ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES FOR PORTS, HARBORS, AND TERMINALS

INTRODUCTION

1. The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).[1] When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry sector guidelines may be necessary. A complete list of industry sector guidelines can be found at www.ifc.org/ehsguidelines.

2. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

3. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

4. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

APPLICABILITY

5. The EHS Guidelines for Ports, Harbors, and Terminals are applicable to marine and freshwater ports, harbors, and terminals for cargo and passengers. Shipping (including repair and maintenance of ships), fuel terminals, and railways are addressed in the **EHS Guidelines for Shipping**; **Crude Oil and Petroleum Product Terminals**; and **Railways**, respectively. Annex A provides a summary of industry sector activities.

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

This document is organized in the following manner:

1. INDUSTRY-SPECIFIC IMPACTS AND MANAGEMENT

6. The following section provides a summary of EHS issues primarily associated with port and terminal construction and operations, along with recommendations for their management as part of a comprehensive environmental and social management system for a given project. Recommendations for the management of EHS issues common to most large industrial and infrastructure projects, including siting and cumulative impact considerations, are provided in the **General EHS Guidelines**. Sites for ports, harbors and terminals should be selected through a systematic, documented environmental assessment process that includes rigorous consideration of siting and alternatives, their direct and indirect environmental and social impacts, and consultation with affected communities. Appropriate site selection may avoid and/or minimize EHS and social impacts associated with ports, harbors, and terminals.

1.1 Environment

7. Environmental issues in port and terminal construction and operation primarily include the following:

- Terrestrial and aquatic habitat alteration and biodiversity
- Climate change resilience
- Water quality
- Air emissions
- Waste management
- Hazardous materials and oil management
- Noise and vibration (including underwater)

1.1.1 Terrestrial and Aquatic Habitat Alteration and Biodiversity

8. Construction and operation of new port and terminal facilities, or the expansion of existing facilities, involves the reclamation, clearing and paving (or compacting) of land for loading/unloading zones, bulk dry/liquid and containerized cargo storage areas, fuel depots, buildings, and roads; the alteration of coast lines for construction of breakwaters, shipyards, dockyards, wharves, piers, and vessel berths; and the transformation of the seabed to establish vessel basins (including areas for vessel turning) and navigation channels through dredging. These activities and related infrastructure, in addition to typical port operational

activities, may result in alteration of terrestrial, freshwater, brackish and marine habitats, with impacts to flora and fauna and related biodiversity. Examples of habitat alteration and biodiversity impacts from these activities may include the alteration and/or fragmentation of areas of high biodiversity value; the modification of coastal processes, watercourses and hydrology with impacts to sedimentation rates and patterns and coastal erosion (as discussed further below); the alteration of aquatic habitat, including the physical removal/suspension of seabed sediments or covering of the seabed through dredging and disposal activities;[2] and adverse impacts to terrestrial, freshwater, and marine species, including loss of habitat and sites of importance for the conservation.

9. Potential impacts to shoreline vegetation, wetlands, coral reefs, fisheries, bird life, and other sensitive aquatic and near-shore habitats during port construction and operation should be fully assessed and the results incorporated into the project's siting[3] and design decisions to avoid, minimize, and offset adverse impacts to areas of high terrestrial and aquatic biodiversity value or those areas required for the survival of critically endangered or endangered flora and fauna. The port design should take into account the amount and type of dredging, blasting and reclamation required and their potential interference with natural or critical habitats. While these Guidelines do not address stand-alone land reclamation projects, the development of port, harbor, and terminal projects may involve extensive land reclamation in proximity to sensitive ecosystems. The scope of land reclamation activities, and the assessment and management of associated environmental impacts, should be incorporated into the project's design.[4] Additional guidance on the avoidance or minimization of impacts to habitats during design and construction activities is presented in the **General EHS Guidelines.**

Coastal Processes and Seabed and Coastal Geomorphology

10. Coastal zones are subject to natural coastal processes including marine and freshwater processes (as related to waves, tides, temperature, and salinity) and atmospheric processes (as related to winds, precipitation, and temperature), Dynamic coastal processes such as coastal land erosion, transportation of

[2] Construction of some water-side structures (e.g., piers and breakwaters) and disposal of new layers of sediment may also create new habitats for aquatic organisms.

[3] Site selection is critical to avoiding and minimizing potential adverse impacts on terrestrial and aquatic habitat alteration and impacts on biodiversity. Site selection should include a review of areas of importance for terrestrial and aquatic species. For example, in marine habitats, this may include fish, marine mammals, and sea turtles (e.g., feeding, breeding, calving, and spawning areas) or other habitats, such as juvenile/nursery habitats, shellfish beds, reefs, or sea grass and kelp beds. Siting should also include a review of productive fishing areas. Consultation with relevant national and/or international conservation organizations may also inform site selection. Additional resources for port site selection issues and master planning are available in *Environmental Best Practice: Port Development: An Analysis of International Best Practices (2013)*, http://www.environment.gov.au/system/files/resources/fd1b67e7-5f9e-4903-9d8d-45cafb5232cd/files/gbr-ports-environmental-standards.pdf.

[4] Additional good international practices for the assessment and management of significant land reclamation are available in OSPAR Commission (2008): *Assessment of the Environmental Impacts of Land Reclamation*, http://qsr2010.ospar.org/media/assessments/p00368_Land_Reclamation.pdf. Additional guidance for land reclamation in proximity to sensitive ecosystems, such as coral reefs, is available in International Association of Drilling Contractors (IADC) (2007) *Environmental Monitoring and Management of Reclamations Works Close to Sensitive Habitats*, https://www.iadc-dredging.com/ul/cms/terraetaqua/document/1/7/6/176/176/1/article-environmental-monitoring-and-management-of-reclamations-works-close-to-sensitive-habitats-terra-et-aqua-108-1.pdf.

sediment by waves and tides, and currents and deposition of transported sediment, contribute to the physical shape and features of coastal zones, and coastal zone ecology.[5]

11. The construction and operation of port and terminal facilities such as piers and breakwaters[6] can lead to changes in coastal processes resulting in alterations to seabed and coastal geomorphology due to the effects of these structures on water currents, wave patterns, and water levels. Resultant impacts could include adverse changes to land erosion, sediment transport and deposition, and coastal inundation profiles; impacts to the safety of navigation and berthing activities at the port, or to adjacent infrastructure such as jetties, water intakes and outfalls; impacts to ecosystem services (for example commercial activities such as aquaculture); and adverse impacts to water quality and aquatic and terrestrial habitats during construction activities and/or over longer periods of time during operations, depending on site characteristics.

12. As part of the design and siting of port facilities, surveys, assessment and modeling of metocean, hydrological, sedimentological and coastal geomorphological conditions should be carried out together with an identification of potential adverse impacts on coastal processes such as erosion and accretion, from the placement of new physical structures. Design, siting considerations and coastal protection measures (e.g., beach nourishment, sand bypassing, groynes, seawalls, coastal revegetation, etc.) should be considered to minimize adverse impacts from these structures. As part of a coastal processes monitoring and management plan, projects should conduct a risk assessment of littoral sediment transport, shoreline morphology and erosion patterns and trends, and coastal inundation profiles; define monitoring requirements (e.g., beach profiling, satellite imagery/remote sensing); and identify action triggers.

1.1.2 Climate Change Resilience

13. Port and terminal facilities are vulnerable to the direct and indirect impacts of climate change. For example, in addition to potential changes in water levels and inundation risks resulting from alterations to coastal processes and seabed/coastal geomorphology caused by port infrastructure development, a port operation may in future be exposed to more damaging storms or a higher mean sea level than has historically been the case as a result of climate change, which may impact the viability of port operations. Critical port and vessel related activities (in particular ship movement and mooring, loading and uploading, and dredging activities) and the port's supply chain infrastructure (road and rail movement, intermodal hubs) may be vulnerable to risks related to climate variability such as increased intensity of rainfall, flash floods, heatwaves, storms and storms surge, and high wind speeds.

14. Given these risks, projected future climate change-related impacts and the development of adaptation measures to enhance resilience should be assessed in the design phase of new port projects (and significant port expansions), to allow for the identification, analysis, and evaluation of climate change

[5] Further information on coastal process and geomorphology is available in Davidson-Arnott (2010) *An Introduction to Coastal Processes and Geomorphology*.

[6] Other port-related infrastructure or port operational activities can also lead to changes in coastal processes geomorphology, such as shoreline regularization, channel/basin dredging, outfall or intake structures, shoreline management structures, reclamation works, among others.

vulnerabilities and risks as part of the consideration of project alternatives, design, and siting.[9,10] In addition, changing climate conditions should be evaluated on a regular basis during the operational phase of port projects. Design and operational issues for consideration as part of climate change adaptation planning include:

- Design port-related infrastructure (e.g., buildings, quays, berths, bridges, foundations, slopes, embankments, breakwaters, storm water drainage) to increase climate resiliency in the context of changing sea levels, and more extreme weather events;
- Select or replace cargo handling, storage, transport equipment (e.g., considering crane stability, enclosing material stockpile bays, location of electrical equipment, corrosion protection) and review cargo transport routes (e.g., avoiding flood prone areas, improving on-site drainage systems and maintenance) to increase climate resiliency in the context of changing climate conditions and events (e.g., increased lightning, precipitation, floods, wind speeds, temperatures);
- Assess the contribution of port construction and operation to incremental climate change impacts on habitats of high biodiversity value and rare, threatened or endangered species found in the vicinity of the port; identify opportunities to improve the adaptive capacity of such species and habitats.

