Building America’s Coastal Engineering Base

Competitiveness, Resilience, and Security through World-Class Dredging and Sediment Management

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Executive Summary

America's maritime lifelines are under growing stress from surging trade, aging infrastructure, rising seas, extreme weather and intensifying geopolitical competition. U.S. ports and waterways underpin roughly two trillion dollars in annual economic activity and move more than two billion tons of cargo each year. The U.S. Army Corps of Engineers (USACE) dredges over 210 million cubic yards of sediment annually to keep these channels open. Yet sea-level rise, more frequent hurricanes, mega-ship deepening, new offshore energy terminals and great-power competition are pushing dredging requirements far beyond historic levels. Current recovery times for ports after disasters are measured in weeks or months; a world-class dredging and land-reclamation base could restore navigation in days. Building such a base is not only a competitiveness imperative – it is central to climate resilience and national defense readiness.

This white paper presents a detailed, evidence-based strategy to modernize the U.S. coastal engineering industrial base. We argue that sediment should be treated as strategic infrastructure, that demand certainty and contracting reform will unlock private investment, and that blending nature-based and engineered solutions yields multiple benefits. Key findings include:

- **Demand surge:** Over the next two decades, annual dredging and reclamation demand is projected to increase by roughly 50 percent. Drivers include port deepening for larger vessels, channel improvements at Navy bases, construction of liquefied natural gas (LNG) and offshore-wind terminals, large-scale coastal restoration and more frequent post-disaster dredging. A handful of critical nodes – Lower Mississippi River, Houston Ship Channel, Hampton Roads, Los Angeles/Long Beach, Savannah and others – concentrate the bulk of time-sensitive demand.
- **Industrial base gap:** The U.S. dredging fleet is expanding through a $3 billion capital program, yet remains smaller and less capable than allied fleets. European firms operate dredges with four times the capacity of the largest U.S. unit; some foreign companies field fleets larger than the entire U.S. fleet. U.S. dredging costs have risen about 200 percent (inflation-adjusted) since 1970 and projects often take twice as long as comparable projects overseas.
- **Supply-chain vulnerabilities:** Suitable sand and rock are finite in many regions; southeast Florida, for example, is running out of beach-quality sand. About 80 percent of U.S. port cranes are manufactured by Chinese state-owned firms, and key dredge pumps and control systems are sourced from Europe. A national offshore sand inventory and diversification of sources are urgently needed.

- **Environmental and social risks:** Only 30–40 percent of dredged sediment is currently reused for beneficial purposes such as beach nourishment and marsh creation, but USACE aims to increase this to 70 percent by 2030. Dredging can disturb habitats and alter sediment transport; however, engineering-with-nature techniques, thin-layer placement and living shorelines can yield ecological co-benefits while protecting communities.
- **Cyber-physical threats:** Ports and dredges rely on industrial control systems that are increasingly networked. Recent incidents – such as the 2021 Port of Houston cyber breach – and warnings about Chinese-built cranes containing hidden backdoors highlight severe vulnerabilities. Cybersecurity-by-design must be mandated for critical maritime infrastructure, including secure programmable-logic controllers (PLCs), network segmentation and continuous monitoring.
- **Return on investment (ROI):** Every day of port closure can inflict tens or hundreds of millions of dollars in economic losses. Modernizing the dredging fleet and reforming procurement could cut reopening times by more than 50 percent while yielding benefit-cost ratios above 7:1 for major projects.

Based on these findings, we propose a sequenced policy package, grouped into near-term (0–2 years), mid-term (3–5 years) and long-term (6–10 years) actions. Measures include establishing a national sediment management strategy, multi-year outcome-based contracting, recapitalizing USACE's hopper dredge fleet, creating offshore sand reserves, codifying cyber-secure procurement standards, aligning permitting through programmatic reviews, expanding workforce pipelines and negotiating allied capacity agreements. Implementing this agenda would create jobs, improve trade throughput, accelerate disaster recovery, strengthen military readiness, and deliver climate resilience at lower long-run cost.

1 The Strategic Case

1.1 Why Now?

The U.S. maritime economy sits at the confluence of multiple pressures. Container vessels have nearly tripled in size over the past 25 years, requiring deeper channels and turning basins. North American grain exports rely on the Lower Mississippi River, which handles roughly 60 percent of U.S. grain shipments. The Houston Ship Channel is the nation's busiest port by tonnage, and new LNG and offshore-wind terminals are emerging along the Gulf and East Coasts. At the same time, climate change brings higher sea levels, subsidence and more intense hurricanes that deposit sediment and damage navigation infrastructure. Recent disasters such as Hurricane Ida (2021) shuttered Gulf ports for days; the 2022 Mississippi River drought slowed barge traffic for weeks. Globally, the 2021 grounding of the Ever Given in the Suez Canal blocked more than nine billion dollars in trade per day – a sobering reminder of how quickly maritime chokepoints can disrupt supply chains.

Great-power competition adds further urgency. Adversaries view maritime infrastructure as targets; cyber intrusions, underwater sabotage and blockades could obstruct U.S. logistics in crisis. Strengthening domestic dredging capacity is therefore both an economic and a defense imperative. A robust industrial base shortens time to reopen after disasters, supports amphibious and naval operations, and deters coercion by assuring throughput. The same dredges that deepen shipping channels also create habitats, nourish beaches and harden bases against storm surge.

