



NAVAL SHIPYARDS

Key Actions Remain to Improve Infrastructure to Better Support Navy Operations

Accessible Version

November 2019

GAO Highlights

Highlights of [GAO-20-64](#), a report to congressional committees

Why GAO Did This Study

The poor condition of infrastructure at the Navy's four public shipyards—Norfolk Naval Shipyard, Virginia; Portsmouth Naval Shipyard, Maine; Puget Sound Naval Shipyard, Washington; and Pearl Harbor Naval Shipyard, Hawaii—affects the readiness of the aircraft carrier and submarine fleets they are charged with maintaining. In response to congressional direction to create a plan to address the shipyards' infrastructure deficiencies, the Navy developed the *Shipyard Infrastructure Optimization Plan*, which the Navy estimates will require \$21 billion and 20 years to implement.

Senate Report 115-262 accompanying a bill for the National Defense Authorization Act for Fiscal Year 2019 included a provision for GAO to review the *Shipyard Infrastructure Optimization Plan*. GAO evaluated the extent to which the plan (1) addresses deficiencies in the infrastructure needed to support the Navy's projected needs, (2) includes reliable cost estimates to address those deficiencies, and (3) identifies clear roles and responsibilities for implementation. GAO reviewed the Navy's shipyard infrastructure plan and cost estimates; conducted site visits to shipyards selected to provide a variety of operational perspectives; and interviewed Navy and shipyard officials.

What GAO Recommends

GAO recommends that the Navy enhance the quality and reliability of its shipyard infrastructure plan by incorporating GAO's cost estimating best practices and determining clear shipyard roles and responsibilities for implementing the plan. The Navy concurred with these recommendations.

View [GAO-20-64](#). For more information, contact Diana Maurer at (202) 512-9627 or MaurerD@gao.gov.

November 2019

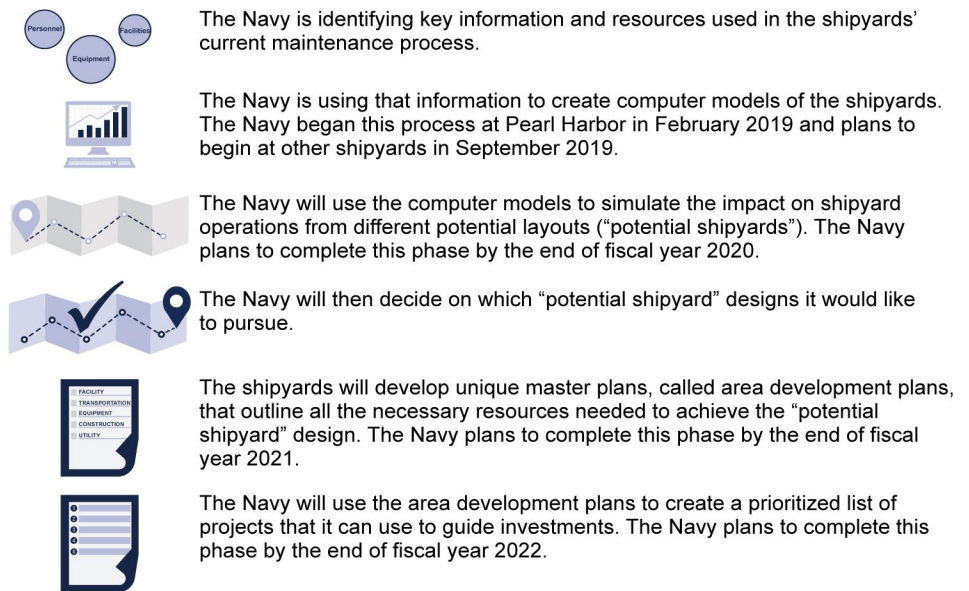
NAVAL SHIPYARDS

Key Actions Remain to Improve Infrastructure to Better Support Navy Operations

What GAO Found

The Navy's 2018 *Shipyard Infrastructure Optimization Plan* includes actions to address critical deficiencies at the shipyards, but the extent to which the plan fully addresses those deficiencies remains to be seen as the proposed actions are complex and years away from being implemented. The plan includes steps to address dry dock deficiencies, which the Navy expects will provide it with the capacity and capability to perform 67 of 68 ship maintenance periods it is currently unable to support through fiscal year 2040. Once area development plans are complete (see figure), the Navy projects it will take at least \$21 billion over 20 years to fully implement the plan.

Figure: Navy's Planned Activities to Address Shipyard Deficiencies through 2022



Source: GAO analysis of Navy documents and discussions with Navy officials. | GAO-20-64

The Navy's initial cost estimate for the plan did not use certain best practices in developing the estimate, such as documenting key assumptions, accounting for inflation, and addressing risks that together could add billions to the ultimate cost. Navy officials stated that high-quality cost estimates will not be possible until they complete modeling and simulation in fiscal year 2020 and subsequently identify the most effective shipyard layouts and prioritize projects in fiscal year 2022. However, without fully following best practices in subsequent estimates, the Navy risks requesting inadequate resources to address shipyard deficiencies.

The Navy created a program management office in June 2018 to oversee the estimated 20-year-long process of optimizing the shipyards. This program office includes representatives from multiple Navy organizations. However, the office has not formally defined the role of shipyard officials. Navy officials stated that they intend to develop an agreement to address roles and responsibilities, but this has not yet been finalized. Without defining clear shipyard roles and responsibilities, the Navy risks an ineffective implementation of its plan.

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November 25, 2019

Congressional Committees

The Navy's public shipyards are critical to maintaining the readiness of its fleet of nuclear-powered aircraft carriers and submarines, and supporting ongoing operations around the world. The four shipyards—Norfolk Naval Shipyard in Virginia, Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility in Hawaii, Portsmouth Naval Shipyard in Maine, and Puget Sound Naval Shipyard and Intermediate Maintenance Facility in Washington—provide the Navy with the capability to perform depot-level maintenance, emergency repairs, ship modernization, and ship inactivations of the nuclear fleet.¹

In 2017, we reported that the shipyards had not been fully meeting the Navy's operational needs, partly because of the age and poor condition of their infrastructure, including their dry docks, facilities, and capital equipment.² For example, we found that during fiscal years 2000 through 2016, inadequate facilities and equipment led to maintenance delays that contributed in part to thousands of lost operational days—days when ships were unavailable for operations—across the Navy's submarine and aircraft carrier fleets. Further, we found that the shipyards would not be able to support almost a third of planned depot maintenance periods for the current fleet of aircraft carriers and submarines over the next two decades. We recommended that the Navy develop a plan to improve the shipyards' infrastructure and incorporate results-oriented practices in its efforts. The Department of Defense (DOD) agreed with the recommendations. Information on the status of DOD's efforts to implement the recommendations is included in appendix I.

¹Depot maintenance is an action performed on materiel or software in the conduct of inspection, repair, overhaul, or the modification or rebuild of end-items, assemblies, subassemblies, and parts, that, among other things, requires extensive industrial facilities, specialized tools and equipment, or uniquely experienced and trained personnel that are not available in lower-echelon-level maintenance activities. Depot maintenance is a function and, as such, is independent of any location or funding source and may be performed in the public or private sectors.

²GAO, *Naval Shipyards: Actions Needed to Improve Poor Conditions that Affect Operations*, [GAO-17-548](#) (Washington, D.C.: Sept. 12, 2017).

We also estimated in 2018 that from fiscal year 2008 through fiscal year 2018, the Navy had spent more than \$1.5 billion in fiscal year 2018 constant dollars to support attack submarines that provided no operational capability—those sitting idle while waiting to enter the shipyards, and those delayed in completing their maintenance at the shipyards.³ We recommended that the Navy conduct a business-case analysis to inform its allocation of maintenance workload across the public and private shipyards. DOD concurred with this recommendation, and in response, the Navy produced a 5-year workload-management plan for the nuclear-maintenance enterprise, which we discuss in more detail in appendix II.