1.1.3 Water Quality

15. Construction and operations of ports, harbors and terminals can have a significant impact on water quality.[11] Construction activities (such as clearing of vegetation, capital dredging, reclamation, paving, and construction of buildings), and operational activities (such as maintenance dredging, ship maintenance, and ship effluent disposal) can result in increased turbidity via suspension of sediment in the water column. In addition, the introduction of pollutants can have adverse impacts on aquatic flora and fauna (including benthic communities), and human health, for example excessive nutrient loading leading to eutrophication, oxygen depletion, and toxic algal blooms.

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[9] Information regarding the assessment of climate change impacts and adaptation guidelines in relation to ports and harbors can be found in *Enhancing the Resilience of Seaports to a Changing Climate (2012)*. In particular, the report section “Adaptation Guidelines” provides a risk management framework, and an overview of opportunities to build adaptive capacity in ports, https://www.nccarf.edu.au/publications/enhancing-resilience-seaports-synthesis-and-implications.

[10] IFC: Climate Risk and Business–Ports (2011) http://www.ifc.org/wps/wcm/connect/869dd2804aa7aed79efbde9e0dc67fc6/ClimateRisk_Ports_Colombia_ExecSummary.pdf?MOD=AJPERES.

[11] As discussed in section 1.1.1, above, alterations to coastal processes from the construction and operation of port infrastructure can adversely impact water quality. For example, altered flushing regimes (due to changes in shoreline or bathymetric profiles) can affect volume, frequency, and duration of flow of water that enters or exits the waterways, and therefore affect industrial outfall discharges or coastal riverine discharges. As discussed in the section on coastal processes, consideration of possible impacts to water quality, and related management measures, for sources proximate to port developments should be considered during the design and siting of port facilities.

Dredged Materials Management[12]

16. Construction dredging (also known as "capital" dredging),[13] maintenance dredging,[14] and dredged material disposal may impact habitats and pose a significant hazard to human health and the environment, particularly from the re-suspension and/or deposition of sediments. Dredging and disposal of dredged material may lead to impacts on water quality from increased turbidity and from release of contaminants to the water column due to re-suspension of sediments and/or changes of certain chemical compounds in the dredged materials when exposed to different level of oxygenation. In addition, marine or freshwater disposal of dredged material may result in the smothering of benthic habitats, reduced light penetration impacting light sensitive organisms, and impacts on seagrass beds, algae and coral reefs from suspended sediment plumes. Careful consideration should also be given to sediments that have been contaminated by historical deposition and accumulation of hazardous substances, whether due to on-site or off-site activities.[15]

17. Projects should conduct a risk assessment for dredging activities as part of the development of a Dredging Management Plan. The Dredging Management Plan should be tailored to the project and should define the dredging methodology; identify and assess dredged materials disposal options and sites; characterize the chemical and physical composition and behavior of the sediments to be dredged; characterize the environmental baseline where the port, harbor, and/or terminal (and disposal area) will be located; define the area of influence with identification, assessment and modeling of sensitive ecological receptors (usually through sediment plume propagation modeling); define mitigation measures to address adverse impacts (for example on aquatic habitat, biodiversity, and water quality), and relevant

[12] For signatory countries, the disposal of dredging material is governed by the International Maritime Organization (IMO), *London Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (and its 1996 Protocol), http://www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx.
http://www.imo.org/en/OurWork/Environment/LCLP/Documents/PROTOCOLAmended2006.pdf.

[13] Numerous reference documents on dredging best practices have been developed by industry associations and regulatory bodies, including the London Convention/Protocol's *Waste Assessment Guidelines under the London Convention and Protocol:* (2014 edition), http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx. Additional guidance on dredging management practices can be found in PIANC (2009) *Report 100: Dredging Management Practices for the Environment*, http://www.pianc.org/2872231668.php, and PIANC (2010) *Report 108: Dredging and Port Construction around Coral Reefs*, http://www.pianc.org/2872231775.php; An overview and guide to environmental issues of dredging is provided in GHD (2013). *Environmental Best Practice: Port Development: An Analysis of International Best Practices*, http://www.environment.gov.au/system/files/resources/fd1b67e7-5f9e-4903-9d8d-45cafb5232cd/files/gbr-ports-environmental-standards.pdf

[14] Maintenance dredging typically involves similar techniques and environmental impacts to capital dredging; however, maintenance dredging typically involves lower volumes and takes place in areas that have already been dredged. Contamination of dredged materials is generally higher in maintenance dredging than in capital dredging, especially for greenfield port projects. In some instances, maintenance dredging can be avoided through use of alternative techniques to mobilize sediments and prevent them from resettling into dredged areas. For example, some ports use water jet techniques to mobilize sediments in lieu of dredging, thus minimizing impacts to benthic habitats and impacts associated with dredged material disposal. However, such techniques are only appropriate in receiving environments where the benefits outweigh the impacts of resuspension of sediments.

[15] Hazardous materials that may accumulate in sediments typically include heavy metals and persistent organic pollutants from urban surface or agricultural runoff or from industrial activities.

environmental monitoring parameters and indicators. The following recommendations should be adopted to avoid, minimize, or control impacts from dredged materials, as part of a Dredging Management Plan.[16]

Dredge Planning Activities

18. Dredging should be based on an assessment of the need for new infrastructure components or port navigation access to create or maintain safe navigations channels, turning basins, and berths/docks, or, for environmental reasons, including the removal or capping of contaminated materials to reduce risks to human health and the environment.

19. Areas of high biodiversity value and/or areas used by aquatic life for feeding and breeding and as migration routes should be identified.

20. The timing of dredging activities should consider seasonal factors such as migration periods (e.g., of marine mammals, fish, birds and turtles); breeding and growing seasons (e.g., for marine flora such as eelgrass, coral spawning, turtle nesting); timing of feeding and periods of reduced ecosystem resilience (e.g., after extreme weather events).

21. Prior to initiation of dredging activities, materials should be sampled and characterized for their physical, chemical, biological, and engineering properties to inform the evaluation of dredged materials behavior once re-suspended, and to inform their reuse or final disposal. In addition, ecotoxicological risk analysis of sample materials should be conducted to assess risks to representative organisms in the area of influence. The number, distribution, frequency, and depth of sampling stations should be representative of the area to be dredged, the amount of material to be dredged, and the variability in horizontal and vertical distribution of potential contaminants.[17,18,19]

22. The planning activities should consider modeling[20] of conditions expected during dredging operations to evaluate short- and long-term effects of dredging, especially in case of contaminated sediments. Near-

[16] The environmental risk depends on the concentration and type of hazardous substances, the dredging method, the intended reuse or disposal option, and the potential exposure of humans and living organisms during the dredged materials management cycle. Therefore, dredging activities should be conducted based on a careful assessment of potential impacts and in consultation with experts.

[17] Additional information on dredge materials characterization methods is provided in the IMO (2014), *Guidelines on the Assessment of Dredged Material,* http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx; and the *OSPAR Guidelines for the Management of Dredged Material at Sea (Agreement 2014 – 06)*, http://www.ospar.org/documents?d=34060.

[18] The IMO (2005) document *Guidelines for Sampling and Analyses of Dredged Material Intended for Disposal at Sea* includes guidance on the number of separate sampling stations required to ensure representative analysis. IMO publication number I537E.

[19] Where a country is a signatory to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972), and the updated version in the London Protocol (1996), national permitting regimes for the management of dredged material are often informed by the Convention/Protocol's IMO (2014), *Guidelines on the Assessment of Dredged Material*. http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx.

[20] Key considerations and guidance on the use of modeling is available in Sun C, Shimizu K, and Symonds G. (2016) *Numerical Modeling of Dredge Plumes: A Review*, Western Australia Marine Science Institution.

field modeling should be carried out to simulate water column suspended solids and contaminant concentrations in the vicinity of the dredge; far-field modeling may be required to assess environmental impacts at sensitive receptors identified in the area of influence of the dredging operations. Assessment of dredge induced suspended solids should be based on concentration-time exposure simulation results at identified sensitive aquatic receptors.

Dredging Techniques

23. Several dredging methods[21] are commonly used depending on the depth of the sediments, and to address site specific environmental concerns. Excavation and dredging methods should be selected to minimize suspension of sediments, minimize destruction of benthic habitat, increase the accuracy of the operation (to minimize impacts to areas adjacent to dredging zones), and maintain the density of the dredged material, especially if the dredge area includes contaminated materials.