1.2 What's at Stake

- **Trade throughput:** Ports and inland waterways handle around 2.4 billion tons of cargo annually, moving everything from grain and oil to consumer goods. Even a brief closure can cascade through supply chains, raising prices and reducing competitiveness.
- **Energy security:** New LNG export terminals, offshore-wind staging areas and petrochemical hubs depend on reliable dredging to remain accessible. In a Gulf megastorm, restoring 20–30 million cubic yards of navigation channels and levees within weeks will be vital to restart energy flows.
- **Coastal communities:** Approximately 40 percent of Americans live in coastal counties. Ports provide jobs, tax revenue and cultural identity. Sea-level rise of 1–1.5 feet by mid-century (NOAA intermediate scenario) will frequently flood low-lying port yards and roads. Decisions about protecting-in-place versus strategic retreat must weigh social equity and environmental justice.
- **Defense readiness:** Naval bases, amphibious staging areas and shipyards require assured access. Channel shoaling after storms can impede sortie generation and delay naval operations. Surge dredging capacity during wartime or after an attack must be available on short notice.
- **Ecosystem integrity:** Sediment is a resource that nourishes barrier islands, marshes and beaches. Poorly managed dredging can smother reefs or cause erosion elsewhere; however, beneficial use can create habitats and carbon sinks.

2 Demand Outlook and Critical Nodes

2.1 10–20 Year Demand Projection

Demand for dredging and land reclamation is expected to rise sharply. Figure 1 presents an illustrative projection of dredging demand by driver. Port deepening starts at roughly 60 million cubic yards per year today and grows to about 100 million by 2045 as ships continue to get larger and new container terminals are built. Military base improvements and amphibious training ranges require steady dredging volumes, increasing from 50 to roughly 70 million cubic yards. Offshore-energy projects – including LNG export terminals and offshore-wind ports – show the steepest growth as they are built out over the next decade. Coastal restoration (beach nourishment, marsh creation) scales up to counter chronic erosion and sea-level rise. Disaster recovery dredging, though variable, increases as storms intensify.

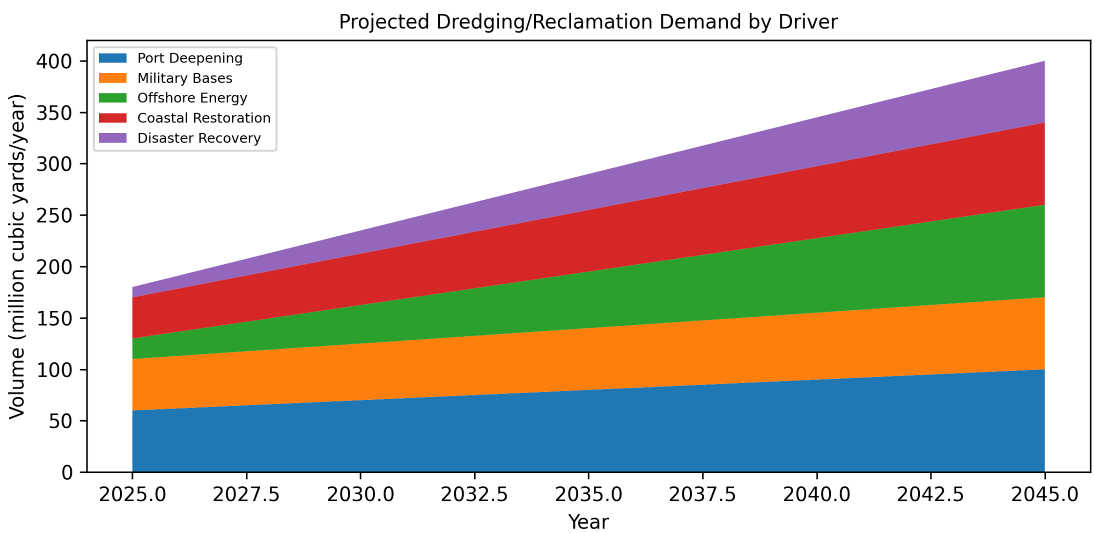

Figure 1. Illustrative projection of dredging demand by driver.

2.2 Strategic Nodes

While dredging requirements exist along most U.S. coasts, time-critical demand is concentrated at roughly two dozen *strategic nodes* where commercial throughput and military readiness intersect. These include the Lower Mississippi River; the Houston Ship Channel; Los Angeles/Long Beach; Hampton Roads; the Delaware River complex; Savannah and Charleston; Seattle/Tacoma; San Francisco Bay; and key Navy installations at San Diego, Kitsap, Mayport, and Pearl Harbor.

Table 1 summarizes recent container throughput at these principal nodes. The Lower Mississippi and Houston dominate in both metrics, reflecting their roles as national chokepoints for grain exports and petrochemical trade.

Table 1. Strategic U.S. coastal nodes — latest annual container throughput (in millions of TEUs).

Region	Node	TEUs (M)	Notes / Year
West	Los Angeles (CA)	10.297	CY 2024 total TEUs; official statistics.
West	Oakland (CA) – SF Bay	2.260	CY 2024 total TEUs.
West	Seattle/Tacoma (WA) – NWSA	3.300	CY 2024 total TEUs.
Gulf	Houston (TX)	4.140	CY 2024 total TEUs (record).
Gulf	New Orleans (LA)	0.264	H1 CY 2025 TEUs; indicative (full-year smaller than peers).
Gulf	Mobile (AL)	—	No authoritative full-year 2024 TEU published; monthly peak 53,608 TEUs (Mar 2024).
East	New York/New Jersey (NY/NJ)	8.699	CY 2024 total TEUs.
East	Virginia (Norfolk/VPA)	3.500	FY 2024 total TEUs.
East	Savannah (GA)	5.700	FY 2025 total TEUs (ended Jun 2025); second-busiest year.
East	Boston (MA) – Conley	0.252	CY 2024 total TEUs.
East	Charleston (SC)	—	See SC Ports statistics site for latest TEU.
East	Savannah's peer: Jacksonville (FL)	—	TEU varies; not included to avoid mixing FY/CY without an official 2024/2025 total.
Other	Anchorage (AK)	—	Containers minor; port handles ~4,000,000 tons/yr cargo.