Recognizing that existing shipyard facilities may not be ideally configured to efficiently and effectively support the Navy's readiness needs, the Senate directed the Secretary of the Navy to submit an engineering master plan for optimal placement and consolidation of facilities and major equipment to support depot-level repair functions, as well as an investment strategy addressing the facilities, major equipment, and infrastructure requirements of the shipyards.⁴ In response, the Navy issued the *Shipyard Infrastructure Optimization Plan* (the plan, also known as the SIOP), in February 2018. The SIOP is the Navy's investment plan to improve the conditions of the shipyards.⁵ The plan calls for the replacement or modernization of critical shipyard infrastructure—including dry docks, facilities, and a portion of capital equipment—over 20 years, at an estimated cost of \$21 billion.⁶ Recognizing the importance of this plan to improving Navy readiness, the Senate included a provision for us to review the Navy's plan and its

³GAO, *Navy Readiness: Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet*, [GAO-19-229](#) (Washington, D.C.: Nov. 19, 2018). Our estimate did not include the support costs incurred for time spent in planned maintenance, only for that due to sitting idle or being delayed.

⁴S. Rep. No. 115-125, at 113 (2017), accompanying a bill for the National Defense Authorization Act for Fiscal Year 2018.

⁵In 2018, the Senate Armed Services Committee noted that the Navy's SIOP improved not only its equipment and facilities, but also the overall layout and configuration of its facilities and equipment leading to reduced man days and cost. The committee then directed the services to produce similar engineering master plans for optimal placement and consolidation of facilities and major equipment at their respective depots, air logistics centers and fleet readiness centers. S. Rep. No. 115-262, at 237 (2018), accompanying a proposed bill for the National Defense Authorization Act for Fiscal Year 2019.

⁶The Navy's plan states that the recapitalization of shipyard equipment will take longer, about 30 years, and cost an additional \$1.5 billion over those extra 10 years.

efforts to limit lost operational days.⁷ This report evaluates the extent to which the plan (1) addresses deficiencies in the infrastructure needed to support the Navy's current and future needs; (2) includes reliable cost estimates to address those deficiencies; and (3) identifies clear roles and responsibilities for implementation. Information on how the Navy's 5-year workload-management plan for the nuclear-maintenance enterprise, both public- and private-sector capacities, is likely to affect submarine idle time and maintenance delays is included in appendix II.

For our first objective, we reviewed the *Shipyards Infrastructure Optimization Plan* and other Navy documents to identify deficiencies in shipyard infrastructure. We also interviewed Navy and shipyard officials at the four naval shipyards and toured three of the four shipyards to identify any challenges and improvements in shipyard infrastructure. To provide a mix of perspectives for our site visits, we selected one shipyard that repairs both aircraft carriers and submarines (Puget Sound), one shipyard that repairs submarines only (Portsmouth), and the shipyard that was the pilot for the modeling and simulation effort (Pearl Harbor). We compared the Navy's 2020 shipbuilding plan with the 2018 shipbuilding plan used in developing the SIOPlan to identify changes to the planned carrier and submarine force structure and how those changes may affect the number of depot maintenance availabilities the shipyards will be expected to support. Finally, we analyzed Navy documents and interviewed officials to understand the SIOPlan implementation steps and timeline.

For our second objective, we reviewed the plan and supporting documentation, including written responses to our data-collection request; detailed shipyard facilities estimates; and a list of capital equipment. Additionally, we interviewed Navy program office officials to discuss how they had developed the plan's cost estimate and the purpose of the estimate. Our cost analysts compared the data received with the best practices identified in the *GAO Cost Estimating and Assessment Guide*, which we developed to establish a consistent methodology that can be used across the federal government to develop, manage, and evaluate cost estimates.⁸ The cost analysts tailored their methodology to reflect an appropriate view of the criteria based on the maturity of the program, specifically taking into account that this plan contained a first estimate.

⁷S. Rep. No. 115-262, at 161 (2018).

⁸GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

We then shared our initial determinations with Navy officials and incorporated their comments into our final determination, where appropriate.

For our third objective, we reviewed the plan and other program documents to identify stakeholder organizations and the extent to which the Navy had identified roles and responsibilities for the plan's implementation. We then interviewed Navy officials about how the plan identifies stakeholder roles and responsibilities and compared these to *Standards for Internal Control in the Federal Government*.⁹ We also spoke with officials from all four public shipyards about their perspectives on the relationship between the shipyards and the program office.

To describe how the Navy's 5-year workload-management plan for the nuclear-maintenance enterprise is likely to affect submarine idle time and maintenance delays, we reviewed the Navy's 5-year nuclear-maintenance workload-management plan. We also interviewed officials from both the public and private shipyards about how the workload-management plan will likely affect submarine idle time and maintenance delays, and any challenges to executing it. We also compared the assumptions in the Navy's 5-year workload-management plan against our recent work related to submarine maintenance, including workforce experience, maintenance completion timeliness, and submarine idle time. Finally, we reviewed Congressional Budget Office documentation comparing the costs of submarine maintenance at public and private shipyards.

To address all of our objectives, we interviewed or obtained documentation from the Office of the Chief of Naval Operations; Naval Sea Systems Command; PMS 555 (a Naval Sea Systems Command program office); Norfolk Naval Shipyard; Portsmouth Naval Shipyard; Puget Sound Naval Shipyard and Intermediate Maintenance Facility; Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility; General Dynamics Electric Boat; and Huntington Ingalls Industries—Newport News Shipbuilding.

We conducted this performance audit from October 2018 to October 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain

⁹GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

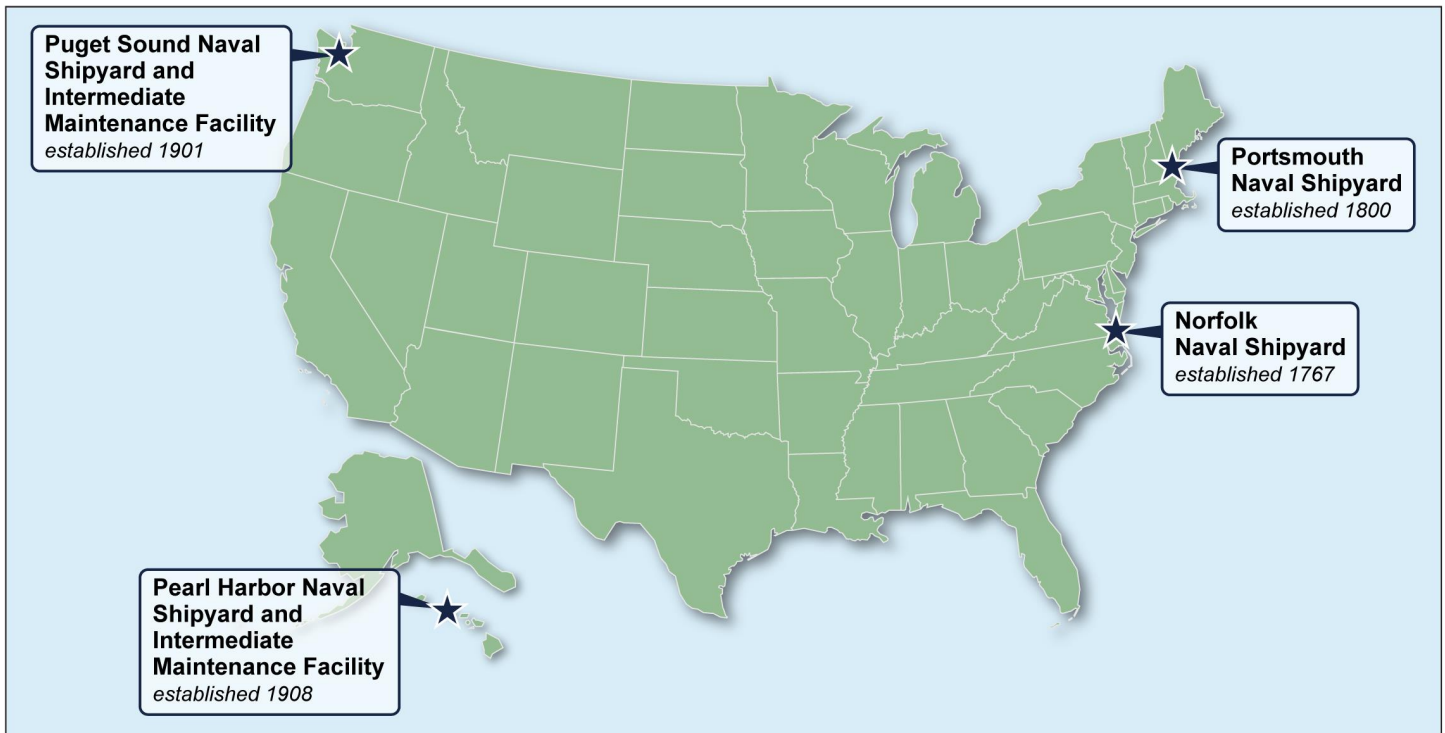
Background

History and Purpose of the Naval Shipyards

The naval shipyards were originally designed to build wind- and steam-powered ships and range in age from 111 years to 252 years old (see fig. 1). Over the years, the Navy has adapted them into highly industrialized, large-scale operations that are essential to national defense and fulfill the legal requirement for DOD to maintain a critical logistics capability that is government owned and operated to support an effective and timely response for mobilization, national defense contingency situations, and other emergency requirements. However, as we have reported, the shipyards' age, residual configuration for the shipbuilding mission, and poor condition reduces their efficiency for their modern-day mission of repairing nuclear-powered ships and submarines.¹⁰

¹⁰[GAO-17-548](#).