24. Consideration should be given to: the rate of removal of material, as slower dredging speeds may reduce impacts; limiting the speed of the cutter head to reduce the amount of material entering the water column; changing dredging schedules based on tide, wind, and background/natural turbidity to minimize effects due to increases in turbidity levels; avoiding "overflow" dredging by transporting the dredge/barge to the disposal zone once the hopper is at capacity.[22]

25. Additional techniques and equipment to minimize adverse impacts on aquatic life from dredging and the re-suspension of sediments, include (where practicable) barriers/sheet piles, silt or bubble curtains/screens, and contained sediment transport systems (e.g., pipeline placement).

26. Inspection and monitoring (such as feedback or adaptive monitoring) of dredging activities should be conducted regularly to evaluate the impact of operations, the effectiveness of mitigation measures, and the need for technical adjustments to avoid and minimize impacts to identified sensitive aquatic receptors. The frequency of monitoring should be determined based on site specific considerations. Additional information on monitoring approaches and parameters is available in Section 2 of this Guideline.

Reuse and Disposal of Dredged Material

27. Since much sediment contamination originates from land use practices in the surrounding watershed, port managers should make efforts to engage with national and local authorities, as well as with facility owners and operators in the watershed, to reduce sources of key contaminants. This may involve informing the authorities of the difficulties involved in the disposal of dredged material; actively participating in watershed protection programs sponsored by local or state agencies or in surface water discharge

http://www.wamsi.org.au/sites/wamsi.org.au/files/files/Numerical%20modelling%20of%20dredge%20plumes_Review_WAMSI%20DSN%20Report%203_1_3_Sun%20et_al%202016_FINAL.pdf

[21] Examples of dredging methods include grab, backhoe, trailing suction hopper, cutter suction and water injection dredgers.

[22] While these techniques may reduce environmental impacts of dredging, they may also prolong the overall period of dredging activities, which may introduce other environmental concerns. As such, a balance of these considerations is needed as part of the dredging plans.

permitting efforts, if any, for sources in the port's watershed; and actively participating in zoning procedures.[23,24]

28. Consideration should be given to a hierarchy of management options, including: (i) avoidance or minimization or dredging; (ii) the maximization of beneficial re-use options for uncontaminated dredged material, such as for wetland creation or enhancements, habitat restoration, land reclamation, or creation of public access and recreational facilities, among other beneficial uses; and (iii) when beneficial re-use options have been maximized to the extent practicable and especially in case of contaminated dredged materials, use of a comparative risk assessment to determine which final disposal option is optimal, including confined land-based disposal (e.g., in a confined disposal facility or landfill), and/or confined aquatic disposal (e.g., confinement in the aquatic environment beneath a cap of clean sediment), and/or use of open sea disposal.

29. The comparative risk assessment should weigh each option in the context of relevant criteria, which typically include: human health risks (e.g., resulting from consumption of contaminated fish); environmental impacts and ecological risks (e.g., sediment toxicity and concentration-time exposure considerations affecting benthic production and biodiversity); safety hazards (e.g., the potential for navigation accidents because navigable depths are not maintained in channels or at disposal sites); economic/financial feasibility; exclusion of future uses (e.g., adverse impacts on nearby fisheries or recreational areas); and, where applicable, transboundary considerations (e.g., sediment plume dispersion into international waters).

30. Treatment of contaminated dredged materials (e.g., using physical, chemical, and biological methods) should be evaluated as part of each management option to reduce/control impacts to human health and the environment based on the characterization of dredged materials and the comparative risk assessment. Treatment of dewatering liquids may be required to remove contaminants prior to discharge. Site-specific discharge quality standards should be considered depending on the type and toxicity of the effluents and the discharge location.

31. Selection of suitable land-based sites for the beneficial use of uncontaminated dredged materials, or the final disposal of contaminated dredged materials, should consider the waste management guidance for non-hazardous and hazardous waste in the **General EHS Guidelines**.

32. Offshore disposal site evaluation should include the assessment and modeling of the impacts of the candidate disposal site, to ensure to the extent practical that the deposit of dredged material does not interfere with or devalue commercial and recreational uses of the aquatic environment, nor produce adverse impacts on sensitive aquatic ecosystems, species and habitats. Sea disposal site selection should therefore consider the size/capacity of the site relative to the disposal volumes; include comprehensive baseline data on the physical, biological, and chemical characteristics of the water column and seabed; identify ecological sensitivities; identify the location of amenities and other uses of the sea (e.g., fishing areas, navigation

[23] Based on recommendations of the American Association of Port Authorities (1998). *Environmental Management Handbook*.

[24] See the International Maritime Organization (IMO), *London Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (and its 1996 Protocol) and the *Guidelines on the Assessment of Dredged Material* (IMO 2014), http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx.

routes/channels, etc.); and assess cumulative impacts if the proposed location is used by other operators for disposal purposes.[25,26]

33. Use of lateral containment in open water disposal should be considered. Use of borrow pits or dikes reduces the spread of sediments and effects on benthic habitat and organisms.

34. Use of submerged discharges should be considered for hydraulic disposal of dredged material, especially when accurate placement is required to minimize the movement of discharged materials outside the disposal zone, or when contaminated materials are to be placed and potentially capped as part of confined disposal.

35. Where confined disposal facilities, either near-shore or on land, are used for disposal of contaminated dredged material, the confined disposal facilities should include liners or other hydraulic containment design options to prevent leaching of contaminants into adjacent surface or groundwater bodies. Capping of sediment containments with clean materials should be considered. Level bottom capping or a combination of borrow pits and dikes with capping reduces the underwater spread of contaminated material.

Wastewater (Port Sewage, Stormwater, and Ship Wastewater)

36. Liquid effluents associated with land-based activities in ports and terminals (such as construction activities, vehicle maintenance and washing, fuel and material storage and transfer, etc.) include stormwater, wash water and sewage. Ship-generated effluents include sewage, ballast water[27] (e.g., from oil tankers), bilge water, and vessel-cleaning wastewater. Wash water from land- and sea-based activities may contain oily residues. Ship sewage and wastewater contains high levels of BOD, total suspended solids, and coliform bacteria, and typically low pH levels (due to chlorination). Bilge water may contain

[25] The London Convention/Protocol's *Guidelines on the Assessment of Dredged Material (IMO 2014)*, includes information on typical site selection baseline data that should be considered in the selection of disposal sites at sea, including: the nature of the seabed, i.e., its depth, topography, geochemical and geological characteristics, its biological composition and activity, and prior disposal activities affecting the area; the physical nature of the water column, including temperature, possible existence of vertical stratification, tides, surface and bottom currents, wind and wave characteristics, suspended matter, and variability in these processes due to storms or seasonal patterns; and the chemical and biological nature of the water column, including pH, salinity, dissolved oxygen at the surface and bottom, chemical and biochemical oxygen demand, nutrients and their various forms, and primary productivity, http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx.

[26] Other uses such as areas of special importance for conservation and scientific purpose; prior disposal activities in the area; renewable energy sites such as offshore wind farms and wave and tidal stream devices; engineering uses of the seafloor such as undersea cables and pipelines; seabed mineral extraction areas *(e.g.,* aggregate, oil, gas *etc.*); shipping lanes; marine archaeological interests such as shipwrecks; beaches and other areas used for recreational purposes; areas of natural beauty or significant cultural or historical importance; and intake sites for industrial uses such as cooling, desalination and aquaculture. Additional information on sea disposal site selection can be found in the London Convention/Protocol's *Guidelines on the Assessment of Dredged Material (IMO 2014)*, http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx.

[27] See International Convention for the Control and Management of Ships' Ballast Water and Sediments (as adopted in February, 2004, with entry into force in September, 2017), http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx.

elevated levels of BOD, COD, dissolved solids, oil, and other chemicals that accumulate as a result of routine operations.

37. Stormwater and sewage from port facilities should be managed according to the recommendations provided in the **General EHS Guidelines**. Additional recommendations specific to stormwater and wastewater from port facilities include the following:

- Avoid installing storm drainage catch basins that discharge directly into surface waters;
- Install filter mechanisms (e.g., draining swabs, filter berms, drainage inlet protection, sediment traps and sediment basins) to prevent sediment and particulates from reaching the surface water;
- Install oil/grit or oil/water separators in all runoff collection areas;
- Regularly maintain oil/water separators and trapping catch basins; and
- Manage recovered, contaminated solids or liquids in accordance with the general and hazardous waste guidance in the **General EHS Guidelines**.

38. Port operators should provide collection, storage, and transfer and/or treatment services, and facilities of sufficient capacity and type for all wastewater generated by vessels at the port in accordance with MARPOL and national regulations, includingthe following:[28]

- Oily waste and wastewater should be collected in barges, vehicles, or central collection systems and storage tanks.[29] The capacity of oily waste collection should be established based on applicable MARPOL provisions.[30]
- Wastewater with noxious chemicals from bulk tank cleaning should be collected through appropriate on-site or off-site treatment prior to discharge. Incompatible substances should not be mixed in the collection system. Treatment methods should be established based on the effluent characteristics.[31]
- Ports should provide ship operators with details on the pertaining ballast water management requirements, including the availability, location, and capacities of reception facilities, as well as with information on local areas and situations where ballast water uptake should be avoided.[32]

[28] Consistent with the International Maritime Organization (IMO) *Comprehensive Manual on Port Reception Facilities* (2016), and (IMO 1973) *International Convention for the Prevention of Pollution from Ships* of 1973, modified by its Protocol in 1978 (MARPOL 73/78), http://www.imo.org/en/Publications/Pages/Home.aspx

[29] Possible oily waste streams which a port receiving facility may need to accept include dirty ballast water, tank washing slops, oily mixtures containing chemicals, scale and sludge from tanker cleaning, oily bilge water, and sludge from fuel oil purifiers. See IMO (2004) MEPC.3/Circ.4/Add.1 *Facilities in Ports for the Reception of Oily Wastes from Ships*. http://www.mardep.gov.hk/en/msnote/pdf/msin0513anx2.pdf.