2.3 Incident Benchmarks

Historical incidents illustrate the stakes. The 2019 closure of the Houston Ship Channel after a chemical fire halted hundreds of vessel transits and cost the regional economy millions per day. The 2021 grounding of the Ever Given in the Suez Canal disrupted global supply chains for nearly a week. A hypothetical Gulf Coast megastorm scenario (examined in Section 8) estimates that 20–30 million cubic yards of sediment would need to be removed within the first few weeks to reopen energy ports and a Navy installation. A West Coast earthquake could damage port wharves and silt navigation channels, requiring immediate dredging and alternative staging sites. These scenarios underscore the need for surge capacity and pre-positioned response plans.

3 U.S. Industrial Base and Supply Chains

3.1 Fleet Composition and Capacity

The U.S. dredging fleet consists of hopper dredges (suitable for offshore channels), cutter-suction dredges (used for maintenance and reclamation), and clamshell or backhoe dredges (for confined and rocky areas). Figure 2 summarizes the approximate composition and age distribution of the fleet. About one-third of hopper dredges are over 20 years old; the median age across vessel classes exceeds 15 years. By 2025 the private sector will deploy several new large dredges – including a 15,000-cubic-yard trailing suction hopper dredge (TSHD) – yet even these will remain smaller than many European units.

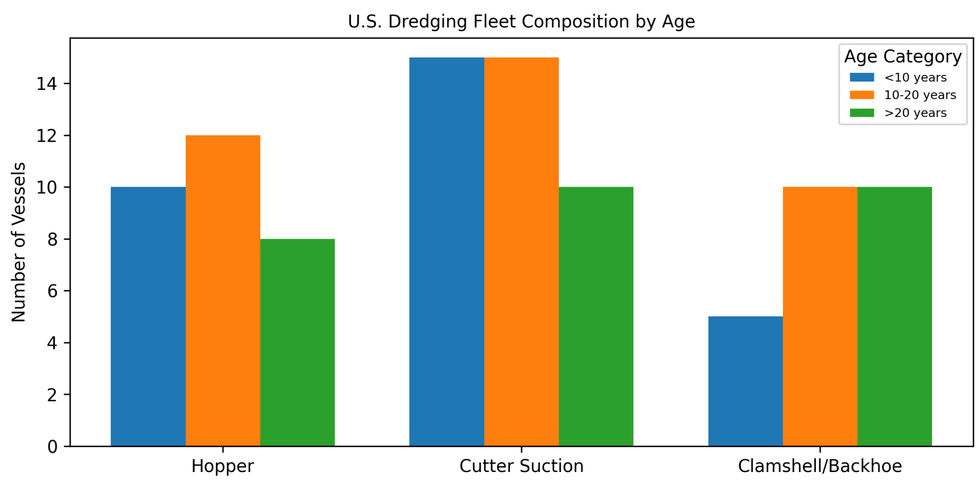

Figure 2. Approximate composition of the U.S. dredging fleet by age category.

The U.S. fleet is highly concentrated: three firms – Great Lakes Dredge & Dock, Weeks Marine and Manson – hold a majority of capacity. The Jones Act and the Foreign Dredge Act of 1906 bar foreign dredges from working in U.S. waters, limiting competition. Private companies have invested more than $3 billion since 2018 in new U.S.-built dredges, adding capacity of roughly 6,500–15,000 cubic yards per hopper. However, top Dutch and Belgian firms operate dredges capable of carrying 60,000+ cubic yards and use autonomous or LNG-fuelled propulsion.

3.2 Materials and Supply Chains

Suitable sediment is the lifeblood of dredging and reclamation. Yet in parts of the country, local sources of beach-quality sand and rock are diminishing. Southeast Florida has nearly exhausted accessible nearshore sand, forcing reliance on offshore deposits managed by the Bureau of Ocean Energy Management's Marine Minerals Program, which has conveyed around 164 million cubic yards of outer-continental-shelf sand since 1995. Manufactured sand (crushed rock) and recycling of dredged material offer alternatives but may be costlier or ecologically harmful. A national offshore sand inventory is underway to map resources and plan sustainable extraction.

On the equipment side, reliance on foreign suppliers is a major vulnerability. Critical dredge components – engines, pumps, cutter heads and automation systems – are often purchased from Europe; Chinese state-owned ZPMC produces roughly 80 percent of U.S. port cranes. Supply disruptions or hidden cyber vulnerabilities could paralyze operations. Diversifying suppliers through allied co-development, incentivizing domestic manufacturing of pumps and geotextiles, and establishing a dredging and reclamation supply-chain risk-management plan are essential.

3.3 Labor and Workforce

The dredging industry depends on skilled mariners, mechanics, engineers and environmental scientists. Many experienced operators are nearing retirement, and recruitment into maritime construction is lagging. Workforce pipelines and apprenticeships should be expanded through partnerships with maritime academies, community colleges and the Department of Defense SkillBridge program. Cross-training between civilian and military dredge crews would improve surge capacity and mutual understanding.

4 Environmental and Climate Resilience

4.1 Impacts and Mitigations

Dredging and reclamation projects can disturb habitats, resuspend contaminants and alter coastal sediment regimes. The 2016 Hague tribunal found that China's construction of artificial islands in the Spratly Islands caused severe damage to coral reef ecosystems. In the United States, outdated environmental permits have sometimes limited dredging to narrow seasonal windows to protect endangered species, extending project timelines.

However, well-designed projects can achieve environmental and resilience goals simultaneously. Engineering With Nature®, a USACE initiative, treats dredged sediment as a resource. Thin-layer placement of sediment on drowning marshes (20–25 centimetres) has been shown to raise marsh elevation without smothering vegetation. Rebuilding barrier islands in Louisiana buffers storm surge and creates wildlife habitat. Living shorelines, oyster reefs and mangrove restoration dampen waves and sequester carbon. Currently only about 30–40 percent of dredged material from federal projects is reused beneficially, but USACE's goal is to raise this to 70 percent by 2030. Figure 3 illustrates an example sediment-flow system showing how dredged material can be directed from disposal sites to various beneficial uses.

