Appendix I: Non-Point Source Pollution

1. Introduction

This appendix addresses Best Design Practices (BDPs) used in new and significantly expanding facilities in the coastal zone. The BDPs apply to siting and design objectives in Section 6217 and Alaska Coastal Clean Water Plan that engineers must consider during the design process.

Congress created Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990, titled "Protecting Coastal Waters," to help address non-point source pollution problems nationwide. Examples of non-point source pollution are failing septic tanks and leach fields, runoff and snowmelt carrying oil and grease into local water bodies, and poorly constructed roads creating sediment. In response, Alaska submitted the Coastal Clean Water Plan.

The goal of the Alaska Coastal Clean Water Plan for Harbors and Marinas is to reduce pollutants entering water using the best available practices in planning, design, construction, maintenance, and operation.

Section 6217 has two major components. The first consists of "management measures," or objectives that coastal states must implement. The management measures are divided into two categories: siting and design, and maintenance. The second component of Section 6217 focuses on restoring degraded waters.

The Coastal Clean Water Plan for Harbors and Marinas applies to new, significantly expanding, and existing facilities in the coastal zone that support at least ten recreational vessels. The terms "harbor" and "marina" are used interchangeably.

Separately, Best Management Practices for Alaska were compiled in a document called, "BMP Examples for Alaska" (Ross, June 30, 1995) to address the operation and maintenance measures. These are not addressed in this document.

All coastal design is site-specific. Each alternative and location must be considered separately. The objective of this appendix is to provide guidance to design engineers so that they may comply with Section 6217 without compromising functional design or structural integrity.

2. Flushing and Circulation

Site and design harbors such that tides and/or currents will aid in flushing of the site or renew its water regularly.

*** Flushing and circulation considerations must be included in all design studies. *** These are critical design parameters in maintaining water quality.

If properly designed, flushing and circulation are generally not a significant problem in Alaska's harbors due to extreme tidal ranges and cold-water temperatures, which reduce the risk of poor flushing and circulation, and water stagnation, respectively.

Good circulation (mixing) provides uniformity of temperature, dissolved oxygen, etc., within a harbor basin.

Good flushing provides a high exchange rate with ambient waters outside the basin.

2.1. Compare Design Alternatives

- Compare design alternatives to determine flushing and circulation patterns as well as potential water quality impacts.
- New and significantly altered basins may be modeled to determine their hydraulic performance. If required, physical modeling is one of the best tools for evaluating the circulation in complex basins. If physical modeling is not available, you can use numerical modeling to quantify physical processes and predict hydraulic performance for given changes in the basin design.

  Note: Model results are only as good as the input data (for example, waves, currents, tides, and bathymetry). Good field data, local information, and observations are essential for verification.

- Coastal and harbor engineering requires site-specific consideration. Every site is unique; evaluate it as such. Aerial photographs, charts, and maps can be used to determine potential sites; however, an on-site visit to evaluate local conditions is always recommended.

  Note: Incorporate community preferences into a design, provided they are economically justifiable and can be included without compromising the basic function or water quality.

- The design fleet will ultimately determine basin size and may affect the entrance configuration. The fleet considered should include the potential for change and growth.

2.2. *Locate Harbor and Channel Entrance*

- You should locate the harbor entrance in an area with deep ambient waters to minimize re-entrainment of water flushed from the basin. While much of Alaska's coastline is fiord-like, areas along the Bering Sea may need additional consideration.

- Avoid placing a harbor basin in areas with fresh water drainage, such as creeks and rivers, which may introduce sediment or other pollutants.

- A higher inflow of freshwater may increase flushing, but may also cause icing problems within a harbor and is, therefore, undesirable in Alaska.

- Freshwater may also create stratification in a low-energy basin, which limits mixing in the upper water column and could affect water quality.

2.3. *Optimize Basin Geometry*

- Basin corners should be rounded to eliminate stagnation effects of sharp-edged corners and promote natural hydraulic gyres.

- Aspect ratios of the basin should be between 0.5:1 and 2:1. If the ratio is greater, attempt to set up secondary circulation cells by asymmetric alignment of the entrance to the channel or maintaining a high tidal prism ratio by minimizing dredging depths.

- Flushing efficiency is inversely proportional to the number of segments in a harbor.

- Complex basin geometry can be modeled to determine internal mixing and exchange rates, potential water quality impacts, and overall hydraulic performance.

- When circulation is tidally driven, orient the entrance channel so the momentum from the flood current drives the circulation cells. The entrance should also be aligned so flow reaches the innermost portion of the basin but does not compromise wave protection.