[30] See Annex I, Chapter II, Regulation 12 of IMO (1973) MARPOL 73/78, http://www.imo.org/en/Publications/Pages/Home.aspx

[31] According to Annex II, Regulation 7 of IMO (1973) MARPOL 73/78, cargo hoses and piping systems receiving noxious liquid substances cannot be drained back into the ship, http://www.imo.org/en/Publications/Pages/Home.aspx

[32] Additional information is provided in the *International Convention for the Control and Management of Ships Ballast Water & Sediments* (2004) and the International Maritime Organization (IMO) *Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens* (1997), http://globallast.imo.org/wp-content/uploads/2015/01/Resolution-A.868_20_english.pdf

- Port facilities that conduct cleaning or repair of ballast tanks should be equipped with adequate reception facilities able to prevent the introduction of invasive species. Treatment technologies may include those applied to other effluents accepted in port reception facilities or more specific methods such as filtration, sterilization (e.g., using ozone or ultraviolet light), or chemical treatment (e.g., biocides).[33]
- Sewage from ships should be collected and treated on-site or off-site according to the recommendations provided in the **General EHS Guidelines**.

39. Smaller vessels used for harbor services should be equipped with recycling or chemical toilets, or holding tanks, that can be discharged to appropriate onshore transfer/treatment facilities.

1.1.4 Air Emissions

40. Air emissions are generated from land- and sea-based sources during port and terminal activities. During the construction phase, land-based activities may result in combustion emissions from the use of vehicles, equipment, and engines (such as trucks, excavators, barge-moving tugs, etc.) to undertake dredging, excavating, paving, material transport, and building construction activities.

41. During operations of ports and terminals, combustion exhaust emissions result mainly from diesel engines used for the propulsion of ships, and ship-based auxiliary engines and boilers for power generation. In addition, combustion exhaust emissions are generated from land-based activities involving the use of vehicles, cargo handling equipment, and other engines and boilers.

42. Other sources of air emissions include volatile organic compound (VOC) emissions from fuel storage tanks and fuel transfer activities, in addition to dust emissions from construction and operational phase activities (e.g., storage and handling of dry bulk cargo and vehicle traffic on unpaved roads).

43. Recommendations for the management of air emissions resulting from typical construction activities can be found in the **General EHS Guidelines**. Recommendations specific to the management of air emissions resulting from the operation and maintenance of ships used for the transport of bulk cargo and goods can found in the **EHS Guidelines for Shipping**.

Air Emissions from Combustion Sources[34]

44. The primary emissions from combustion exhaust sources are sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM), and greenhouse gases such as carbon dioxide (CO_2). Depending on the fuel type and quality, other substances such as heavy metals, unburned hydrocarbons and other VOCs may be emitted in smaller quantities, but may have a significant influence on the environment due to their toxicity and/or persistence.

[33] Additional information on ballast water treatment designed to avoid release of harmful aquatic organisms is provided by the Global Ballast Water Management Program’s Technical Guidelines, http://globallast.imo.org/the-bwmc-and-its-guidelines/.

[34] Further information on managing combustion related air emissions in port facilities can be found in the *International Association of Ports and Harbors Toolbox for Port Clean Air Programs*, http://wpci.iaphworldports.org/iaphtoolbox/; and http://wpci.iaphworldports.org/iaphtoolbox/DRAFT%20IAPH%20TOOL%20BOX%20priority%20pol.pdf.

45. Recommended air emissions management strategies relevant to port and terminal operations include:

- Application of air quality management procedures (including for GHG emissions) for ship operations while in port areas, such as:[35]
  - Validate ship engine performance documentation and certification to ensure compliance with combustion emissions specifications (including NOx, SOx, and PM), within the limits established by international regulations,[36] and as noted in the **EHS Guidelines for Shipping**.
  - Require use of low-sulfur fuels in port, if feasible, or as required by international regulations.[37]
  - When practical and without affecting the safety of vessel navigation, use reduced ship propulsion power in port access areas.
  - For appropriately configured vessels, including port tugs during idling periods, use shore-based power in port where it is available.
- Application of air quality management procedures to avoid, minimize, and control combustion emissions, including GHG emissions, related to land-based port activities, including:
  - Where practicable, design port layouts and facilities to minimize travel distances and transfer points, for example from ships' off-loading and on-loading facilities to storage areas, and to avoid/minimize re-storage and re-shuffling of cargo.
  - Where practicable, upgrade land vehicle and equipment fleets with low emission vehicles, including use of alternative energy sources, and fuels/fuel mixtures (e.g., vehicle and equipment fleets powered by electricity or compressed natural gas, hybrid locomotives, etc.).
  - Maintain cargo transfer equipment (e.g., cranes, forklifts, and trucks) in good working condition to reduce air emissions.
  - Encourage reduced engine idling during on- and off-loading activities.

[35] While the port authority may not always have direct control over the operation of vessels and tenant operations in the port, it can establish regulations for use of the port facilities and stipulate conditions in tenant rental and lease agreements. The port operator can also establish financial incentives, such as tariffs, to influence the behavior of vessels and tenants at the port.

[36] NOx, SOx, and PM emissions from ships are regulated under Annex VI (as revised in October, 2008), Chapter III, Regulation 13 (for NOx), and Regulations 14 (for SOx and Particulate Matter) of IMO (1973) MARPOL 73/78, http://www.imo.org/en/Publications/Pages/Home.aspx; in addition to information at: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Air-Pollution.aspx.

[37] Sulfur content of fuel oil used by ships is regulated under Annex VI (as revised in October, 2008), Chapter III, Regulations 14 and 18 of IMO (1973) MARPOL 73/78, http://www.imo.org/en/Publications/Pages/Home.aspx ; in addition to information at: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Air-Pollution.aspx

Volatile Organic Compounds

46. VOC emissions from fuel and cargo storage, and transfer activities should be minimized through vapor recovery systems[38] for fuel storage, loading/offloading, and fueling activities, the use of floating top storage tanks, and the adoption of management practices such as limiting or eliminating loading/unloading activities during poor air quality conditions and implementing tank and piping leak detection and repair programs, among others. Additional prevention and control recommendations for VOC emissions applicable to fuel storage and handling are provided in the **General EHS Guidelines** and the **EHS Guidelines for Crude Oil and Petroleum Product Terminals**.[39]

Dust

47. Fugitive dust emissions are generated during port and terminal construction activities, such as excavation and bulldozing; movement of fill and materials by front end loaders, excavators and trucks; and the re-suspension of dust from equipment and vehicle movement on port roadways. Dust prevention and control recommendations applicable to construction and operational phase activities are provided in the **General EHS Guidelines**.[40]

48. Recommended equipment and techniques to manage fugitive dust associated with dry bulk materials storage and handling facilities in ports and terminals include:

- Cover storage and handling areas, where practicable (e.g., store pulverized coal and pet-coke in silos);
- Install dust suppression mechanisms (e.g., water spray);
- Use telescoping arms and chutes to minimize free fall of materials and eliminate the need for slingers;
- Regularly sweep docks and handling areas, truck and rail storage areas, and paved roadway surfaces, and use vacuum collectors at dust-generating activities;
- Use slurry transport, pneumatic or continuous screw conveyors, and covering other types of conveyors;
- Minimize dry cargo pile heights and contain piles with perimeter walls and/or wind break fencing;
- Remove materials from the bottom of piles to minimize dust re-suspension;

[38] See (IMO (1973) MARPOL 73/78 Annex VI Regulation 15 on VOCs, http://www.imo.org/en/Publications/Pages/Home.aspx; in addition to information at: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Air-Pollution.aspx and IMO (1992) MSC/Circ.585 Standards for Vapor Control Systems, https://www.transportstyrelsen.se/globalassets/global/sjofart/dokument/imo_dokument/msc/msc_circ_585.pdf.

[39] Additional VOC emissions management strategies are also presented in the European Union (EU) *Best Available Technique Reference Document* (BREF) on Emissions from Storage (July 2006), http://eippcb.jrc.ec.europa.eu/reference/; See also the EU VOC Directive 1999/13/EC with 2005/33/EC amendments, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0013 and IMO (2009) MEPC.1/Circ. 680 focused on development of VOC management plans, http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Circ-680.pdf.

[40] Additional dust management strategies are presented in the EU *Best Available Technique Reference Document* (BREF) for Emissions from Storage (2006), http://eippcb.jrc.ec.europa.eu/reference/.