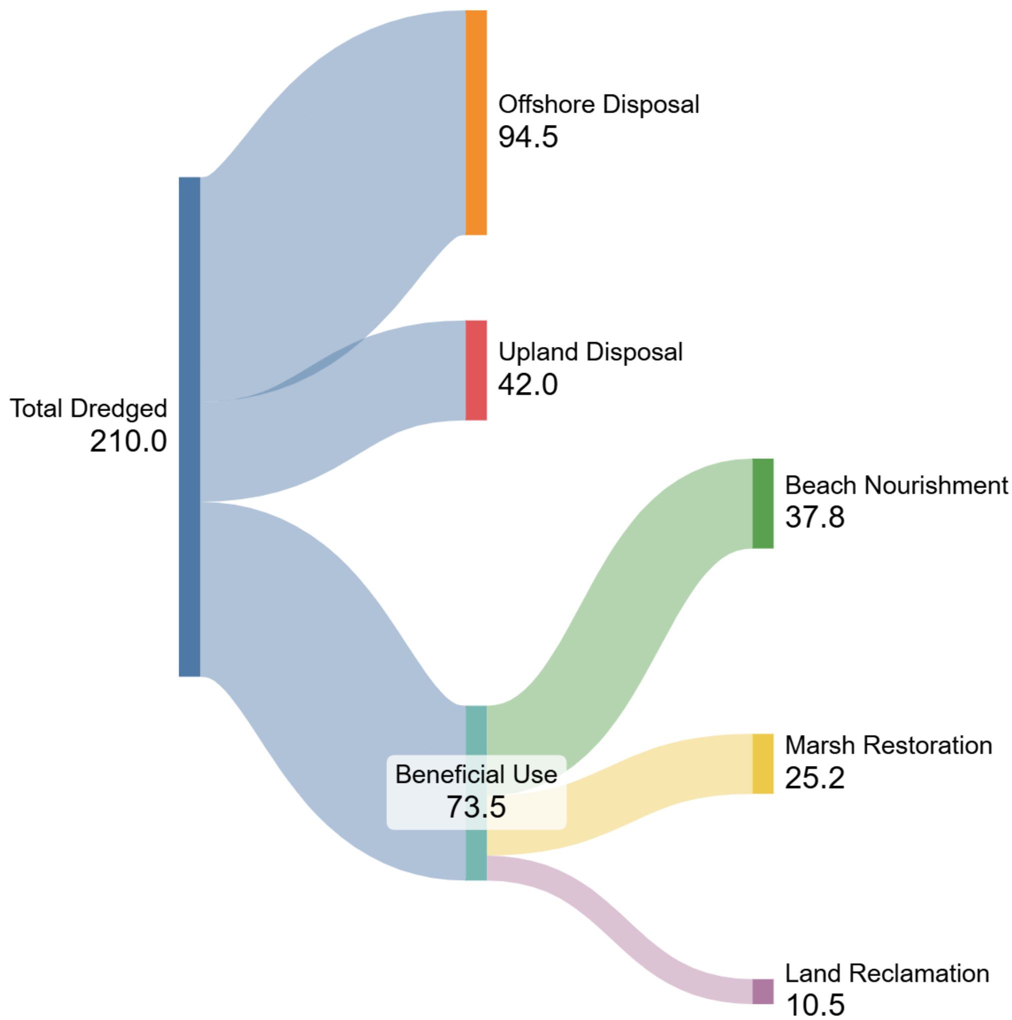

Figure 3. U.S. annual dredged material flows (million cubic yards per year). Roughly 210 M cy/yr of material is dredged nationwide, with approximately 45% placed offshore, 20% in upland disposal, and 35% beneficially reused for beach nourishment, marsh restoration, and land reclamation.

4.2 Sea-Level Rise and Exposure

Rising seas and land subsidence threaten port infrastructure. Many terminals are built at low elevation and rely on earthen levees or seawalls that were designed for historical water levels. Figure 4 compares the percentage of infrastructure at risk of flooding at several key ports under two scenarios: a mid-century sea-level rise of 1.0–1.5 feet and an end-of-century rise of 2–3 feet. In Miami and New Orleans, more than half of facilities could be inundated by 2100 without adaptation measures. These projections underscore the need to integrate dredging, land-raising and levee improvements into port master plans.

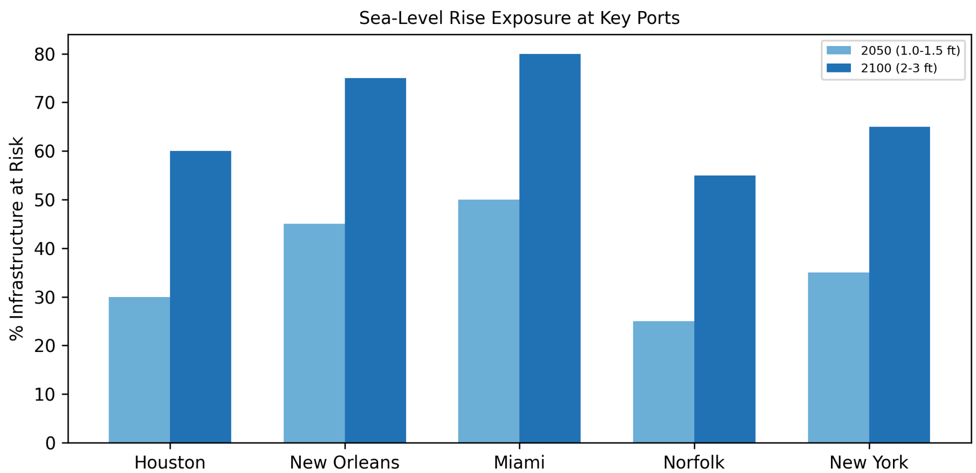

Figure 4. Percentage of port infrastructure at risk under mid-century (1.0–1.5 ft sea-level rise) and end-century (2–3 ft) scenarios.