2.4. *Incorporate Climatic Conditions*

- Interview locals, and review U.S. Coast Guard and Weather Service records, to determine extreme wind/wave climates. If properly done, a video tape of storm events or design conditions can be used to estimate or verify design parameters.

- Long-period swell moving into shallow water will often generate long shore currents, which can be used to enhance circulation.

- Wind stresses are beneficial to enhance vertical mixing. Wind is also important where tides are negligible.

- In Alaska, tidal ranges vary an average of 10 feet statewide with a maximum of nearly 40 feet in upper Cook Inlet (Anchorage) and a minimum of 1 or 2 feet in the Bering Sea (Nome). Two-thirds of the state's harbors have tides in excess of 10 feet; in 90 percent of the state's harbors, the tidal range exceeds 6 feet.

  Note: Designers can take advantage of tides to provide natural flushing of a harbor basin.

  Note: If you cannot accomplish natural flushing using tides, take care to optimize basin geometry. You should consider modeling for complex basins.

- In areas of heavy precipitation or snowmelt, you should design upland to move runoff waters away from the harbor. The runoff may carry sediments or other pollutants into the basin.

- Harbors in areas such as rivers or estuaries that have strong long-shore currents with little sediment transport, but limited tides, may benefit form a more "open" design; e.g., a detached breakwater, which promotes a flow-through mode of flushing. Very few harbors in Alaska warrant a detached breakwater based on environmental, functional, and economic analysis.

- You should consider littoral processes in determining sediment loads and dredging depths.

2.5. *Calculate Needed Depths*

Basin depths are calculated based on the design fleet requirements.

- The bottom of the harbor and entrance channel should not be deeper than the surrounding navigable waters.

- Flushing may be incomplete if a depression exists that is lower than the entrance. The basin floor should become shallower moving away from the entrance.

- Keel clearance required for the design fleet will dictate the depths of the harbor basin and entrance channel.

- Try not to have basin depths greater than necessary. A shallow basin has a naturally greater tidal prism ratio, thus a greater percentage of the basin water is exchanged on each tide. Additionally, a shallow basin is generally more economical.

- Basin dredging depths should not be greater than necessary. Dredging is generally expensive and requires future maintenance. If you must dredge a harbor, the depth of dredging equals the deepest anticipated keel and clearance, plus an advanced maintenance-dredging factor.

3. Water Quality

Assess water quality as part of harbor siting and design.

*** You must include water quality considerations in all design studies. ***

Water quality concerns generally do not apply to properly designed harbors in Alaska.

Water quality will be affected by the circulation (mixing) and flushing of a basin. It may also be affected by freshwater influence of rivers, streams, runoff and groundwater entering the basin.

You must acquire an Alaska Department of Environmental Conservation (DEC) 401 permit prior to construction of any new harbor, or modification of an existing facility (see Appendix C). Typically, as part of this permitting process, an environmental analysis (usually an environmental impact statement or environmental assessment) is performed. The analysis determines the project's effects on water quality; the extent they can be avoided; and, for those that cannot be avoided, how can they can be minimized or mitigated.

3.1. Compare Design Alternatives

- Base the preferred design on the engineering parameters required to meet the needs of each specific facility. Compare alternatives to determine water quality concerns.

- Glacial rivers carry thousands of cubic yards a day of fine suspended sediments to the ocean. The sediments not only affect dredging needs in harbors, but also impact baseline total suspended solids (TSS) values. While harbors are located and designed to avoid the influence of these rivers, ambient TSS values may be high.

- Much of the Southeast Alaska and Gulf of Alaska coastline is characterized by high mountains, deep fiords, and high tidal ranges. Designers can use the effects of the tidal prism to flush a harbor basin.

  Note: Improperly designed basins may trap pollutants or sediments and reduce the water quality in an area.

- Western Alaska has long, gently sloping beaches; moderate near-shore ocean depths with rapidly increasing depths offshore; with sand, gravel, and silt bottom conditions. The water quality within harbors is assumed to have little or no impact on the ambient water outside the basin. You should still take care to allow for proper circulation and flushing.

  Note: Sedimentation, interruption of the littoral drift, and shoreline erosion may be an issue along the western coast of Alaska.