Figure 1: Location of Naval Shipyards as of 2019



Source: Map Resources and GAO analysis of Navy documents. | GAO-20-64

The naval shipyards perform depot-level maintenance, which involves the most comprehensive and time-consuming maintenance work, including ship overhauls, alterations, refits, restorations, nuclear refuelings, and inactivations—activities crucial to supporting Navy readiness. This maintenance is performed during periods designated in the Navy’s *Optimized Fleet Response Plan*, an operational schedule of maintenance, training, and deployment periods for the entire fleet. It is designed to maximize the fleet’s operational availability to combatant commanders while ensuring adequate time for the training of personnel and maintenance of ships. We reported in 2016 that successful implementation of the *Optimized Fleet Response Plan* depends, in part, on the shipyards completing maintenance on time and that maintenance delays reduce the time that ships are available for training and operations.¹¹ As a result, successful implementation of the *Optimized*

¹¹GAO, *Military Readiness: Progress and Challenges in Implementing the Navy’s Optimized Fleet Response Plan*, [GAO-16-466R](#) (Washington, D.C.: May 2, 2016).

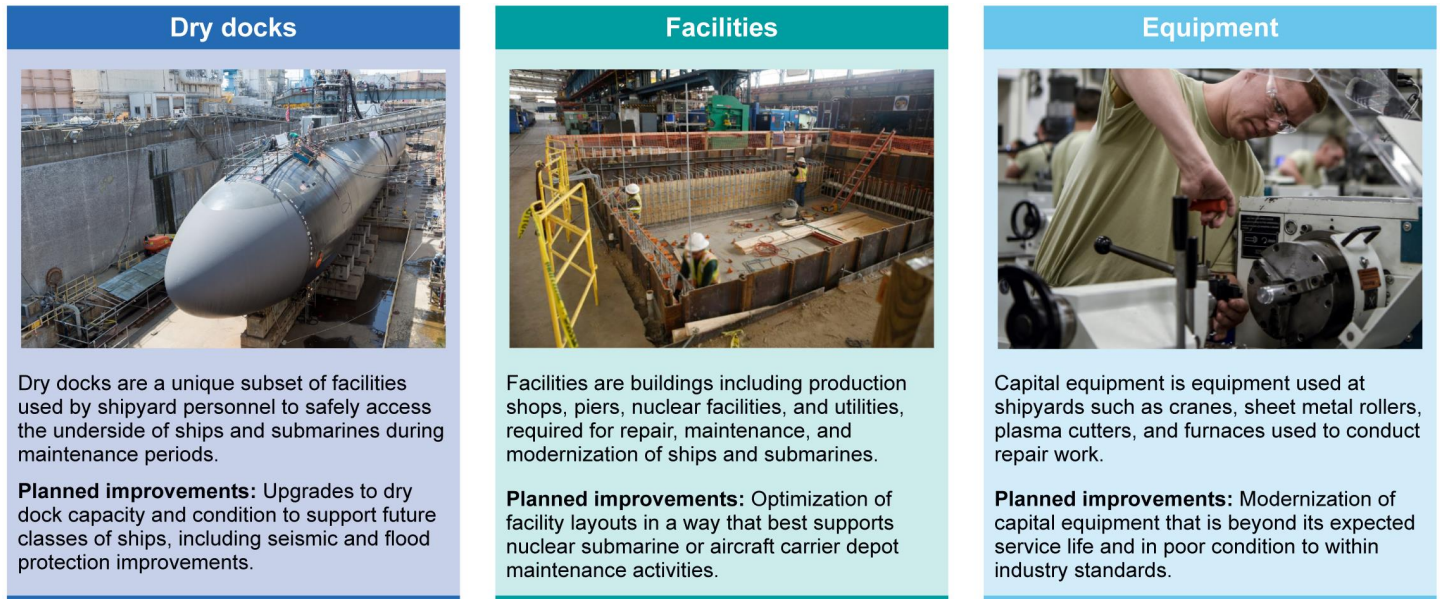
Fleet Response Plan is essential to the Navy's ability to maintain readiness and support operational needs.

The Navy's Shipyard Infrastructure Optimization Plan

The Navy developed the congressionally directed Shipyard Infrastructure Optimization Plan (the plan) to mitigate infrastructure deficiencies at the public shipyards.¹² For some infrastructure, the Navy had preexisting planning that it used to outline specific mitigation projects that would address deficiencies. For other aspects of its infrastructure, the plan outlines the Navy's strategy for developing a more detailed mitigation approach. The plan serves as the Navy's engineering analysis and strategy for the optimal placement of facilities and major equipment at each public shipyard, including a 20-year investment plan for infrastructure investments needed to improve shipyard performance. The plan proposes mitigations to address limitations with three major facets of the public shipyards' operations: their dry docks, facilities, and capital equipment (see fig. 2).

¹²The Senate directed the Secretary of the Navy to submit an engineering master plan for optimal placement and consolidation of facilities and major equipment to support depot-level repair functions, as well as an investment strategy addressing the facilities, major equipment, and infrastructure requirements of the shipyards. S. Rep. No. 115-125, at 113 (2017), accompanying a bill for the National Defense Authorization Act for Fiscal Year 2018.

Figure 2: Major Areas for Improvement Identified in the Navy’s Shipyard Infrastructure Optimization Plan



Source: GAO analysis of Navy documents; Defense Visual Information Distribution Service (photos). | GAO-20-64

Navy officials said they integrated previous studies in these three areas to create the plan. For example, Naval Sea Systems Command (NAVSEA)—which is responsible for program management of the shipyards—completed a dry dock study that identified gaps in capacity and configuration, which served as the basis for the dry dock portions of the plan. In addition, the Navy had previously developed capital investment strategies intended to help improve the state of the shipyards’ facilities and equipment, which were also included in the plan. The Navy estimates that the plan could eventually save 328,000 labor-days each year and recover most of the maintenance periods it currently cannot support.

Capital Planning and Reliable Cost Estimates

Capital planning is the process by which an organization prepares for the acquisition of capital assets such as the facilities and equipment in the

Navy's plan.¹³ Congress, the Office of Management and Budget, and we have identified the need for effective capital planning, which can help ensure that capital funds are spent productively. In the overall capital programming process, planning is the first phase, and it drives the remaining phases of budgeting, procurement, and management.

For decision makers to conduct effective capital planning, they must have reliable cost estimates. A reliable cost estimate is critical to the success of any program. Such estimates provide the basis for informed investments, realistic budgets, meaningful measurement of progress, proactive course correction, and accountability for results. According to the Office of Management and Budget, cost estimates should be well-documented and updated on a regular basis.¹⁴ Estimates should also encompass life-cycle costs of the program. Without high-quality estimates, agencies are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls.