- Ensure that hatches are covered when material handling is not being conducted; and
- Cover transport vehicles.

1.1.5 Waste Management

49. The type and amount of solid and liquid wastes associated with port operations may vary significantly depending on the nature of port operations and the types of ships serviced. Wastes originating at the port may include inert solid waste from cargo packaging and from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle maintenance operations, such as paint, scrap metal, used lubricating oils and engine degreasing solvents. Wastes originating from ships may include oily sludge (addressed above under “Wastewater”), inert materials such as food packaging, and food waste. Guidance applicable to port generated wastes, whether hazardous or non-hazardous, is discussed in the **General EHS Guidelines**. Specific pollution prevention, minimization, and control recommendations for ship-generated wastes received by port facilities are outlined below.

General Waste Reception

50. Port facilities should provide adequate means of receiving and managing effluents and wastes to meet the needs of the port and those of visiting ships that the port is designed to service.[41] The provision of waste reception facilities should be developed in coordination with the local governments according to their commitments to the MARPOL Convention[42] as port states. Port waste reception facilities should provide adequate capacity to receive port- and ship-generated wastes, including appropriately sized and located receptacles, and the capacity to deal with seasonal fluctuations.[43]

Ship Wastes

- Information should be available for ship captains to identify solid waste reception facilities and acceptable handling procedures at ports;
- Discharge of solid waste from vessels should be prohibited while in port in accordance with MARPOL and national regulations;
- A collection and disposal system should be developed for ship-generated garbage for ships alongside and at anchor, consistent with the International Maritime Organization (IMO) Comprehensive Manual on Port Reception Facilities. Closable skips should be provided at the berths, and towed or self-propelled barges fitted with skips should be used to collect garbage from ships at anchor; and

[41] Since ships are responsible for the costs associated with the management of their waste streams, these services should be provided within the context of a balanced fee structure that allows for the recovery of these costs while not fostering illegal disposal at sea (EU Directive 2000/59/EC Port Reception Facilities for Ship-generated waste and cargo residues, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0059:EN:HTML; and amending 2002/84/EC amending Directives on maritime safety and the prevention of pollution from ships, http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32002L0084.

[42] IMO (1973) MARPOL 73/78, http://www.imo.org/en/Publications/Pages/Home.aspx

[43] *IMO Comprehensive Manual on Port Reception Facilities* (2016).

- Food waste from ships delivered to the port should be managed according to applicable local regulations intended to protect human and animal health.[44] Local requirements may include rendering, incineration, or landfilling of food waste and mixed waste containing food waste.

1.1.6 Hazardous Materials and Oil Management

51. Hazardous materials at ports typically include large volumes of hazardous cargo, as well as oil, fuels, solvents, lubricants and other hazardous substances used in port activities including vessel, vehicle, equipment and grounds maintenance. Spills may occur due to accidents (e.g., collisions, groundings, fires), equipment failure (e.g., pipelines, hoses, flanges), or improper operating procedures during cargo transfer or fueling, and involve crude oils, refined products or residual fuels, liquid substances, and substances in packaged form. General hazardous materials management is addressed in the **General EHS Guidelines**. Additional recommended prevention, minimization, and control techniques specific to ports are listed below.

Spill Prevention

52. Oil and chemical-handling facilities in ports should be located with consideration of natural drainage systems and the presence of environmentally-sensitive areas/receptors (e.g., mangroves, corals, aquaculture projects, and beaches, etc.). Siting of these facilities should include provisions for physical separation/distance to avoid and minimize adverse impacts.

53. Hazardous materials storage and handling facilities should be constructed away from traffic zones and should include protective mechanisms (e.g., reinforced posts, concrete barriers, etc.) to protect storage areas from vehicle accidents. Covered and ventilated temporary storage areas should be designed to facilitate collection of potentially hazardous leaks and spills, including the use of sloped surfaces to direct spill flows, and the use of catch basins with valve systems to allow spills and releases to enter a dead-end sump from which spilled materials can be pumped/recovered. Where hydraulic equipment is used over or adjacent to water or other sensitive receptors, biodegradable[45] hydraulic oils should be used.

54. Ports should include secondary containment for above ground liquid storage tanks and tanker truck loading and unloading areas.

55. Fueling areas should be equipped with containment basins in areas with a high risk of accidental releases of oil or hazardous materials (e.g., fueling or fuel transfer locations). Fuel dispensing equipment should be equipped with “breakaway” hose connections that provide emergency shutdown of flow should the fueling connection be broken by movement. Fueling equipment should be inspected prior to fueling activities to ensure all components are in satisfactory condition.

[44] Countries have specific regulatory requirements for the disposal of food catering waste originating from international ship arrivals. The objective of most of these regulations is to prevent the spread of communicable diseases across borders.

[45] Biodegradability is defined in the OECD (2006) *Guidelines for the Testing of Chemicals, Section 3. Part 1: Principles and Strategies Related to the Testing of Degradation of Organic Chemicals*, http://www.oecd-ilibrary.org/environment/oecd-guidelines-for-the-testing-of-chemicals-section-3-degradation-and-accumulation_2074577x

Spill Control Planning

56. Port operators should prepare a spill prevention, control, and countermeasure plan consistent with the IMO Manual on Oil Pollution Section II—Contingency Planning, which:

- Identifies areas within the port zone and nearby vicinity that are sensitive to spills and releases of hazardous materials and locations of any water intakes (e.g., cooling water for shore-based industries);
- Outlines responsibilities for managing spills, releases, and other pollution incidents, including reporting and alerting mechanisms to ensure any spillage is reported promptly to the Port Authorities;
- Includes provision of specialized oil spill response equipment (e.g., containment booms, recovery devices, and oil recovery or dispersant application vessels, etc.); and
- Includes regular training schedules and simulated spill incident and response exercises for response personnel in spill alert and reporting procedures, the deployment of spill control equipment, and the emergency care/treatment of people and animals impacted by the spill.

Dangerous Goods Handling

57. Ports should implement systems for the proper screening, acceptance, and transport of dangerous cargo based on local and international standards and regulations,[46] including the following elements:

- Requiring and validating Dangerous Goods Manifests for hazardous materials whether in transit, loading or unloading to and from ships, including proper shipping (technical) name, hazard class, United Nations number, and packing group;[47]
- Training of Port Authority staff in relevant aspects of dangerous goods management, including screening, acceptance, and handling/transfer/storage of dangerous goods at the port; and
- Establishment of segregated and access-controlled storage areas for dangerous goods with emergency response procedures and equipment to ensure collection and/or containment of accidental releases.

1.1.7 Noise and Vibration (Including Underwater)

Terrestrial Noise

58. Noise and vibration may be generated during land-based port and terminal construction activities, such as blasting, piling, dredging, reclamation, and construction of breakwaters and access/internal roads. Excessive noise may also result from typical port operations include cargo handling, vehicular traffic, and

[46] Examples of additional requirements may include host country commitments under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal (UNEP 1992) (http://www.basel.int/) and Rotterdam Convention on the Prior Inform Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (UNEP 1989) (http://www.pic.int/).

[47] According to the IMO International Convention for the Safety of Life at Sea (SOLAS) Chapter VII: Carriage of Dangerous Goods (1974) and International Maritime Dangerous Goods (IMDG) Code (2004), http://www.imo.org/en/Publications/IMDGCode/Pages/Default.aspx.

loading/unloading of containers and ships. Excessive noise should be avoided or minimized during construction and operation of ports to prevent harmful exposure to workers, nearby communities, and sensitive, terrestrial environmental receptors, including wildlife.

59. Guidance on noise management, setbacks and acceptable noise levels can be found in the **General EHS Guidelines**. Management measures to prevent, minimize, and control terrestrial noise sources in port facilities include:

- Establishing noise deflection walls;
- Paving and leveling the terminal area;
- Replacing forklifts and reach-stackers with gantry cranes with rubber tires;
- Substituting diesel engines with electric power;
- Reducing noise from warning bells; and
- Insulating machinery.

Underwater Noise and Vibration

60. High underwater noise and vibration levels may be generated from several sources, including offshore pile driving, dredging, and ship traffic, during ports' construction and operational phases. Noise from these activities may adversely impact aquatic habitats and the health and behaviors of aquatic life, including fish, marine mammals, and sea turtles. Environmental parameters that determine underwater sound propagation are site-specific, and aquatic species can be impacted differently depending on their sensitivity to underwater sound frequencies. Assessments should be conducted to (i) identify where and/or when underwater noise has the potential to impact aquatic life significantly and (ii) to identify appropriate mitigation measures.

61. Measures to prevent, minimize, and control underwater noise from offshore pile driving and dredging during construction and operational phases of ports and terminals include:[48]

- Coordinating and scheduling offshore piling and dredging activities to avoid or minimize the presence of sensitive aquatic species, for example by respecting migratory patterns and calving/breeding seasons;
- Employing observers during offshore piling and dredging activities to detect the presence of sensitive aquatic species, and allow for these species to vacate the area;
- Using soft-start/slow ramp-up during pile driving and dredging activities to allow time for sensitive aquatic species to vacate the area; and
- Implementing noise mitigation techniques for offshore pile driving, including bubble curtains, pile caps, and cofferdams (where practicable) to absorb/scatter pile driving energy.

