1999-2003; 448 KCY was placed during 2003. As of 12 September 2003, there was 1 MCY of dredged material on the seabed within the site. This means that during June 1999 - Sept 2003, about 1.6 MCY (or 62% of the material placed) had been dispersed out of the site. Figure 23a shows the bathymetric change that occurred at the NJ site during 1999-2003. Some of the dispersed sediment was transported east of the site, and some was deposited along the northern edge of the MCR entrance channel. As of 12 September 2003, dredged material remaining within the NJ site was 3-8 ft thick, w.r.t. the June 1999 pre-disposal condition.

Figure 23b shows the difference between the 12 September 2003 and 6 October 2003 surveys at the NJ site and documents the deposition of dredged material placed within the site. Of the 448 KCY placed at the site during 2003, 290 KCY deposited in the seabed. Note the scour area paralleling the north jetty. The objective of placing dredged material within the NJ site during 1999-2003 was to fill the scour area. Although dredged material was placed 300 ft south of the jetty (offset for reasons of navigation safety and jetty slope

stability), dredged material placed in the NJ site did directly accomplish the objective of protecting the toe of the north jetty from scour.

Figure 24a shows the difference between the 15 June 1999 and 6 October 2003 surveys at the NJ site. As of 6 October 2003, dredged material accumulation with the NJ site was 6-10 ft high, w.r.t. the June 1999 pre-disposal condition. It was anticipated that up to 400,000 CY will be dispersed out of the NJ site during winter 2003. Figure 24b shows the difference between the 15 June 1999 and 31 March 2004 surveys at the NJ site. Dispersion at the NJ site during winter 2003 did not occur. Instead, the NJ site had experienced shoaling (deposition) of 700 KCY. This degree of shoaling at the NJ site has not been observed before.

6.3 Recommendation for NJ site. The NJ site should not be used until the present accumulation (w.r.t June 1999) has been reduced to 8 ft or less. This will be verified by periodic surveying of the NJ site prior to use in 2004. If the NJ site is used during 2004, **dredged material should be evenly dispersed through the site, with a preference along the northern edge of the site toward the north jetty.** Based on prior years' observed dispersion during spring-summer, the NJ site may be able to receive 100-200 KCY in 2004. Based on shoaling trends along the north edge of MCR channel, between River Mile 1 and 2, it appears that some of the dredged material placed at the NJ site may be migrating into the MCR navigation channel. This effect will be closely monitored.

7.0 DEEP WATER SITE – SECTION 103 AREA

A small area within the Deep Water Site is available for dredged material disposal during 2004. Refer to figures 1, 4, and 5. In the event that ODMDS E and the NJ site do not have the capacity to handle all 2004 MCR dredging disposal volume, the "section 103" area of the Deep Water Site could be used. The 3,000 f x 3,000 ft "placement zone" within the "Section 103" area of the DWS will be partitioned into 9 cells. Dredged material would be placed uniformly throughout the "placement area" using the 9 cells to promote uniform distribution. Clarification for availability and potential use of the DWS during 2004 will be presented in the "2004 Annual Use Plan" for MCR disposal sites (scheduled for May 2004).

8.0 LONG-TERM BATHYMETRIC CHANGE AT ODMDS E AND PEACOCK SPIT

8.1 General Construction of the MCR jetties during 1885-1917 redistributed a huge volume of sand (estimated at 600 MCY) offshore, and to the north and south, resulting in large ebb tidal deltas known as Peacock Spit and Clatsop Spit. Recent bathymetry change at ODMDS E must be placed in context to the rate and magnitude of historical change at MCR, since the jetties were built in 1885-1917. Figure 25 shows the historical change of the -40 ft depth contour at MCR, since 1889. Note the seaward advancement of the -40 ft contour in response to jetty construction (1885-1917). During 1993-2000 Peacock Spit has receded landward by 2,000 ft; as measured by the recession of the -40 ft contour. During this time, the rate of landward recession of the -40-ft depth contour on Peacock Spit was more than 4 times faster than during 1930-1993. Since 1997, 78% of sand dredged from the MCR channel has been placed at ODMDS E and the North Jetty site (totaling 20.7

MCY), reducing the rate of Peacock Spit erosion and re-introducing sand into the littoral system north of MCR.

8.2 Long-term Bathymetry Change Near ODMDS E The long-term fate of dredged material placed at ODMDS E was examined by comparing the present bathymetry of Peacock Spit with that of 1958 (using the difference between surveys, figure 26). This comparison integrates the effects of seabed change on Peacock Spit, due to natural forces and placement of dredged material at ODMDS E. Note that since 1973, approximately 65 MCY of dredged sand has been placed at ODMDS E (as compared to 18 million since 1997).

Figure 26 shows that the seaward half of Peacock Spit, between the 50-60 ft depth contour, has eroded during 1958-2003 while areas deeper than 70 ft have experienced pronounced deposition. Essentially, the top of Peacock Spit is being sheared-off (by waves and currents) and the sediment is being deposited at the west and northwest base of the spit. Note the significant erosion immediately south of ODMDS E, along the MCR entrance channel. This is believed to be due to:

1) MCR dredging and related channel sideslope adjustment. This is a localized process.
2) Natural channel migration, toward the north. This is a regional process.

It appears that as the "natural" MCR channel migrates northward, Clatsop Spit is following suite: Clatsop Spit is migrating north into the "project" limits of the MCR navigation channel.

Between 1958 and 2003, it appears that dredged material placed at ODMDS E has been transported primarily north-northwest (and then east-southeast) as indicated by the pink vectors in figure 26. Dredged material placed within the eastern half of ODMDS E is believed to be transported north-northwestward onto the crest of Peacock Spit, and ultimately toward Benson Beach. Dredged material placed within the western half of ODMDS E is believed to be transported west-northwestward onto the crest and ocean-facing slope of Peacock Spit. Dredged material that is transported onto the crest and ocean-facing slope of Peacock spit appears to be carried along the flank of the spit (parallel to the bathymetry contours) in a clockwise path, and ultimately carried back toward shore. Dredged material placed in the eastern half of ODMDS E appears to be subjected to a ***higher*** transport potential than dredged material placed in the western half of the site.

8.3 Summary It is speculated that if dredged material had not been placed at ODMDS E (65 MCY during 1973-2003), erosion would have occurred over a much larger area of Peacock Spit than what is indicated at present. Consequently, Benson Beach (Ft. Canby State Park) would have experienced significantly higher erosion (landward recession). Based on results shown in figure 20, 22, and 26, dredged material placed at ODMDS E does not appear to be moving south toward the navigation channel (at least in any appreciable quantity).

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