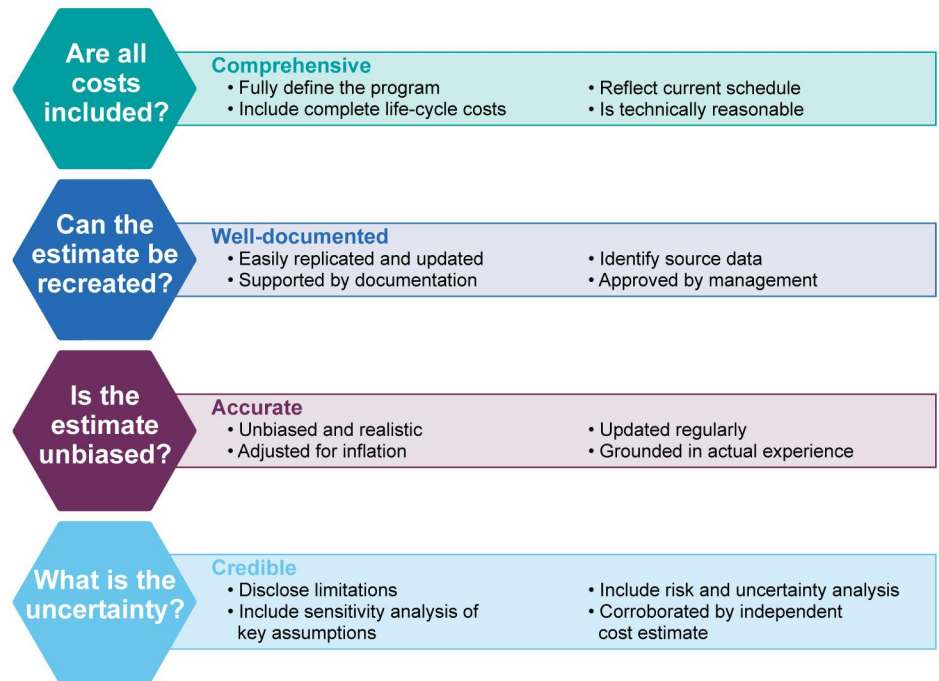
The GAO *Cost Estimating and Assessment Guide* has identified a number of best practices grouped into four "characteristics" that are the basis of effective program cost estimating and should result in reliable and valid cost estimates that management can use to make informed decisions, as shown in figure 3 and discussed below.¹⁵

¹³The Office of Management and Budget and GAO have defined capital assets as those assets that improve the efficiency of internal federal agency operations and are acquired for the government's own use, such as land, structures, equipment, and intellectual property (including software) and that have an estimated useful life of 2 years or more. Some examples are office buildings, waste storage facilities, motor vehicles, aircraft, marine vessels, construction equipment, pieces of scientific research equipment, and scanning and detection equipment. GAO, *Federal Capital: Three Entities' Implementation of Capital Planning Principles Is Mixed*, [GAO-07-274](#) (Washington, D.C.: Feb. 23, 2007).

¹⁴Office of Management and Budget, *Preparation, Submission and Execution of the Budget, Capital Programming Guide*, Circular No. A-11, ver. 3.0 (2019).

¹⁵[GAO-09-3SP](#).

Figure 3: Characteristics of Reliable Cost Estimates



Source: GAO. | GAO-20-64

- **Comprehensive:** A comprehensive cost estimate includes all costs of the program over its complete life cycle, from the start of the program through design, development, deployment, operation and maintenance, and retirement. It also fully defines the program, reflects the current schedule, and is technically reasonable. Comprehensive cost estimates provide sufficient detail to ensure that cost elements are neither omitted nor double counted.¹⁶ Finally, where information is limited and judgments must be made, the comprehensive cost estimate documents all cost-influencing ground rules and assumptions.
- **Well-documented:** A well-documented cost estimate is supported by detailed documentation that describes how it was derived and how the funds will be spent in order to achieve a given objective. Therefore, the documentation includes such things as the source data used, the

¹⁶The cost estimate should be based on a work breakdown structure that allows a program to track cost and schedule by defined deliverables, such as hardware or software components.

calculations performed and their results, and the estimating methodology. Moreover, this information is captured in such a way that the data used can be easily replicated and updated. The documentation also discusses the technical baseline and how the data were standardized.¹⁷ Finally, the documentation includes evidence that the cost estimate was reviewed and accepted by management.

- **Accurate:** An accurate cost estimate provides results that are unbiased, and is not overly conservative or optimistic. An estimate is accurate when it is based on an assessment of the most likely costs, adjusted properly for inflation, and contains few, if any, minor mistakes. In addition, an accurate cost estimate is updated regularly to reflect significant changes in the program—such as when schedules or other assumptions change—and actual costs, so that it always reflects the program’s current status. During the updating process, differences between planned and actual costs are documented, explained, and reviewed. Among other things, the estimate is grounded in a historical record of cost estimating and actual experiences on comparable programs.
- **Credible:** A credible cost estimate discusses any limitations of the analysis resulting from uncertainty or biases surrounding the data or assumptions. Major assumptions should be varied and other outcomes recomputed to determine how sensitive they are to changes in the assumptions. Risk and uncertainty analysis are performed to determine the level of confidence associated with the estimate. Finally, an independent cost estimate is developed by a group outside the organization to determine whether other estimating methods produce similar results.

The Navy’s Plan Identifies Critical Shipyard Deficiencies, but Planning Has Not Been Completed, and Implementation Will Be Complex, Taking over 20 Years

The *Shipyard Infrastructure Optimization Plan* has identified a number of infrastructure deficiencies at the Navy’s four public shipyards—including

¹⁷A technical baseline provides a common definition of the program from which all cost estimates could be derived.

deficiencies in dry docks, facilities, and capital equipment—that negatively affect their ability to support the Navy’s current and future force structure. However, the extent to which the Navy’s plan addresses these deficiencies remains to be seen because facility planning has not been completed and the proposed actions are complex and years away from being implemented.

The Plan Generally Addresses Dry Dock Deficiencies, but Planned Improvements Will Not Be Complete Until 2035

The Navy’s plan outlines steps that generally address the critical dry dock deficiencies the Navy has identified, although it does not anticipate completing these steps until 2035. Of the shipyards’ 18 dry docks, the plan states that eight require modernization and recapitalization projects to meet the Navy’s operational needs, including accommodating new classes of ships. If all of the projects are completed as planned, the Navy anticipates that it will be able to recover 67 of the 68 maintenance periods that it currently cannot support through fiscal year 2040.¹⁸ According to the Navy, without these planned dry dock investments, the Navy would lack sufficient capacity for about a third of its planned maintenance periods at the shipyards and would have to defer maintenance for some ships. This could result in ships being unavailable for use until a dry dock is available, effectively reducing the size of the fleet available for operational missions. However, the extent to which the plan’s actions will address the shipyards’ dry dock deficiencies remains to be seen because the initiation and completion of many of these projects is years away.

¹⁸The Navy calls these scheduled periods of ship maintenance or modernization “maintenance availabilities.”

Puget Sound's Dry Dock 3



Source: Puget Sound Naval Shipyard and Intermediate Maintenance Facility. | GAO-20-64