[48] Additional information on underwater noise management can be found in *Environmental Best Practice: Port Development: An Analysis of International Best Practices (2013)*, http://www.environment.gov.au/system/files/resources/fd1b67e7-5f9e-4903-9d8d-45cafb5232cd/files/gbr-ports-environmental-standards.pdf; *California Department of Transport, Technical Guidance for Assessment and Mitigation of the Hydro-Acoustic Effects of Pile Driving on Fish (2009)*, http://www.dot.ca.gov/hq/env/bio/files/Guidance_Manual_2_09.pdf.

62. While underwater noise from ships in the vicinity of ports is primarily related to ship and propeller design, a possible mitigation measure to minimize underwater noise related to ship operation includes the establishment of low power propulsion zones near ports. This may also improve air emissions, occupational safety, and avoid ship strikes with marine megafauna.

1.2 Occupational Health and Safety

63. Occupational health and safety issues during the construction and decommissioning of ports are common to those of most large infrastructure and industrial facilities, and their prevention and control is discussed in the **General EHS Guidelines**. These issues include, among others, exposure to dust and hazardous materials that may be present in construction materials and demolition waste (e.g., asbestos), hazardous materials in other building components (e.g., PCB and mercury in electrical equipment), and physical hazards associated with the use of heavy equipment, or the use of explosives.

64. Specific occupational health and safety issues relevant to port operations primarily include the following:

- Physical hazards;
- Chemical hazards;
- Confined spaces;
- Exposure to organic and inorganic dust; and
- Exposure to noise.

1.2.1 General Approach

65. Port operation activities should be conducted in accordance with applicable international regulations and standards, including:

- International Labour Organization (ILO) Code of Practice for Safety and Health in Ports (2005);
- General Conference of the International ILO Convention concerning Occupational Safety and Health in Dock Work, C-152, (1979);
- General Conference of the ILO Recommendation concerning Occupational Safety and Health in Dock Work, R-160;
- IMO Code of Practice for Solid Bulk Cargo (BC Code);
- International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code);
- International Code for the Safe Carriage of Grain in Bulk (International Grain Code);
- Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code); and
- International Maritime Dangerous Goods Code (IMDG Code).

1.2.2 Physical Hazards

66. The main sources of physical hazards at ports are associated with cargo handling and the use of related equipment, machinery, and vehicles. General recommendations for managing physical hazards are addressed in the **General EHS Guidelines**. Additional prevention, minimization, and control techniques specific to ports and the implementation of applicable recommendations from the above-referenced international codes of practice, include the following:[49]

- Separate people from areas of vehicle traffic and make vehicle passageways one-way, to the extent practical;
- Design materials handling operations to allow for a simple, linear layout and reduce the need for multiple transfer points, which can increase the potential for accidents/injuries;
- To the extent practical, locate access and transit routes to avoid situations where suspended loads pass overhead;
- Construct the surface of port areas to be of adequate strength to support the heaviest expected loads. The surface should be level or only slightly sloped; free from holes, cracks, depressions, unnecessary curbs, or other raised objects; continuous; and skid resistant;
- Consider, when determining the method by which the goods are stacked, the maximum permissible loadings of quays or floors; the shape and mechanical strength of the goods and containers (including allowable stacking mass and stack height); the natural angle of repose of bulk material; and the possible effects of high winds;
- Provide safe access arrangements suitable for the size and type of vessels calling at port facilities, such as guard rails and/or properly secured safety nets between ships and the adjacent quay;
- Install and use guarding arrangements (e.g., rails, etc.) for weatherdeck and 'tween-deck' hatchways when open;
- Avoid placing cargo on, or allowing passage of vehicles over, any hatch cover that is not of adequate strength for that purpose;
- As far as is reasonably practicable, prevent workers from working in the part of a hold where a trimming machine or grab is operational;
- Minimize the risk of free fall of materials by installing telescoping arm loaders and conveyors; inspect all slings before use;
- Equip lifting appliances with means of emergency escape from the driver's cabin and a safe means for the removal of an injured or ill driver; and
- Inspect disposable pallets and similar reusable devices before use and avoid re-use of such devices if the integrity of the device has been weakened or otherwise compromised.

1.2.3 Chemical Hazards

67. Port workers may be exposed to chemical hazards, especially if their work entails direct contact with fuels or chemicals (including pesticides and fumigants), or depending on the nature of bulk and packaged

[49] The listed recommendations are largely based on the International Labour Organization (ILO) *Code of Practice for Safety and Health in Ports* (2005).

products transferred in port activities. Work with fuels may present a risk of exposure to VOC via inhalation or skin contact during normal use or in the case of spills. Fuels, flammable liquid cargo, and combustible dust (e.g. from grain or coal) may also present a risk of fire and explosions. Recommended measures to prevent, minimize, and control risk of exposure to chemical hazards are provided in the **General EHS Guidelines**.

1.2.4 Confined Spaces

68. As in any industry sector, confined space hazards can be potentially fatal. The potential for accidents among port workers varies among port facilities and activities: confined space hazards may arise in ship cargo holds, silos, sewage tanks, and water tanks. Port operators should implement confined space entry procedures as described in the **General EHS Guidelines**. With specific reference to access to cargo holds, confined space entry programs should include procedures that prevent or minimize the use of combustion equipment, including fueling activities, in the interior of cargo holds and in spaces that do not provide an alternative means of egress.

1.2.5 Dust

69. Potential exposure to fine particulates is associated with handling dry cargo (depending on type of cargo handled, e.g., china clay, grain, and coal) and from roads. Occupational health and safety impacts associated with nuisance dust in ports are similar to those for other industries, and their prevention and control are discussed in the **General EHS Guidelines**. Specific recommendations for prevention, minimization, and control of dust generation are identified in this document under "Air Emissions."

1.2.6 Noise

70. Noise sources in ports may include cargo handling, vehicular traffic, and loading/unloading containers and ships. Occupational exposures should be managed as described in the **General EHS Guidelines**.

1.3 Community Health and Safety

71. Community health and safety issues during the construction of ports are common to those of most large infrastructure or industrial facilities, and are discussed in the **General EHS Guidelines**. These impacts include, among others, dust, noise, and vibration from construction vehicle transit, and communicable diseases associated with the influx of temporary construction labor. The following operational phase issues are specific to ports and discussed below:

- Port marine safety;
- Port security; and
- Visual impacts.

1.3.1 Port Marine Safety

72. Port operators have certain key responsibilities for the safe operation of ships, ranging from passenger safety to the safe access and maneuvering of chemicals and oil transporting ships inside the harbor and port areas. Port operators should therefore implement a Safety Management System (SMS) able to

effectively identify and correct unsafe conditions. The SMS should be informed by initial risk and hazard assessments, and should include consideration of alterations to coastal processes and seabed and coastal geomorphology that may impact navigational and vessel berthing activities, as discussed in section 1.1.1. The SMS should be adapted as needed based on regular operational hazard assessments of port activities.[50]

73. The Safety Management System should include procedures to regulate the safe movement of vessels within the harbor (including pilotage procedures, port control and vessel traffic services, navigational aids, and hydrography surveys), protect the general public and communities from dangers arising from offshore activities at the harbor, and prevent events that may result in injury to workers and the public, including fishers and recreational users. The Safety Management System should also include comprehensive emergency preparedness and response plans that provide a coordinated response based on government, port authority, port users, and community resources required to manage the nature and severity of the emergency event.[51]

1.3.2 Port Security

74. Port operators should have a clear understanding of their responsibilities, including international legal and technical obligations to provide security to passengers, crews, and personnel in port. In accordance with applicable international legal requirements, port security arrangements (e.g., access control) may be established through the completion of a Port Facility Security Assessment of port operations followed by the appointment of a Port Facility Security Officer and the preparation of a Port Facility Security Plan, depending on the outcome of the risk assessment.[52]

1.3.3 Visual Impacts

75. Permanent and temporary installations and ships can make visual changes to the landscape. One of the most significant changes attributable to ports is nighttime illumination, depending on the proximity of the port and associated bulk storage facilities to sensitive land uses such as residential or tourist areas, Excessive illumination may also result in changes to invertebrate flight paths and settlement/breeding patterns.[53] Visual impacts, including excessive background illumination, should be prevented during the port planning process or managed during operations through the installation of natural visual barriers such as vegetation or light shades, as applicable. The location and color of bulk storage facilities also should be selected with consideration of visual impacts.

[50] Additional guidance on Safety Management System (SMS) approaches is available from Ports Australia (2016) *The Australian Port Marine Safety Guidelines*, http://www.portsaustralia.com.au/assets/Publications/Port-Marine-Safety-Management-Guidelines-Low-Res.pdf; and the Port of London Authority (2016) *Marine Safety Management System Manual*, https://pla.co.uk/assets/smsmanual-issue20-july2016.pdf

[51] Port security arrangements should follow IMO requirements and guidelines applicable to ports of the International Ship and Port Facility Security Code and Solas Amendments 2002 (2003).