3.2. Identify Concerns for Water Quality

- Identify sources of pollutants that may enter the basin or adjacent waters. These sources can include:

  1. Discharge from storm water collection systems or sewage from landside facilities or boats
  2. Groundwater seepage and storm water runoff
  3. Fuel leakage
  4. Leaching of preservative chemicals
  5. Weed killers, fertilizers
  6. Suspension of silts and other fine particles during construction, maintenance dredging, or boat movement
  7. Anti-fouling chemicals and other solvents
  8. Solid waste discharges
  9. Discharge of sanitary waste from boats directly into the water

10. Pollutants associated with upland development and facility construction
11. Runoff from parking lots or boat maintenance areas

- Harbor construction and operation may modify natural processes. Consider effects on the water column and benthic processes.
- Changes in dynamic processes, i.e., circulation, water column mixing, and wave action, can affect water quality. These issues are addressed under Flushing and Circulation.
- Permits are required from ADEC and EPA.

3.3. Determine Ambient Water Quality

- Identify the characteristics of the local topography and watershed that might influence the ambient water quality.

  1. Local cliff erosion
  2. Significant long-shore sediment transport
  3. Local creeks, rivers, or other drainage

  Note: Aerial photographs are useful in assessing potential sediment sources and sinks.

- Although regulated under different legislation, the presence of industrial pollution, such as discharge from lumber mills or fish processing facilities, may affect the ambient water quality of an area.
- It is important to determine the historical use of an area. Past uses such as mining could adversely affect the ambient water quality.

4. Habitat Assessment

Site and design harbors to protect against adverse effects on shellfish, wetlands, submerged aquatic vegetation, or other important riparian and aquatic habitat areas as designated by local, state or federal governments.

*** You should map and consider local habitat in all design studies. ***

Minimize the impact on a local area through proper design. Identify critical habitat areas, and avoid them, if possible.

4.1. Compare Design Alternatives

- Base the preferred design on engineering parameters required to meet the needs of each specific facility, and compare alternatives to determine habitat impact and concerns.
- Inquire locally to determine typical and historical uses of proposed sites. Note uses such as gathering of shellfish, such as mussels or clams.
- The study should address all areas of impact, including potential impacts from disposal of dredged material.
- We generally discourage use of vertical-walled structures (e.g. curtain wall wave barriers) in fish migration areas.
- If a harbor is proposed in an important aquatic habitat such as eel grass or shellfish beds, or salmon migration and rearing areas, you should perform a habitat assessment. In addition, the Department of Fish and Game may require a habitat assessment during the permit review phase.
- If an anadromous fish stream runs into a harbor basin, address the impact on fish runs. Coordinate the study with Fish and Game.

  Note: Alaska Department of Fish and Game may require a Special Area Permit or Fish Habitat Permit (Title 16, Parts 840 and 870).

4.2. Survey Alternative Sites

- Study aerial photographs of the project area and outline potential impacts.
- We highly recommend a site visit to study alternatives and determine their potential impacts. Coordination should begin early on with resource and environmental agencies.
- Habitat assessments can include dive surveys along transect lines, vegetation community mapping, macro invertebrate mapping and substrate mapping. Additionally, locate endangered marine mammals if present.

4.3. Identify Environmentally Sensitive Areas

- Coordinate with environmental and resource agencies to determine whether there are anadromous fish streams, eel grass beds, shellfish, or other habitat areas that may be affected.

- Determine whether new habitat should be created, if existing habitat such as tidelands must be affected. It is important to coordinate these issues with resource agencies. Proper design can enhance local habitat.

- Freshwater streams may be habitat for anadromous fish. For the designer, creeks may also introduce sediments, which can increase the cost of potential dredging, and freshwater into the harbor basin that can cause icing problems. Avoid these if possible.

  Note: Habitat assessments try to identify resources such as eel grass beds, clam/cockle beds, mussel beds, herring spawning areas, and salmon rearing areas.

4.4. Locate Dredge Disposal Sites

- Coordinate with environmental and resource agencies to determine the best location for disposal of dredged materials. Proper disposal of these materials can actually enhance local habitat.

- You may test bottom samples to determine the level of important pollutants, if any.

- We encourage the use of clean bottom sediment for beach nourishment, structural or construction fill, landfill cover, erosion mitigation, etc.

- Typically, the best location for dredged materials may be the intertidal zone. Placement in the intertidal zone can often be used to create valuable uplands for harbor development, and may create the lowest impact on the local environment. (See Appendix C)

  Note: Deep-water disposal may or may not influence sensitive benthic organisms.

  Note: If contaminants are present, upland disposal may or may not affect ground water and runoff.