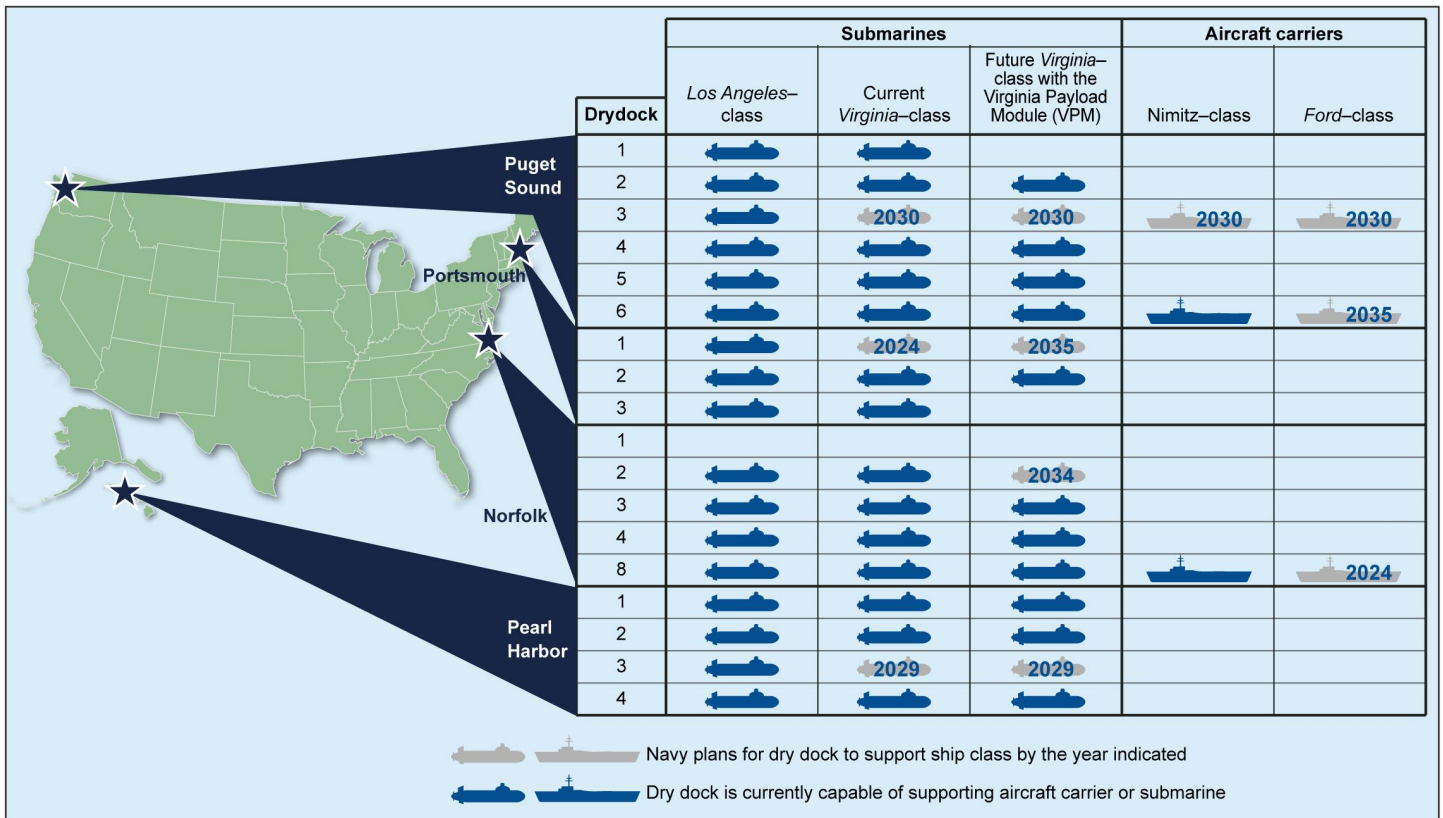
Built in 1919, dry dock 3 is not certified to handle nuclear fuel, which means submarines must be defueled elsewhere before this dock can be used, according to Navy officials. Additionally, because of its shallow depth, the Navy can move Los Angeles-class submarines into or out of the dock only during high tides. Even then, the shipyard has to remove portions of the submarine to decrease weight and over-flood the dock to create enough clearance for the boat. Shipyard officials said dry dock 3 could be modified to create a new multimission dry dock (M2D2) that would provide an additional spot to dry dock an aircraft carrier on the West Coast. This would provide the redundancy necessary to allow the Navy to perform significant seismic upgrades to dry dock 6, which faces significant seismic risks and is the only dry dock on the West Coast capable of accommodating an aircraft carrier. Navy officials said the final decision regarding the location of the M2D2 is pending a formal Environmental Impact Study.

Source: GAO discussions with Navy officials. | GAO-20-64

The Navy plans to address several critical dry dock deficiencies at the public shipyards that negatively affect its ability to complete maintenance on time. The deficiencies the Navy identified include

- an inability to support the Navy's aircraft carrier and submarine maintenance schedule through 2040,
- flooding and seismic vulnerabilities,
- an inability to support the new Ford-class aircraft carrier,
- insufficient capacity to support the longer Virginia-class submarines with the Virginia Payload Module (see fig. 4),
- lack of redundancy for a West Coast aircraft carrier, and
- various other capacity and capability deficiencies that hinder the maintenance process such as small dry docks that require time-consuming workarounds or an inability to handle nuclear fuel (see sidebar).

Figure 4: Current and Planned Ability of the Naval Shipyard Dry Docks to Accommodate Various Ship Classes

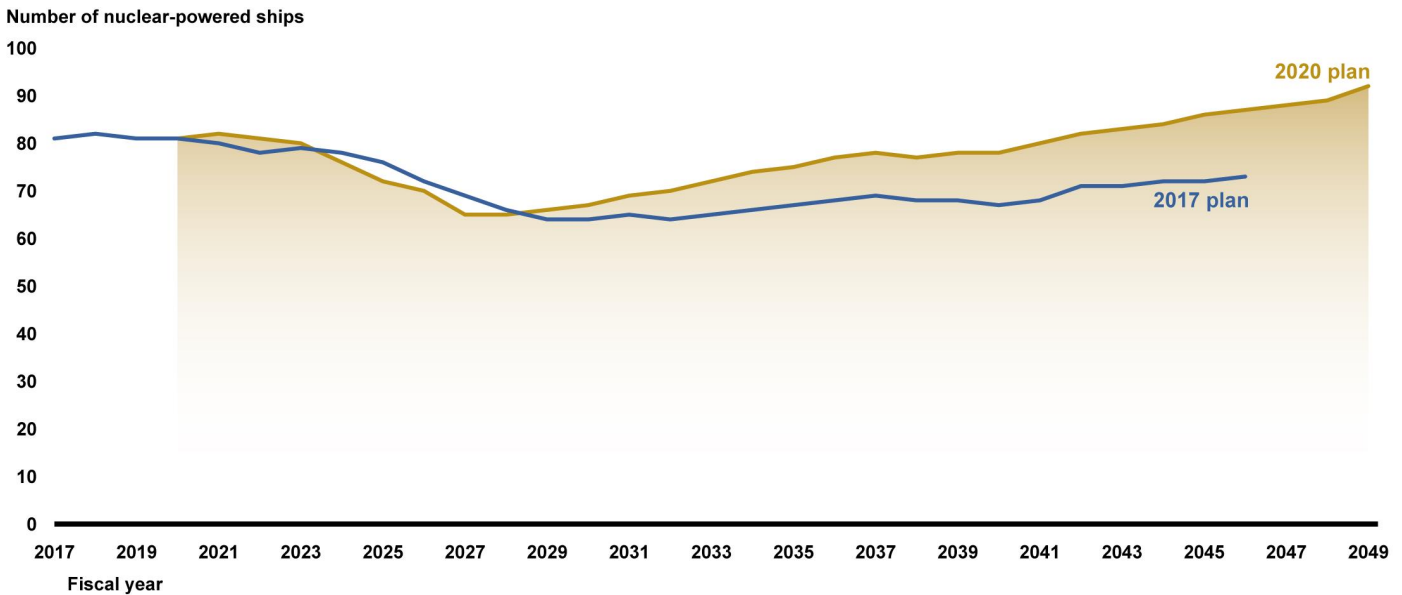


Source: GAO analysis of Navy documents; Map Resources. | GAO-20-64

Though the Navy intends to recover most of the missed maintenance periods with these projects, according to Navy officials, the plan was developed using then-current estimates of fleet size and shipbuilding schedules derived from the fiscal year 2017 force structure projection.¹⁹ The Navy has since revised that projection, and the fiscal year 2020 shipbuilding projection increases both the number and accelerates the build rate of the nuclear powered ships supported by the naval shipyards (see fig. 5).

¹⁹Force structure projections are plans that describe the Navy's 30-year shipbuilding goal. They identify the size goal of the fleet, as well as how rapidly the Navy will build ships in order to meet that goal. The projections also outline what types of ships will be built.

Figure 5: Comparison of the Projected Inventory of Nuclear-Powered Ships under the Navy’s 2017 and 2020 Shipbuilding Plans



Source: GAO analysis of Navy documents. | GAO-20-64

Note: The public shipyards primarily repair nuclear-powered ships.