[52] Port security arrangements should follow IMO requirements and guidelines applicable to ports of the International Ship and Port Facility Security Code and Solas Amendments 2002 (2003).

[53] Lights may attract prey (e.g., insects), which in turn attracts predators. Guidance on anti-collision lighting is provided in the **EHS Guidelines for Wind Energy**, http://www.ifc.org/ehsguidelines.

2. PERFORMANCE INDICATORS MONITORING

2.1 Environment

2.1.1 Emissions and Effluent Guidelines

76. A port is different from a traditional industry since it has few point-source effluent streams (such as wastewater and stormwater) and thus it is difficult to continuously monitor most emissions and effluents. Sanitary wastewater, contaminated drainage and stormwater discharge quality is addressed in the **General EHS Guidelines**.[54]

77. Combustion source emissions guidelines associated with systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated thermal heat input capacity of between three Megawatt (MWth) and 50 MWth are addressed in the **General EHS Guidelines**. Larger power source emissions are addressed in the **EHS Guidelines for Thermal Power.** Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

2.1.2 Environmental Monitoring

78. Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during construction and normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to a particular project.

79. Monitoring of water and sediment quality during construction and operational activities of ports and terminals (in particular dredging and disposal activities) should generally include the monitoring parameters listed in Table 1 as part of a feedback (also known as 'adaptive') monitoring program.[55] The selection of parameters should be based on local site considerations and the objectives of the monitoring program, including local water quality issues and water uses of interest.

80. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

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[54] For guidance on effluent treatment levels applicable to tank barge or ocean/sea tanker cleaning operations, refer to US EPA 40 CFR 442.30 (Subpart C) *Tank Barges and Ocean/Sea Tankers Transporting Chemical and Petroleum Cargoes* (2000), http://www.ecfr.gov/cgi-bin/ECFR?page=browse

[55] Additional guidance on monitoring is available in CEDA (2016) *Environmental Monitoring Procedures*, http://www.dredging.org/media/ceda/org/documents/resources/cedaonline/2015-02-ceda_informationpaper-environmental_monitoring_procedures.pdf; and PIANC (2010) *Report 108: Dredging and Port Construction Around Coral Reefs*, http://www.pianc.org/2872231775.php.

TABLE 1: WATER AND SEDIMENT QUALITY MONITORING PARAMETERS[a]
Dissolved oxygen
Temperature
pH
Turbidity
Secchi disk transparency
Conductivity/Salinity
Condition of biological communities
Total suspended solids (TSS)
Chlorophyll
Total phosphorus
Filterable reactive phosphate
Total nitrogen
Oxides of nitrogen
Ammonia
Toxics: Metals and metalloids; non-metallic organics; organic alcohols; chlorinated alkanes and alkenes; anilines; aromatic hydrocarbons (including phenols and xylenols); organic sulfur compounds; phthalates; organochlorine and organophosphorus pesticides; herbicides and fungicides
Sediment (metals and metalloids; organometallics; organics)[b]
Other site-specific parameters, as relevant[c]

[a] Parameters adapted from CCME (2006) *The Canadian-Wide Framework for Water Quality Monitoring* (Table 3, Page 16, http://www.ccme.ca/files/Resources/water/water_quality/wqm_framework_1.0_e_web.pdf; *The Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 1991-2015), http://st-ts.ccme.ca/en/index.html?chems=all&chapters=1; *The Canadian Sediment Quality Guidelines for the Protection of Aquatic Life* (CCME 1997-2015), available at: http://st-ts.ccme.ca/en/index.html?chems=all&chapters=3); and *The* Australian and New Zealand *Guidelines for Fresh and Marine Water Quality* (Chapter 3 Aquatic Ecosystems, http://www.environment.gov.au/system/files/resources/53cda9ea-7ec2-49d4-af29-d1dde09e96ef/files/nwqms-guidelines-4-vol1.pdf.
[b] Further guidance is available from *The OSPAR Guidelines for the Management of Dredged Material at Sea (Agreement 2014 – 06)*, in particular, the sections on 'Action Lists' and 'Levels for Dredged Materials', www.ospar.org/documents?d=34060, and the London Convention / Protocol's *Guidelines on the Assessment of Dredged Material (IMO 2014)*, http://www.imo.org/en/OurWork/Environment/LCLP/Publications/wag/Pages/default.aspx.
[c] Additional good practice information related to water and sediment quality monitoring is available from The *Canadian Council of Ministers Environmental Quality Guidelines* (CCME 2003), http://ceqg-rcqe.ccme.ca/en/index.html; and *Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives* (CCME 2003), http://ceqg-rcqe.ccme.ca/download/en/221.

81. Additional recommended monitoring approaches include the European Sea Ports Organization's (ESPO) Self Diagnosis Methodology that ports can use to audit their environmental strengths and weaknesses (ESPO 2015). ESPO recommends that ports carry out the assessment annually.

2.2 Occupational Health and Safety

2.2.1 Occupational Health and Safety Guidelines

82. Occupational health and safety performance should be evaluated against internationally published exposure guidelines, examples of which include the *Threshold Limit Value (TLV®)* occupational exposure guidelines and *Biological Exposure Indices (BEIs®)* published by American Conference of Governmental Industrial Hygienists (ACGIH),[56] the *Pocket Guide to Chemical Hazards* published by the United States National Institute for Occupational Health and Safety (NIOSH),[57] *Permissible Exposure Limits (PELs)* published by the Occupational Safety and Health Administration of the United States (OSHA),[58] *Indicative Occupational Exposure Limit Values* published by European Union member states,[59] or other similar sources.

2.2.2 Accident and Fatality Rates

83. Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g., US Bureau of Labor Statistics and UK Health and Safety Executive).[60]

2.2.3 Occupational Health and Safety Monitoring

84. The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[61] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

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[56] http://www.acgih.org/tlv-bei-guidelines/policies-procedures-presentations/overview and http://www.acgih.org/store/

[57] http://www.cdc.gov/niosh/npg/

[58] http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992.

[59] https://osha.europa.eu/en/legislation/directives/exposure-to-chemical-agents-and-chemical-safety/osh-related-aspects/council-directive-91-414-eec.

[60] http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm.

[61] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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ANNEX A. GENERAL DESCRIPTION OF INDUSTRY ACTIVITIES

85. A harbor is a stretch of water where vessels can anchor or secure to buoys or alongside wharves to obtain protection (by natural or artificial features) from storms and rough water. A port is a commercial harbor or commercial part of a harbor with terminals, quays, wharves, enclosed docks, and facilities for transferring cargo from shore–to-vessel or vessel-to-shore. This includes onshore facilities and structures for receiving, handling, storing, consolidating, and loading or delivering waterborne shipments or passengers. Ports may include terminals, which generally serve a specific function, such as for containers, bulk shipments of cement, iron ore, grain, etc., and these terminals maybe be operated by a third party. Ports also may provide ship support facilities and services, including waste management and effluent discharge facilities, maintenance of vehicles and equipment, painting and other vessel maintenance.

86. Ports are located either in marine and estuarine zones or on rivers or lakes at inland sites far from the sea, and may range in size from small harbors accommodating pleasure craft to large international ports covering several miles of waterfront.[62] Most ports are controlled by government-owned port authorities and are governed by national and local legislation tailored to meet the needs of each port. Under these laws and regulations, the port authority is responsible for administering ports and coastal waters and safe navigation of vessels within its jurisdiction.

87. Port ownership and operation typically falls into three categories:

- “Operating” ports, where the port authority itself conducts the majority of activities;
- “Landlord” ports, where the port provides basic services and infrastructure while tenants conduct the majority of activities; and
- “Combination” ports, where the port authority may operate some activities and tenants operate other activities.

88. Operating ports are directly responsible for managing components of their operations that may affect the environment. While landlord ports generally do not have direct control over the activities of their tenants, they have a significant stake in tenants’ activities and the impact of those activities on the environment.

A.1 Onshore Construction

89. Onshore construction typically includes site preparation and development, the removal of any existing vegetation, and the grading and excavation of soils for the installation of structural foundations and site utilities that are typical of industrial development projects. Port development may include construction of new infrastructure and/or rehabilitation of existing infrastructure, such as piers and buildings. Onshore facilities typically include:

- Cargo storage and handling facilities, including crane tracks and bridges for loading/unloading cargo; pipelines, roads, railway lines and other areas for cargo distribution, storage and stacking areas; above-ground and underground storage tanks; warehouses; and silos;

[62] An example is the Port of Los Angeles, which comprises 7500 acres, 43 miles of waterfront, and 26 cargo terminals.

- Facilities for embarking/disembarking passengers, such as parking areas and administration buildings;
- Vessel support facilities, such as those used to store and supply water, power, food and oil/used oil;
- Drainage networks (e.g., for stormwater);
- Waste management and effluent treatment and discharge systems, such as for wastewater/sewage, oil contaminated wastewater, and ballast water;
- Port administration buildings;
- Equipment maintenance and repair facilities, such as vehicle maintenance bays; and
- Flood defenses such as gates and dikes in ports exposed to high water and flood risks.