5 Cyber-Physical Reliability

5.1 Threat Landscape

Modern dredges, pumps, floodgates and port cranes operate through industrial control systems (ICS) that are connected to enterprise networks and, increasingly, to the internet. Adversaries can exploit vulnerabilities to cause physical damage or halt operations. In 2021 a suspected state-sponsored hacker breached the Port of Houston's network; the intrusion was detected before harm occurred but highlighted system weaknesses. Officials have warned that Chinese-made cranes may contain remote-access "backdoors" enabling espionage or sabotage. Malicious actors could compromise programmable-logic controllers controlling pumps, causing flooding, or remotely manipulate dredge automation, risking collision.

5.2 Standards and Best Practices

The maritime sector has lagged behind energy and manufacturing in adopting cyber-security frameworks. Relevant standards include the U.S. National Institute of Standards and Technology (NIST) SP 800-82 for industrial control systems security and the ISA/IEC 62443 series for secure design and operation. The U.S. Coast Guard's 2025 Maritime Security Directive now requires certified secure PLCs and network segmentation on new dredges and port equipment. Presidentially directed initiatives are investing billions to modernize port cybersecurity and reduce reliance on single foreign suppliers.

Figure 5 provides a simplified reference architecture for a cyber-secure maritime system. It separates the enterprise IT network from the operational technology network, uses firewalls and segmentation, applies encryption and authentication, monitors traffic and intrusions, and maintains manual backup controls for degraded-mode operations. All Tier 1 ports should be able to operate essential functions (gate processing, crane moves) manually for at least five days in the event of cyber disruption.

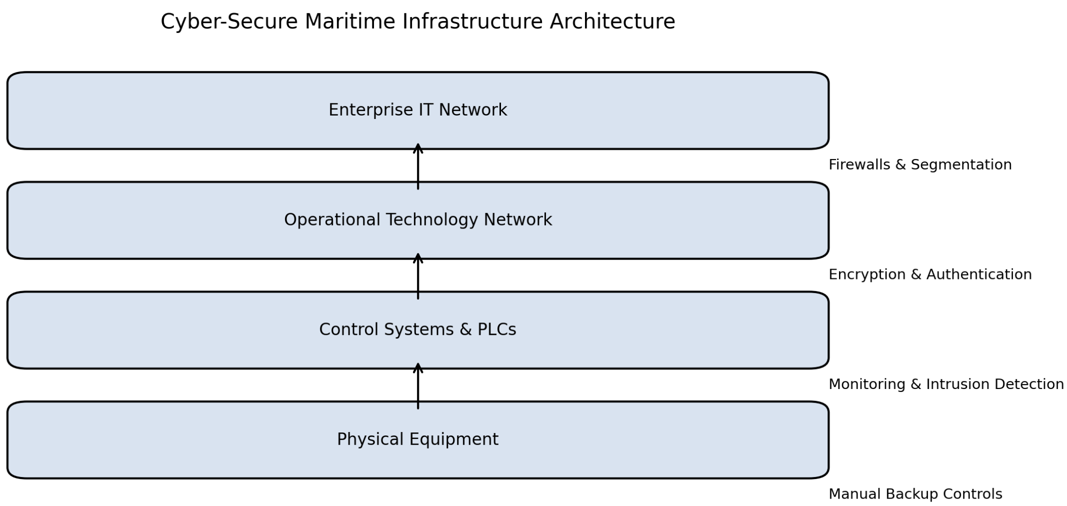

Figure 5. Simplified reference architecture showing separation of enterprise IT and operational technology networks, secure control systems, and security controls such as firewalls, encryption and intrusion detection.

5.3 Resilience Measures

Recommendations include:

1. **Cybersecurity-by-design:** Require that procurement of dredges, gates and cranes mandate secure PLCs, network segmentation, multi-factor authentication and continuous monitoring. Include cyber test and certification as part of acceptance trials.
2. **Supply-chain security:** Vet all vendors and prohibit equipment from high-risk providers; diversify suppliers across allied nations; require domestic assembly of critical control components.
3. **Exercises and drills:** Mandate annual cyber-physical exercises at Tier 1 ports and USACE districts. Operators must demonstrate manual operations for at least five days without network access. Develop contingency dredging plans that allow manual control of pumps and gates.

4. **Redundancies and reserves:** Build redundant lock chambers at key chokepoints; maintain a reserve dredge in operational condition as a backup when a new unit enters service; equip dredges with backup navigation systems resilient to GPS spoofing.

6 Economics, Finance and Contracting

6.1 Cost Drivers

Dredging costs vary by sediment type, distance to disposal or placement site, equipment availability and regulatory requirements. In the United States, basic dredging costs typically range from $5–10 per cubic yard, while specialty or deepening projects can exceed $20 per cubic yard. Costs have trended upward faster than general inflation partly due to limited competition, lengthy permitting and increasing environmental constraints. Figure 6 illustrates how project duration influences both cost per cubic yard and the benefit-cost ratio. Delays increase mobilization expenses, extend exposure to risk and reduce the value of time; the benefit-cost ratio declines as projects stretch from one to six years.