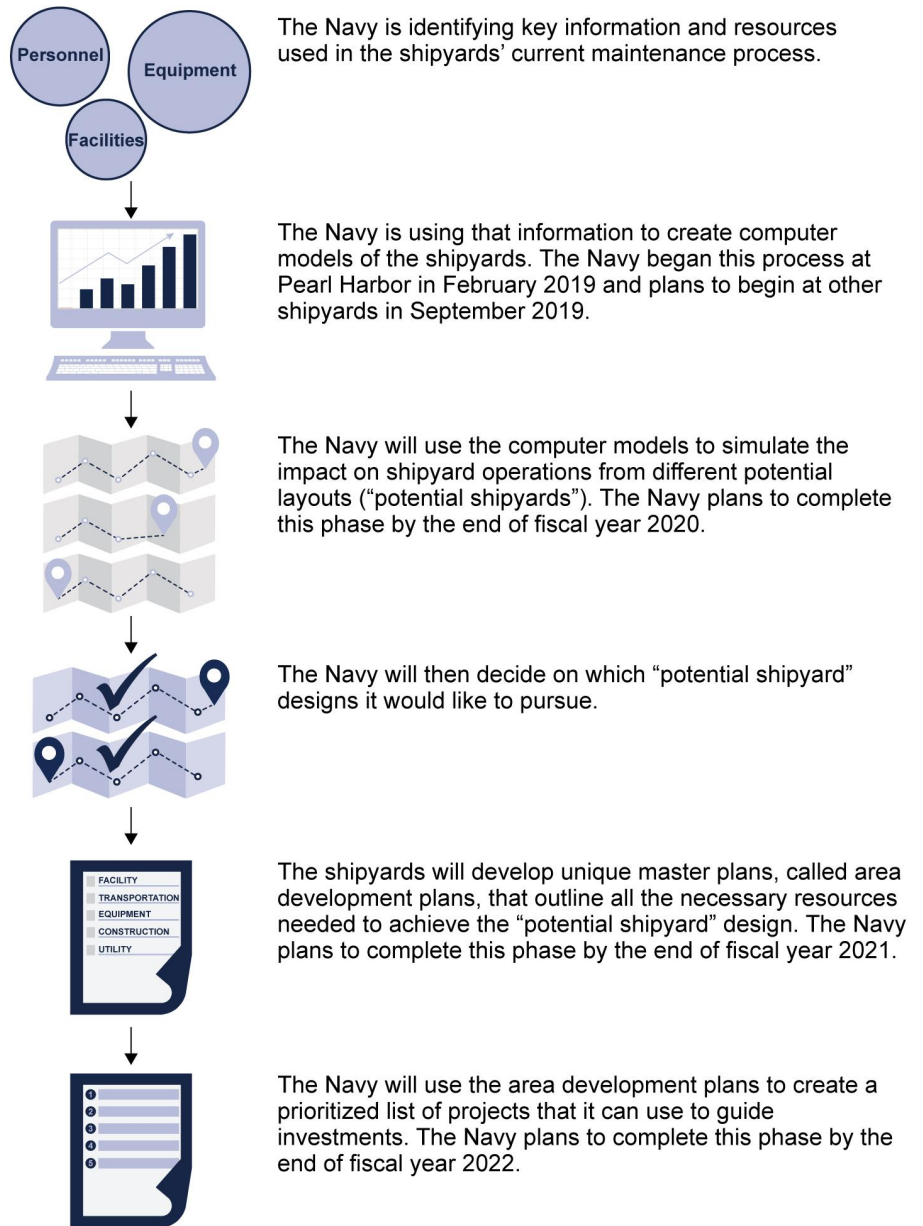
Program office representatives told us that the plan, if implemented, will support the higher numbers and accelerated schedule of the Navy’s 2020 shipbuilding plan. Officials also stated that they plan to stay aware of further changes to depot maintenance requirements by attending annual fleet scheduling conferences in the future. These conferences are intended to reach a Navy-wide consensus on, among other things, changes to shipbuilding plans and the schedules for various ships to undergo their dry dock maintenance. Program officials noted that their presence at the conference allows them to update the SIOP in the event that there are additional changes to the shipbuilding schedule in the future. We have previously recommended that the Navy assess the risks to implementing shipyard infrastructure improvements; changes to the shipbuilding schedule are one such risk.²⁰ Because of our previous recommendation and the Navy’s process for reviewing changes, we are not making an additional recommendation on this matter.

²⁰GAO-17-548.

Planning to Fully Address Shipyard Facility Deficiencies Is Ongoing, with Improvements Expected to Take at Least 20 Years to Implement

It is too soon to determine whether the Navy's plan will fully address the shipyards' facility deficiencies as the Navy has not yet completed the complex effort necessary to develop detailed facility optimization plans for each shipyard. Implementing the plan will be a complex, multiyear effort to redesign the workflows at each shipyard and will involve several steps (see fig. 6).

Figure 6: Planning Steps to Optimize the Naval Shipyards' Facilities



Source: GAO analysis of Navy documents and discussions with Navy officials. | GAO-20-64

As part of the facility optimization effort, the Navy will seek to address several critical facility deficiencies it has identified at the public shipyards

that negatively affect the Navy's ability to complete maintenance on time. These include

- the average age of shipyard production shop facilities is 76 years, exceeding DOD's expected average service life of 67 years for facilities;²¹
- the average condition rating of shipyard production shop facilities is 66, which is considered poor, falling below the Navy standard of 80;²² and
- inefficient facility layout at the shipyards that has not been optimized to support the maintenance, repair, and disposal of nuclear-powered Navy ships and submarines.

²¹We have previously noted that age is not a perfect metric regarding the usefulness of facilities, since many facilities are modernized over the course of their lifetimes. See GAO, *Military Depots: Actions Needed to Improve Poor Conditions of Facilities and Equipment that Affect Maintenance Timeliness and Efficiency*, [GAO-19-242](#) (Washington, D.C.: Apr. 29, 2019).

²²A facility's condition rating indicates the Navy's assessment of the physical condition of the facility with a rating from 0 to 100. The condition of facilities with scores of 90 to 100 is considered good, 80 to 89 is considered fair, 60 to 79 is considered poor, and below 60 is considered failing. See GAO, *Defense Facility Condition: Revised Guidance Needed to Improve Oversight of Assessments and Ratings*, [GAO-16-662](#) (Washington, D.C.: June 23, 2019).

Pearl Harbor's Building 6—Close to the Waterfront, but Abandoned



Source: GAO. | GAO-20-64

Building 6 at Pearl Harbor Naval Shipyard is a former foundry that has not been used since the 1980s. The building's distinctive 3-tier roof architectural style make it a historic facility and therefore difficult to restore and modernize, according to shipyard officials. Because of its size and close proximity to the waterfront, shipyard officials would like to use the facility to support the maintenance mission, rather than let it sit empty. However, the building has extensive health and safety issues and also requires environmental remediation.

Source: GAO analysis of Navy information. | GAO-20-64

According to the Navy, the shipyards were originally designed to support the construction of ships and submarines and not the maintenance mission for the nuclear fleet that they perform today. Because the shipyards were designed for a different mission, key facilities such as maintenance shops may be located at significant distances from where the majority of work is performed. As a result, it is not uncommon for workers to walk several miles each day because of the inefficient layout of the shipyards, according to shipyard officials. For example, building 155 at Pearl Harbor Naval Shipyard, which is actively involved in submarine maintenance, is about 1/3 mile away from the nearest dry dock. This distance creates additional travel time for both personnel and material, resulting in maintenance inefficiencies. We have noted previously that waterfront locations are often ideally located to support the shipyards' maintenance mission, but that the challenges of dilapidated structures, historical designations, and other issues can make it difficult for the shipyards to make full use of the locations (see sidebar).²³

The Navy's plan estimates that the implementation of facility optimization will take at least 20 years and require increased spending for facility construction and modernization over that time. In addition, this will be a highly complex effort to redesign four large operational industrial installations, and the time frame for its completion remains uncertain at this stage. The modeling and simulation of shipyard production facilities began in February 2019 and will not be completed until 2020. According to program office representatives, Pearl Harbor's "current state" facility model is scheduled to be completed near the end of fiscal year 2019, and the optimal facility model is scheduled to be completed in the 2nd quarter of fiscal year 2020 (see fig. 7). Modeling and simulation at the Norfolk, Portsmouth, and Puget Sound shipyards are not scheduled to be completed until the end of fiscal year 2020. However, some shipyard officials have expressed doubt about this timeline, stating that the modeling and simulations may take more effort to complete. For example, officials from Puget Sound Naval Shipyard told us they have done some degree of industrial modeling and simulation since 2007, but never at this magnitude and with this many variables. Because the modeling and simulation effort is so complicated, officials said it may be necessary to use the model to optimize the most critical parts of the industrial process first before gradually adding others. Shipyard officials also said that

²³GAO-17-548.

running the models will require a highly skilled and interdisciplinary team due to the complexity of the effort.