A.2 Waterside Construction

90. Waterside facilities include berthing facilities, such as harbor basins, approaches, access channels, locks, harbor dams, and breakwaters; cargo handling and ferry facilities, including goods transfer quays and piers, shoreline protection; and landing bridges, shipbuilding berths, fitting quays/wharfs, and dry docks. Offshore construction activities specific to ports include preparing the waterside, including construction/capital dredging (and disposal of dredged material); excavation and blasting; and filling and other work related to the construction of quays, piers, harbor basins, access channels, dams, breakwaters, and dry docks.

Dredging and Disposal of Dredged Material

91. Capital dredging for new ports includes the excavation of sediments to increase depth of berths and navigation channels for access by larger vessels. Sediments, even in new port developments, may contain contaminants. Much of this contamination originates from land-use practices in the adjacent watershed and is transported by rivers and surface runoff to lakes, bays, and the sea, where certain contaminants, such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, and pesticides, tend to concentrate in the sediments.

92. In areas affected by sedimentation from rivers, estuaries, and land runoff, sediments are usually deposited over a period of time. Therefore, concentrations of contaminants can vary substantially over a vertical profile of the dredge cut. Typically, the upper layer is organic-rich and fine-grained, and is the most contaminated. The deeper materials are typically coarse-grained or hard-pan materials that are less contaminated. However, historical contamination, such as from previous shipyards and spills, can result in contamination even in these materials. Material dredged from channels or outer harbor areas tend to be relatively coarse-grained and uncontaminated, although the nature of the materials is a function of the historical activities within the region. Sediment quality can be assessed by sampling and testing.

93. The re-suspension of sediment during dredging or excavation processes may be reduced by selecting an appropriate dredging method:

- *Grab or clamshell dredgers* collect sediments in a crane-mounted bucket, helping to keep material consolidated (e.g., lower water content);

- *Bucket dredgers* pick up sediment by mechanical means, often with many buckets attached to a wheel or chain;
- *Backhoe dredgers* are shore-based or "pontoon mounted" diggers used in shallow waters and confined spaces;
- *Trailing suction hopper dredgers* are typically used for maintenance dredging in coastal areas. Sediments from the seabed are pumped through trailing drag-heads into a reception tank (hopper); and/or
- *Water injection dredgers* are used for maintenance dredging in coastal areas and rivers, particularly in muddy areas and in areas with sandy ripples on the bottom. Water injection dredgers inject water in a small jet under low pressure into the seabed to bring up sediment in suspension as a turbidity current that flows downslope before being moved by a second burst of water from the dredger, or carried away by sea currents.

94. Non-contaminated, dredged materials can usually be disposed of in open waters or used to counter shoreline erosion, for beach nourishment, or as fill materials, although a license from national authorities is typically required to discharge dredged material. Contaminated sediments are generally placed in confined disposal sites located either on land or in the water.

Excavation/Blasting and Disposal of Crushed Material

95. Installation of pier columns, piles and other underwater foundations, and construction of harbor basins and access channels, may require excavation of sediment and underlying material. Soft material can be excavated using conventional means, however, excavation of hard materials often involves blasting. Foundations can penetrate natural low-permeability layers and facilitate vertical migration of saline water and contaminants. As with dredging, these construction activities also cause turbidity and generate crushed material and other debris requiring disposal. The use of explosives usually releases nitrogen and blasted material into the water. Other contaminants, including metals and petroleum products, may also be released from sediments. Uncontaminated materials can be disposed of in open water, or used to construct breakwaters and other features, or for land reclamation. Contaminated material may need to be placed in a confined disposal facility.

Construction of Piers, Breakwaters, Bulkheads, and Other Structures

96. Piers, wharves, and similar structures create the ship berths and provide the platforms for waterside cargo handling. These structures are typically constructed of concrete, steel, or lumber treated with chromated copper arsenate (CCA) or creosote as a preservative. Preservatives can leach from treated lumber, and the use of CCA-treated lumber is being phased out due to toxicity concerns. Filled structures, such as breakwaters, are crucial elements of port design and constitute sizable areas of artificial shoreline that are often projected into a bay, harbor, or estuary. Rubble mound breakwaters are commonly used and constructed by dumping rocks or debris of various size distributions from dump trucks, barges, or from fall pipes by barges.

A.3 Onshore Operations

97. Land-based operations at ports include cargo handling; fuel and chemical storage and handling; passenger embarking and disembarking; ship support services; waste and wastewater management; vehicle and equipment maintenance; and buildings and grounds maintenance.

Cargo Handling

98. Cargo handling includes unloading, storage/stacking, and loading dry and liquid cargo. Cargo typically includes containers, dry bulk, liquid bulk, and general cargo. Cargo handling includes use of vehicular traffic such as harbor vessels, trucks, buses, and trains and on-dock cranes, terminal trucks, and track cranes. Bulk cargo may be transferred using cranes with grab buckets and front-end loaders, or pneumatic continuous ship loaders and unloaders, or belt conveyors.

Chemical and Petroleum Storage and Handling

99. Hazardous cargo, such as oil, liquefied gas, pesticides, and industrial chemicals, may require specific handling facilities or areas within the port, including separation from other cargo by cofferdam, void space, cargo pump room, or empty tanks. Pipe systems are required for handling bulk fuels and liquid chemicals. Hazardous cargo may be released through leaks and spill during transfer and storage, contaminating soil, surface water, or groundwater. Volatile organic chemicals may also evaporate and be released to the air.

Embarking/Disembarking Passengers

100. Passenger terminals may be required within the port area for embarking and disembarking passengers, including provision of parking facilities and temporary holding areas.

Ship Support Services

101. A port may offer ship support services such as solid waste and wastewater collection, electricity supply, fuels, and fresh water. The port or a separate company located within the port area may offer ship fuels, and fuel may be supplied by bunker boats. Fresh water may also be offered and pumped onboard ships.

Waste and Wastewater

102. Port operations generate and manage their own waste and wastewater. Solid waste may be generated from property upkeep and administrative operations, while wastewater may originate from storm drainage and from domestic wastewater and sewage. However, the most significant sources of wastes and wastewater are ships, and government-owned port authorities are often responsible for providing receiving facilities for these and other waste streams. The following sections summarize the types of ship-generated wastes that must be managed in these shore-based facilities.

Solid Waste

103. Waste materials generated on vessels and at ports include plastic, paper, glass, metal, and food wastes. Hazardous wastes generated on vessels and by maintenance activities include waste oil, batteries,

paints, solvents, and pesticides. Ports typically manage collection and storage of hazardous and non-hazardous wastes, with transportation, treatment, and disposal managed by third parties. The port may provide reception facilities for waste such as containers, general-use skips, and bins.

Water Effluents

104. Water effluents generated by ships include sewage, tank cleaning water, bilge water, and ballast water. Water effluents are typically collected and transported using trucks or pipes within the port area. Ports may collect and treat the wastewater using on-site wastewater treatment systems before discharging to surface water, or municipal sewage treatment plants.

A.4 Waterside Operations

Ship Berthing

105. Ships may enter and leave the port under their own power or assisted by tugboats. While berthed in the harbor, vessels need an ongoing source of power for cargo handling, climate control, communications, and other daily operations. Power can be supplied by the ships' engines or by shore-based utilities. Most vessels are powered by diesel internal combustion engines, although some vessels may be powered by boilers and steam engines/turbines. Air emissions from vessels consist primarily of particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides from propulsion and auxiliary boilers and engines. Coal-fired boilers generate a large quantity of particulate matter. Heavy particulate matter emissions are also generated when carbon deposits are blown from coal- and oil-fired boilers.

Maintenance Dredging

106. Maintenance dredging involves the routine removal of siltation material and sediment in harbor basins and access channels. This activity is important to maintain depths and widths and ensure safe access for the ships as well as efficient navigation depth in the neighborhoods and dock gates to ensure access to basins and dry docks. Maintenance dredging may take place continuously or once every few years, depending on the port.

Vessel Repair and Maintenance

107. Vessel repair and maintenance, including repainting, is often conducted in a dry dock. Chemical stripping agents used for paint removal commonly contain methylene chloride, although less hazardous alternatives, such as dibasic esters, semi-aqueous terpene-based products, aqueous solutions of caustic soda, and detergent-based strippers, are available. Abrasive blasting may also be used to remove old paint. Steel shot is most often used as a blasting agent, although plastic shot may be used. Paint is usually applied by spray or by hand. Anti-fouling paints used on hulls are solvent-based, containing heavy metals or organometallic biocides to minimize growth of marine organisms on ships' hulls. Water-based paints are generally used on areas of the vessel that are not immersed in water. Other repair work may include sheet metal work and metal finishing, among others. Wastes produced from vessel repairs and maintenance include oils, oil emulsifiers, paints, solvents, detergents, bleach, dissolved heavy metals, antifouling paint scrapings, and sandblasting waste. In the case of metal finishing operations, wastewater may also contain cyanide, heavy metal sludge, and corrosive acids and alkalis.