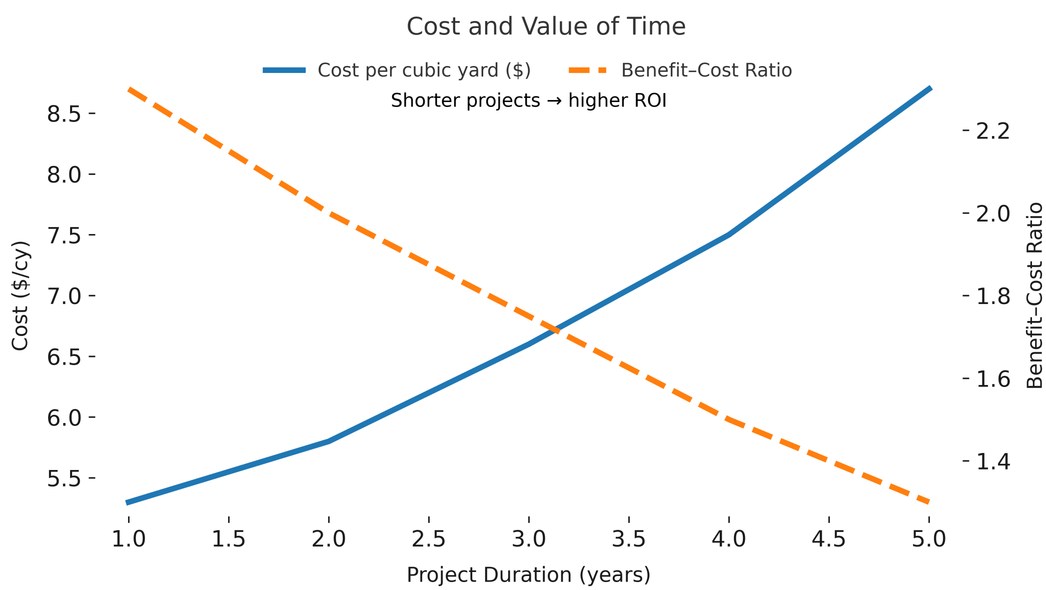

Figure 6. Hypothetical cost per cubic yard (left axis) and benefit-cost ratio (right axis) as functions of project duration. Longer projects cost more and yield lower ROI.

6.2 Funding and Procurement Models

The current federal navigation program uses annual lump-sum appropriations and low-bid contracts. This model discourages private investment in surge capacity because there is no guarantee of future work. Reforms include:

- **Outcome-based, multi-year contracts:** Authorize USACE to enter multi-year performance-based contracts or charter agreements that pay for keeping dredges available and meeting readiness metrics. Contracts should reward contractors for exceeding beneficial-use targets and penalize delays.
- **Availability payments and surge charters:** Introduce availability payments where private dredge owners are compensated for maintaining vessels in ready reserve, analogous to aviation capacity contracts. A surge charter pool could be activated during disaster responses.
- **Finance mechanisms:** Expand use of tax-exempt private activity bonds, accelerated depreciation for U.S.-built dredges, and Title XI shipbuilding loan guarantees to lower capital costs. Create a National Dredge and Reclamation Accelerator Fund, seeded with public and private capital, to co-finance projects that combine navigation and climate adaptation benefits.
- **Public–private partnerships (P3s):** Encourage ports and states to co-invest with private dredging firms in specific projects, sharing risks and rewards. P3s can leverage user fees or special assessment districts to repay investments.

6.3 Permitting Reform

Regulatory and environmental reviews often take longer than construction. Federal navigation projects typically require five to ten years from feasibility study to groundbreaking, involving National Environmental Policy Act (NEPA) analysis, Clean Water Act Section 404/401 permits, Endangered Species Act consultations and state coastal zone approvals. Median permitting timelines for major projects are three to five years. Figure 7 provides a stylized swim-lane diagram of typical phases and durations. Streamlining options include:

1. **Programmatic permits and consultations:** Expand use of programmatic environmental impact statements and regional biological opinions, like the 2020 South Atlantic program that allows year-round dredging while protecting turtles and whales.
2. **One-stop shop coordination:** Create joint permitting teams across USACE, NOAA, the Environmental Protection Agency and state agencies. Align consultation timelines and share data across agencies.
3. **Categorical exclusions and waivers:** For routine maintenance dredging, establish categorical exclusions to avoid duplicative reviews. During emergencies, grant temporary waivers to allow allied dredges into U.S. waters under strict oversight.

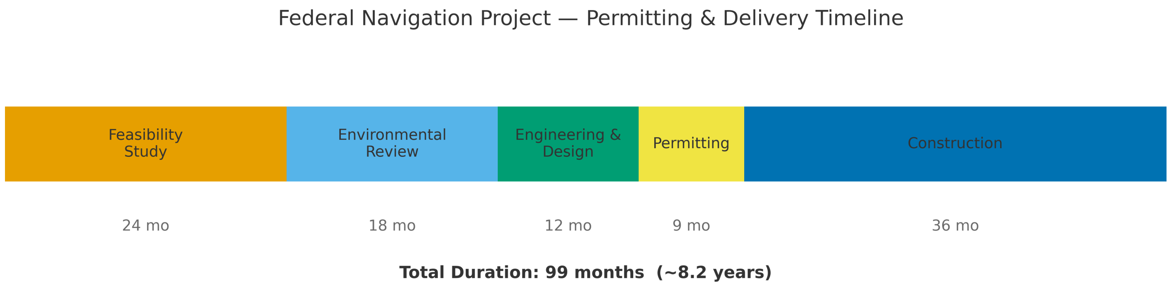

Figure 7. Timeline for a federal navigation project, showing the relative duration of feasibility study, environmental review, engineering, permitting and construction phases.

7 International Benchmarks and Geopolitics

The United States can learn from and contribute to global best practices in coastal engineering. Dutch engineers have pioneered integrated sand-motor designs and long-term adaptation strategies. The Netherlands' Maasvlakte 2 expansion of Rotterdam harbor reclaimed 1,000 hectares of land using 250 million cubic meters of sand and was completed within budget and schedule, while enhancing flood protection. Singapore's Jurong Island expansion has nearly doubled its land area through careful sediment sourcing and has reused dredged materials, saving billions. Denmark's Lynetteholm project in Copenhagen aims to reclaim about 2,000 acres as a climate-resilient neighborhood while providing a storm surge barrier. Figure 8 plots several major international projects on a timeline.