Figure 7: Production Facilities Optimization Timeline



Source: GAO analysis of Navy documents and discussions with Navy officials. | GAO-20-64

If the simulations are completed as planned, the Navy expects to use them to complete the shipyard Area Development Plans in fiscal year 2021 and a prioritized list of facility development projects by fiscal year 2022. Navy officials said the list would likely inform facility investments for the following 5 years. Navy officials told us that they are suspending work on many facilities' projects in order to avoid funding projects that do not serve the larger optimization goal, although some critical projects have been allowed to continue because they provide improvements needed to meet immediate operational needs, such as dry dock improvements. However, according to Navy officials, some projects have been deferred until 2022 when the prioritized list of projects to support shipyard optimization is expected to be complete.

In addition, specific actions to address other infrastructure deficiencies at the shipyards are not addressed in the current plan, adding additional uncertainty. Navy officials explained that the optimized layout of shipyard facilities, which is still in early development, will drive the future efforts that address deficiencies associated with roads, utilities, sidewalks, and information-technology systems, which are not addressed in the plan. These officials explained that it will likely be several years before they can incorporate specific actions into the plan to address these deficiencies.

Planning to Fully Address Equipment Deficiencies Awaits Completion of Facility Optimization Effort, with Improvements Expected to Take at Least 20 Years

The Navy plans to mitigate equipment deficiencies at the shipyards through increased funding to replace aged shipyard equipment.

Specifically, the Navy’s plan states that funding levels for shipyard capital equipment will need to increase from historical levels to about \$150 million annually and be sustained for at least 20 years to bring the average age of shipyard equipment to within industry standards. However, it is not clear whether this will fully address shipyard equipment deficiencies, because the Navy officials stated that they will not be able to create a more detailed goal until after the facility modeling and simulation effort is complete.

The Navy’s plan states that most shipyard capital equipment is beyond its effective service life, obsolete, unsupported by the original manufacturers, or at risk of failure. According to the plan, the average age for industrial equipment in the private sector is 7 to 10 years, while the average age of equipment at the four shipyards is 24 years. According to the Navy’s plan, aged equipment can increase the costs of depot maintenance for submarines and aircraft carriers and place schedules at risk. Modernizing the capital equipment at naval shipyards is essential to improving their efficiency, reducing maintenance costs, and supporting fleet readiness, according to the plan. The capital equipment deficiencies identified by the Navy’s plan are consistent with our recent work, which found that the equipment at the shipyards was, on average, past its expected service life (see table 1).²⁴

Table 1: Average Age of Equipment at Public Shipyards

Years

Shipyard	Average equipment age	Time past average service life
Norfolk Naval Shipyard	29	15.3
Portsmouth Naval Shipyard	19	3.5
Puget Sound Naval Shipyard	22	5.2
Pearl Harbor Naval Shipyard	15	0.8

Source: GAO analysis of Navy data. | GAO-20-64

However, it is too early to determine whether the Navy’s plan to increase equipment funding will fully address the shipyards’ equipment deficiencies. Navy officials told us that they have not yet established a specific improvement goal for shipyard capital equipment, because developing this metric will not be possible until after the modeling and

²⁴See [GAO-19-242](#).

simulation phase to develop optimized facilities is complete.²⁵ For example, during the modeling and simulation phase to optimize shipyard operations, the Navy will likely make decisions that will affect the amount and cost of capital equipment, such as concentrating some specialized equipment at certain yards, standardizing equipment items and purchasing them in bulk at lower cost, or purchasing more efficient items that may reduce the quantity needed. Officials stated that they developed a rough order-of-magnitude estimate of the cost to replace aging equipment. The Navy has, in the past, spent about \$50 million to \$60 million annually to invest in capital equipment at the shipyards. However, the Navy estimates that it will require average annual funding of \$150 million over the course of 20 years at a total cost of \$3 billion in order to modernize capital equipment to within private industry standards. If this effort is sustained over the 20 years identified in the plan, the capital equipment deficiencies at the shipyards will not be fully addressed until fiscal year 2040. However, this estimate is based off an earlier Navy study that identified a need for annual average funding of \$150 million over a longer, 30-year period. According to this earlier equipment study, the 10 additional years of investment would total \$1.5 billion. Navy officials have stated that they will attempt to address the shipyards' equipment deficiencies over the 20-year time frame by taking advantage of different equipment purchasing strategies and gaining efficiencies from the facility optimization effort that will allow the Navy to recapitalize equipment more effectively than was possible with its previous strategies. However, the efficacy of these strategies cannot be assessed until the Navy completes its modeling and simulation phase in fiscal year 2020 and develops more detailed plans for recapitalizing its shipyard equipment.

The Navy's Initial Cost Estimate of \$21 Billion to Implement Its Plan Is Preliminary and Does Not Identify All Required Resources

The Navy estimates the *Shipyard Infrastructure Optimization Plan* will cost about \$21 billion to implement; however, the estimate is preliminary

²⁵The Navy's stated goal for the equipment is to bring the average age of equipment up to industry standards. However, the Navy has not specified what "industry standards" it will use, nor has it developed interim goals for improving equipment age over the 20 year plan.

and therefore is not complete or reliable. To develop the plan, the Navy first identified deficiencies in three major categories—dry docks, facilities, and equipment—and then developed a cost estimate to understand the resources it would need to mitigate those deficiencies. For the dry dock and equipment portions of the estimate, the Navy was able to build on previous cost estimates that had investigated additional investments in those areas. For the facilities portion of the estimate, the Navy assumed total reconstruction of most current facilities based on current processes, using notional square-footage facility requirements in the absence of a more detailed engineering assessment. The initial estimated cost to implement this plan over 20 years includes \$4 billion for improvements to the dry docks, \$14 billion for facilities, and \$3 billion for capital equipment.

Navy officials stated that they wanted to provide Navy leadership and congressional decision makers with a rough order-of-magnitude estimate, not a budget-ready cost estimate. That is why the estimate was released in its 2018 report to Congress, instead of after the Navy completes its shipyard modeling and simulation effort, which they believe will give them a more accurate picture of the necessary investments. For example, the Navy acknowledges that several expected costs are not included in its plan, such as those for utilities, roads, and environmental remediation. Officials with the Navy agree that including these will likely add hundreds of millions of dollars to the plan's cost. However, they decided that it was not useful to calculate these costs before the facility optimization process was complete, since the facility layout is going to have an effect on the placement of roads and utilities, for example. Navy officials stated that the initial cost estimate was prepared using applicable Navy guidance and that they plan to develop a more detailed cost estimate after the Navy has finished creating digital models of the shipyards and they start prioritizing specific projects, which they estimate will be in fiscal year 2021.²⁶

We found that the Navy's initial cost estimate minimally met two characteristics of a reliable cost estimate, partially met one, and did not meet one, as shown in table 2. The GAO Cost Estimating and Assessment Guide identifies four "characteristics" of a reliable cost

²⁶We reviewed DOD's cost estimating guidance in 2018 and found that DOD's guidance does not fully incorporate the steps needed for developing reliable estimates. We recommended that DOD ensure that its cost estimating guidance fully incorporate the steps needed for developing reliable construction cost estimates. See GAO, *Defense Infrastructure: Action Needed to Increase the Reliability of Construction Cost Estimates*, [GAO-18-101](#) (Washington, D.C.: Mar. 27, 2018). We did not assess the Navy's compliance with its own guidance.

estimate as well as associated cost estimating best practices as previously discussed.²⁷

Table 2: GAO Assessment of the Shipyard Infrastructure Optimization Plan Initial Cost Estimate

Characteristic	GAO assessment	Rationale
Comprehensive	Minimally met	The Navy excluded some costs from each section of the estimate. For example, costs for the program office, utilities, roads, environmental remediation, historical preservation, and alternative workspaces are not included, which are expected to total hundreds of millions of dollars. In addition, not all cost-influencing ground rules and assumptions are included, such as the program baseline or assumptions surrounding inflation and cost estimating methodology. Furthermore, there is no detailed work breakdown structure established to help prevent omissions and double counting. The Navy has stated that a more detailed work breakdown structure would not be possible until after the modeling and simulation of the shipyards is complete, after fiscal year 2020.
Well-documented	Partially met	The Navy provided the SIOP plan, the Capital Equipment Inventory Model, and the facility cost estimating models for each shipyard as documentation. However, only the facilities and equipment portions of the estimate included information regarding the sources of data and estimating methodology, and the links between the technical specifications in these documents are not clearly traceable to dry dock and capital equipment cost estimates.
Accurate	Minimally met	In general, calculations and costs are traceable from the plan's documentation to the supporting cost models; however there are several discrepancies between the estimating models provided and the plan. Data sources are provided for the facilities and capital equipment portions. For dry docks, the documentation provides limited information about estimating methodology or associated assumptions. Finally, the estimate does not account for inflation, which could add about 45 percent to the \$21 billion.
Credible	Not met	The Navy did not perform a sensitivity analysis on the estimate. Further, Navy officials identified risks to completion, but did not identify mitigation strategies for those risks. While mitigation strategies for these risks were not included in the plan, Navy officials have stated that they are involved in a number of efforts to address them. Contingencies were added to the facilities estimate on a percentage basis, but risk assessment or analysis was not developed for the dry dock or capital equipment costs. Finally, there was no independent cost estimate.