5. Shoreline Stabilization

Where shoreline erosion is a non-point source pollution problem, you should stabilize shorelines. Vegetative methods are strongly preferred unless structural methods are more cost effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines and offshore areas.

*** Shoreline stabilization problems are not common in Alaska. ***

Equilibrium of a natural shoreline environment depends on a balance of sediment sources and sinks. Eroding shorelines from wind-generated waves are one of the primary sources for nourishment of Alaska's approximately 35,000 miles of shoreline. Only in isolated cases, where boat wakes may be a primary source of erosion of critical habitat, should you consider protective measures. Disturb natural beach processes as little as possible.

5.1. Compare Design Alternatives

- Base the preferred design on engineering parameters required to meet the needs of each specific facility, and compare alternatives to determine impact to the local shoreline.

- In areas with high rates of sediment transport, carefully consider siting and design to minimize interruption.

- Typical shorelines along the southeastern Gulf of Alaska and Aleutian coasts are steep and rocky with pocket beaches; mainland Bering Sea beaches are composed of very fine sand.

- In areas of extreme weather, waves, and tidal ranges, structural methods of reducing marine and estuarine shoreline erosion are typically preferred over vegetative methods. In well-protected areas, vegetative methods using native species may be preferred.

- Carefully identify sources, such as cliff erosion, and sinks, including offshore features, to identify the sediment budget for an area. Minimize disruption of natural beach processes.

5.2. Survey Alternative Sites

- We highly recommend a site visit to study the alternatives and determine their potential impacts.

- Study aerial photographs of the project area and outline potential impacts. This should be followed by a site visit to confirm the findings.

5.3. Explore Alternatives

Structural

- Prevent or minimize the need for shoreline stabilization by conforming to natural beach processes whenever possible. Absorbing rather than reflecting breakwaters minimizes impact on adjacent shorelines.

- We generally discourage vertical walls (e.g. curtain wall wave barriers) for shoreline stabilization, since they tend to be reflective.

- Consider dynamically stable beaches where appropriate. Dynamically stable beaches are designed to dissipate wave energy using smaller stones (cobbles). They take advantage of natural beach processes and tend to cause less damage to the environment.

Non-Structural

- In well-protected areas, vegetative methods using native species may be preferred.

5.4. Storm Water Runoff

Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas.

Reduce the average annual loading of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

*** Storm water runoff is generally considered in the design and operation of upland hull maintenance and parking facilities. ***

Baseline ambient water quality analyses may be needed to determine if changes to a harbor require storm water considerations.

5.5. Compare Design Alternatives

- The preferred design will be based on engineering parameters required to meet the needs of each specific facility. Alternatives should be compared to determine habitat impact and concerns.
- Inquire locally to determine the typical and historical uses of proposed sites.
- Determine whether the site will be paved or a maintained gravel lot. It is important to know the fleet distribution to determine whether boats will be maintained by being hauled out on a boatlift or trailer, or maintained on tidal grids.
- Upland hull maintenance areas, preferably on gravel lots, should be set back from the water to reduce the risk of runoff pollution. The gravel provides natural filtration for runoff.
- Storm water discharges from new upland hull maintenance areas are evaluated by the Department of Environmental Conservation to determine the potential for impact on ambient water. Oil-water separators, settling ponds, sediment traps, or other mitigation may be required.

6. Storm Water Runoff

6.1. Survey Alternative Sites

- A site visit to study the alternatives and determine their potential impacts is highly recommended.
- Study aerial photographs of the project area and outline potential impacts. This should be followed by a site visit to confirm the findings.

6.2. Identify Storm Water Runoff Concerns

- Drainage control structures may be required for upland areas such as parking lots and hull maintenance areas, especially if these areas are paved.
- Provide a vegetated or gravel buffer zone between water bodies and upland parking areas, ship yards, boat cleaning areas, or other areas that may be the source of contaminants. Use of native vegetation is preferred.
- Determine if water traps or filtration are required prior to release into natural drainages.
- Concrete or paved pads for boat washing or bottom work should be graded to allow wash water and runoff to enter traps to control TSS.

7. Fueling Station Design

Design fueling stations to allow for ease in cleanup of spills.