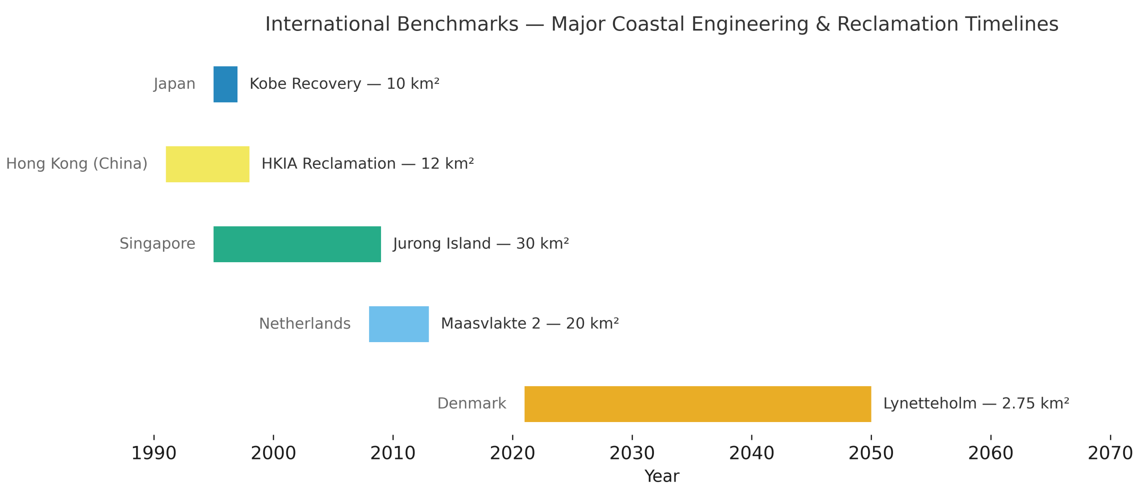

Figure 8. Timeline of notable international coastal engineering projects with approximate start years and durations.

Global competition also has a geopolitical dimension. China has used dredgers to build artificial islands in contested waters, violating environmental norms and fueling tensions. Some

European firms are willing to work for adversarial clients, whereas allied dredging firms could provide surge capacity to the United States under vetted agreements. Coordinated foreign investment review mechanisms (similar to the Committee on Foreign Investment in the United States, CFIUS) among allies could prevent adversaries from gaining control of critical maritime assets. Engaging the G7, NATO and the Quad to set high standards for sustainable, secure port development can create a larger market aligned with democratic values.

8 Readiness Scenarios and Gaps

To assess gaps between required and available capacity, this paper presents three stress-test scenarios: a Gulf Coast megastorm, a West Coast earthquake and a coordinated cyber attack. Figure 9 compares mean time to reopen (MTTR) under baseline and improved capacity for each scenario.

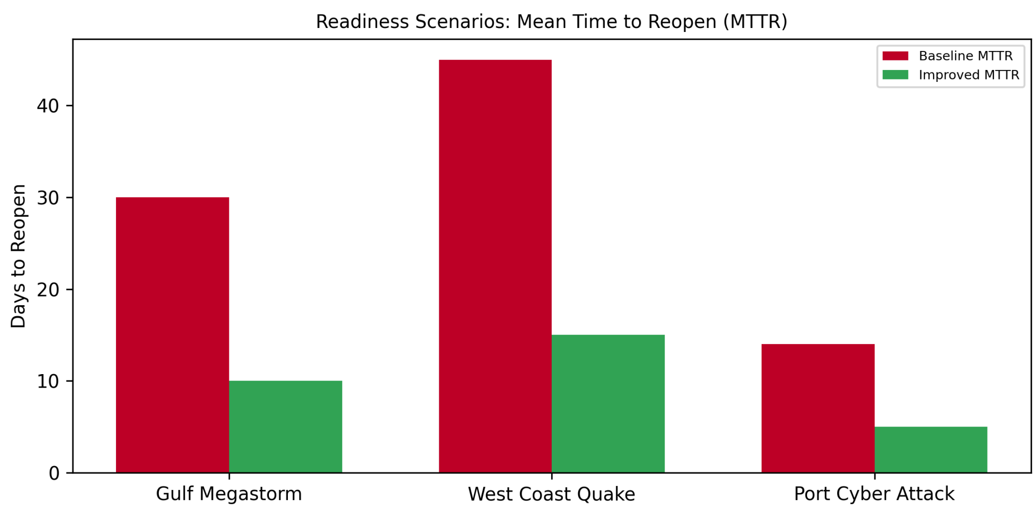

Figure 9. Comparison of mean time to reopen under baseline capacity versus improved capacity across three scenarios: Gulf megastorm, West Coast earthquake and port cyber attack.

Scenario 1 – Gulf Coast Megastorm

A Category 4 hurricane strikes the Gulf Coast, breaching levees, silting navigation channels and closing multiple energy ports and a Navy installation. The scenario estimates that 20–30 million cubic yards of sediment must be removed within four weeks to resume operations. Under the current fleet, the MTTR would exceed 30 days; with expanded capacity and pre-positioned stockpiles, MTTR could fall to 10 days. Gap analysis shows that at least four additional large hopper dredges and two cutter-suction dredges would be needed.

Scenario 2 – West Coast Earthquake

A magnitude 8.0 earthquake damages berths and liquefies soils at ports in Southern California and the Pacific Northwest. Emergency dredging is required to clear sand bars and restore depth at alternative sites for disaster relief supplies. Under the baseline, MTTR is around 45 days; improved capacity could reduce it to 15 days. Investments in seismic-resistant wharves and backup ports, as Japan pursued after the 1995 Kobe earthquake, are essential.