*** If a fueling station is installed in a harbor, non-point source concerns should be addressed. ***

7.1. Compare Design Alternatives

- The preferred design will be based on engineering parameters required to meet the needs of each specific facility. Alternatives should be compared to determine habitat impact and concerns.
- Concrete construction is recommended over timber for fueling stations for ease of clean up and reduction of potential fire hazards.
- Current National Fire Protection Association (NFPA) standards should be used in evaluating design alternatives including

1. NFPA 303 Fire Protection Standard for Marinas and Boatyards
2. NFPA 302 Fire Protection Standard for Pleasure and Commercial Motor Craft

Underground fuel storage should comply with

- NFPA 30 Flammable and Combustible Liquids Code
- NFPA 30A Automotive and Marine Service Station Code
- NFPA 329 Underground Leakage of Flammable and Combustible Liquids

Current standards for the American Petroleum Institute should also be applied.

- Above ground fuel storage will require secondary containment such as an impervious berm or wall or double-hulled tanks. Underground fuel storage tanks require leak detection, spill and overfill protection, and corrosion protection.
- You should locate pipes for filling tanks over a concrete trap or other containment system to prevent leakage.

7.2. Survey Alternative Sites

- A site visit to study the alternatives and determine their potential impacts is highly recommended.
- Study aerial photographs of the project area and outline potential impacts. Follow this with a site visit to confirm the findings.

7.3. Optimize Location

- You should locate fueling areas to facilitate and ease boat maneuvering. Locate them in an area with easy access, but away from the other floats due to fire potential.
- If located within a harbor, they should be visible from the harbormaster's office.

Note: Optimize the location to minimize the potential for spills, and maximize the ease and speed of clean-up should a spill occur.

- Fueling stations should be located in an area of high circulation and flushing.

7.4. Provide for Spill Response Equipment

- Provide an area on the fuel facility for storage containers for containment and emergency response equipment. Trained harbor staff should be able to easily access these.

7.5. Include Spill Prevention Features

- Incorporate back pressure automatic shutoff valves and nozzles, concrete decking for ease of cleaning, and other state-of-the-art systems to minimize spillage and facilitate clean-up. Piping from storage tanks should also have back pressure automatic shutoff valves and other state-of-the-art systems to minimize leakage and facilitate clean-up.
- You may place fuel pipes in utilidors above the concrete deck to provide easier access and maintenance.

7.6. Explore Alternatives for Fuel Storage

- Compare the benefits of underground versus above ground storage tanks.

8. Sewage Facility

Install pump-out, dump station, and restroom facilities where needed at new and expanding harbors to reduce the release of sewage to surface waters. Design these facilities to allow ease of access and post signs to promote use by the boating public.

*** Sewage pump-out facilities and a dump station may be required if a harbor has at least ten recreational vessels. Restrooms are recommended at all public harbors. ***

8.1. Compare Design Alternatives

- The preferred design will be based on engineering parameters required to meet the needs of each specific facility. Compare alternatives for potential impacts and concerns.
- Know the fleet distribution! Determine how many vessels have toilets (marine sanitation devices [MSDs] I & II), holding tanks (MSD III) and portable toilets. If there are live-aboard vessels in the harbor, additional care may be required in the design to determine the potential impact of their sewage. This is especially important if there is poor circulation within the harbor basin.

- Determine which sewage disposal and treatment options are available, if any; identify practical alternatives.
- You must obtain a design plan approval permit from ADEC prior to construction.

Note: Signs should be posted to encourage boaters to use pump-outs and other sewage facilities.

Note: A minimum of one pump-out station is recommended for every 300 berths.

Note: One toilet facility is recommended for about every 50 boats in a harbor.

Note: You should provide a dump station for portable toilets. It should be located near the pump-out facility.

8.2. Survey Alternative Sites

- In selecting a site for a sewage pump-out facility and dump station, convenience to the boater is critical. A boater is more likely to use the facility if it is placed in a location with good access and high visibility.
- Place the pump-out facility and dump station in an area with good circulation and flushing.
- Consider placing the sewage facility near the fueling station. If the pump-out, dump station, and fueling station share a float, it should be lengthened to accommodate additional vessel traffic.
- Consider the location of existing sewer lines in the placement of sewage facilities. Tie restroom facilities into existing lines, if possible.
- Small treatment plants are not recommended because the volume of sewage from boats is nominal, and pump-out use tends to be seasonal and not daily as required to sustain plant operation. Holding tanks, if used, should be sized to the capacity of the local septic truck tank. You may consider Individual Septic Disposal Systems (ISDS), commonly called septic systems with leach field, as an alternative to holding tanks.

8.3. Compare Alternative Systems

- Pump-out systems may be on shore, on a float, or on a boat that may be put on a trailer. The boat may provide the most efficient and convenient pump-out facility.
- Portable toilets may be preferred over a permanent structure.

9. Other Considerations

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