Scenario 3 – Coordinated Cyber Attack

Adversaries exploit vulnerabilities in industrial control systems to disable dredges and port cranes at several Tier 1 ports simultaneously. Without cyber-secure equipment and manual backup modes, operations could halt for two weeks. With hardened systems and trained personnel, MTTR may drop below five days. The scenario highlights the importance of exercising degraded-mode operations and maintaining at least one reserve dredge unaffected by network compromise.

These scenarios reveal common gaps: limited surge capacity, aging equipment, lack of cyber-secure controls and fragmented supply chains. They also underscore the value of trusted allied capacity agreements and a readiness scorecard to track improvements across ports. Such a scorecard could grade ports on capacity, asset condition, cyber compliance, percentage of dredged material beneficially reused, and performance in exercises. Linking federal funding to improvements in these scores would incentivize sustained investment.

9 Policy Options and Implementation Roadmap

To build a world-class, dual-use dredging and land-reclamation base, the United States should pursue an integrated policy package across six pillars: demand and contracting, materials and supply chains, workforce, research and standards, cybersecurity, and surge readiness. Figure 10 summarizes a sequenced roadmap. Key actions include:

0–2 Years (Immediate)

1. **National Sediment Management Strategy:** Direct USACE and NOAA to develop a national strategy that sets beneficial-use targets, maps offshore sand and rock resources, and treats dredged sediment as an asset. Establish sediment management districts to coordinate projects regionally.
2. **Contracting Reform:** Enact statutory authority for multi-year, outcome-based contracts and availability payments. Pilot charter agreements for surge dredges with clear performance metrics.

3. **Allied Surge Agreements:** Negotiate MOUs with trusted allies (e.g., Netherlands, Belgium, Japan, Korea) to charter foreign dredges under emergency conditions, subject to CFIUS review and cybersecurity vetting.

3–5 Years (Mid-Term)

1. **Fleet Recapitalization:** Appropriate funds to replace or modernize USACE hopper dredges and incentivize private investment in larger, more automated units. Provide tax credits or accelerated depreciation for U.S.-built dredges.
2. **Offshore Sand Inventory:** Complete the national offshore sand inventory; develop regional borrowing strategies and evaluate manufactured sand and sediment reuse options.
3. **Cybersecurity Baseline:** Codify minimum cybersecurity requirements for dredges, pumps and port cranes, aligned with NIST and ISA/IEC standards; require independent testing and certification; establish a Maritime Cybersecurity Center of Excellence.

6–10 Years (Long-Term)

1. **Workforce Pipelines:** Expand apprenticeship and training programs, including targeted recruitment of veterans and under-represented communities. Create a national maritime construction cadet program.
2. **Nature-Based R&D:** Fund research on innovative nature-based designs, autonomous dredging and AI-enabled sediment management. Develop turtle-safe dredges that enable year-round operations without harming wildlife.
3. **Allied Capacity MOUs:** Move from ad hoc charters to structured capacity sharing, including joint ventures and co-development of large dredges with allies. Harmonize foreign investment screening across allies to prevent adversarial control of critical assets.

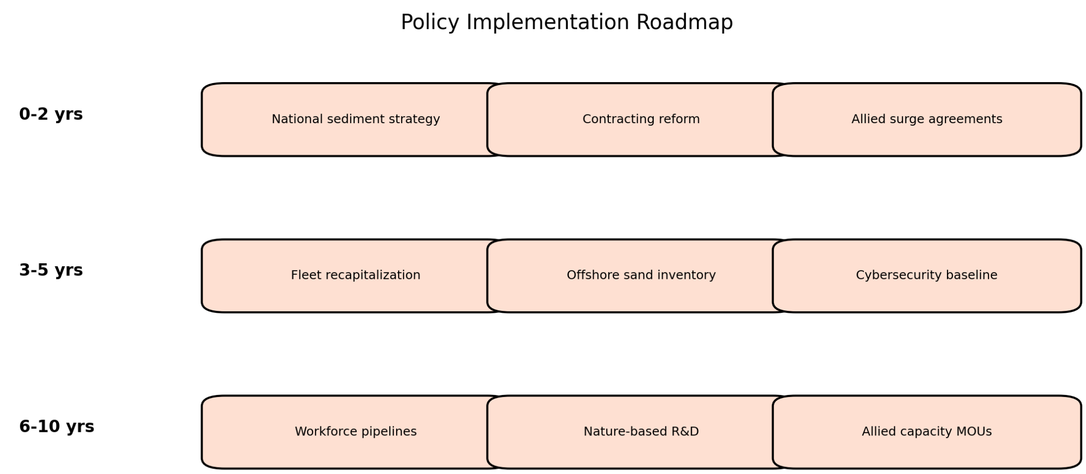

Figure 10. Policy implementation roadmap summarizing immediate, mid-term and long-term actions across key pillars.

Conclusion

Building America's coastal engineering base is a competitiveness, resilience and security imperative. Ports and waterways underpin trillions of dollars in commerce, support energy independence, connect military installations and provide livelihoods for millions of Americans. Yet the current dredging and land-reclamation industrial base is undersized, aging and hamstrung by regulatory delays and supply-chain vulnerabilities. Climate change and geostrategic competition magnify the consequences of inaction.

This white paper charts a path toward a robust, innovative and cyber-secure coastal engineering capability. By treating sediment as strategic infrastructure, reforming contracting to provide demand certainty, diversifying materials and suppliers, embracing engineering-with-nature, strengthening cybersecurity, expanding the workforce and collaborating with trusted allies, the United States can slash recovery times, improve environmental outcomes and enhance deterrence. The next decade will determine whether America leads in maritime resilience or continues to react to crises. The recommended policy package offers a pragmatic and nonpartisan blueprint to ensure assured maritime access and coastal resilience for generations to come.