Source: GAO analysis of Navy information. | GAO-20-64

Note: A cost estimate is considered reliable if it substantially or fully reflects each of the four characteristics. If any of the characteristics is not met, minimally met, or partially met, then the cost estimate does not fully reflect the characteristics of a high-quality estimate and cannot be considered reliable.

Specifically, we found that the initial cost estimate was not reliable because it was not developed using the following best practices:

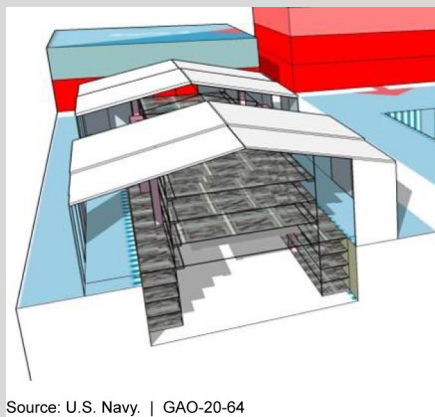
- **Program Baseline:** The Navy's plan includes some pieces of a program baseline, such as a schedule and goals, but does not fully

²⁷ [GAO-09-3SP](#).

establish a common definition of the program from which all cost estimates could be derived. A program baseline for cost and schedule may be established prior to contract award or funding work and allows decision makers to track and report on cost and schedule deviations above certain thresholds from initial estimates throughout the life of the project, to facilitate oversight. Navy officials stated that the plan's first phase is meant to serve as the program baseline, containing all relevant data to address systemic issues across all four shipyards. However, only the facilities estimate was developed specifically for the plan; the dry dock and equipment estimates came from previous Navy efforts, conducted under different conditions. Without a program baseline, a cost estimate will not be based on a complete program description and will lack specific information regarding technical and program risks.

- **Work breakdown structure:** The Navy's plan includes a broad list of high-level goals, such as timelines for completing major lines of effort, but the estimate does not include a more detailed work breakdown structure. Including a work breakdown structure is an important part of a comprehensive plan. A work breakdown structure deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. This allows program office and shipyard personnel to accurately track and closely monitor the progress of efforts to meet the SIOP's goals. In addition, including this structure would ensure consistency across the various cost estimating contributors, the shipyards, and NAVSEA, and would ensure that there were no omissions from the analysis and that costs are not double counted. Navy personnel stated that a more detailed work breakdown structure would not be possible until after the modeling and simulation of the shipyards is complete, after fiscal year 2020.
- **Methodology and key assumptions:** The Navy's plan describes assumptions, but not the methodology used to develop the initial cost estimate. For example, the plan states that the size and configuration of existing facilities make it difficult to increase capacity without a significant investment, but does not describe how the Navy intends to address the issue of a larger fleet. Cost estimates are often built around assumptions—such as the rate of inflation or material costs—because they are attempting to predict future costs. However, the plan must include a clearly identified methodology to be considered well-documented according to GAO best practices. Unless methodology and assumptions are clearly documented, it will be impossible to reproduce the estimate, and decision makers will lack information on which costs are concrete and which are best guesses.

Covered Dry Docks—Risk versus Reward



Source: U.S. Navy. | GAO-20-64

Navy officials noted that they are currently evaluating the use of a covered dry dock model at the shipyards, which could result in significant maintenance efficiencies. A covered dry dock is a dry dock with an area built over it, which allows the shipyard to develop production space that can minimize personnel and materiel movement. However, the Navy is still investigating the cost benefit of the covered dry dock, which means that there could be additional costs or complications not included in the current plan.

Source: GAO analysis of Navy documents. | GAO-20-64

- Inflation:** The estimate did not account for inflation, which is an important component of an accurate cost estimate. If an estimate does not include adjustments for inflation, cost overruns can result. Inflation costs on a \$21 billion program over 20 years could reach 45 percent or more. Applying inflation is an important step in cost estimating because, in the development of an estimate, cost data must be expressed in like terms. If a mistake is made or the inflation amount is not correct, cost overruns can result.
- Risk and uncertainty:** Our analysis showed the Navy's estimate did not include a cost risk or uncertainty analysis. A comprehensive analysis of risk and uncertainty in the estimate is an important component of an accurate cost estimate. Navy officials have identified a number of risks to implementing the plan, such as the costs of complying with historical preservation requirements, environmental remediation, and the acquisition or adaptation of alternative workspace for shipyards to use while facility upgrades are performed. Officials have stated that these factors could add hundreds of millions of dollars more to the total cost of the plan. For example, an official from Norfolk Naval Shipyard said that environmental remediation of certain sites at Norfolk alone could easily cost millions of dollars to execute. Furthermore, the plan excluded certain costs that the Navy will necessarily incur in implementing it, such as those related to utilities or roads. Because cost estimates predict future program costs—sometimes for projects that have never been built before—Navy officials always associate uncertainty with them (see sidebar). Lacking risk and uncertainty analysis, management cannot determine a defensible level of contingency reserves that is necessary to cover increased costs resulting from unexpected design complexity, incomplete requirements, technology uncertainty, and other uncertainties. While the Navy did not initially include mitigation strategies for these risks in the plan, Navy officials have stated that they are involved in a number of efforts to address them.
- Sensitivity:** Our analysis showed that the Navy's estimate does not include a sensitivity analysis, which evaluates the effect that individual elements or assumptions can have on the estimate. Without a sensitivity analysis, cost estimators and management will not have a full understanding of the implications that changes in ground rules and assumptions can have. Officials have stated that they plan to include a sensitivity analysis in their more detailed cost estimate in 2021.
- Independent Cost Estimate:** Our analysis showed that the Navy's plan does not include an independent cost estimate. An independent cost estimate provides an evaluation of the quality, accuracy, and

reasonableness of a program's cost estimate by a neutral third-party, with emphasis on specific cost and technical risks. It also helps to identify risks associated with budget shortfalls or excesses. Navy officials noted that an independent cost estimate was likely not feasible at this point, considering that the effort was still in its very early stages. However, the officials stated that given the size and projected cost of the plan, they anticipate they will likely seek out an independent cost estimate in the future.

Navy officials said they plan to develop a more detailed cost estimate after the Navy has finished creating digital models of the naval shipyards and identifying their optimized layouts, which they estimate will be in fiscal year 2021. However, even in the context of a preliminary estimate, the best practices associated with the four characteristics are foundational and should be the building blocks upon which any sound program is based. The importance of best practices is only magnified by the size of the program, which means ignoring best practices can have meaningful effects. For example, as we noted previously, not adjusting for inflation is likely to underestimate the cost of the program. Navy officials have expressed openness to the best practices as they prepare the more detailed cost estimate. However, without incorporating these cost estimating best practices that inform Navy decision makers and Congress of the full costs of shipyard optimization, the Navy is at risk of not identifying the resources it needs to fully implement its optimization plan. In addition, without fully accounting for all costs, management will have difficulty successfully planning program resource requirements.

The Navy Has Created a Management Structure to Oversee the Shipyard Optimization Effort, but Has Not Yet Identified Clear Roles and Responsibilities for Shipyards

The Navy created a management structure—a program management office (referred to as PMS 555)—to oversee the estimated 20-year-long process of optimizing the shipyards in June 2018.²⁸ Shortly thereafter, in September 2018, the Assistant Secretary of the Navy for Research, Development, and Acquisition stated that, though the shipyard

²⁸Naval Sea Systems Command, NAVSEA Note 5450, *Establishment of the Shipyard Infrastructure Optimization Program Management Office* (June 5, 2018).

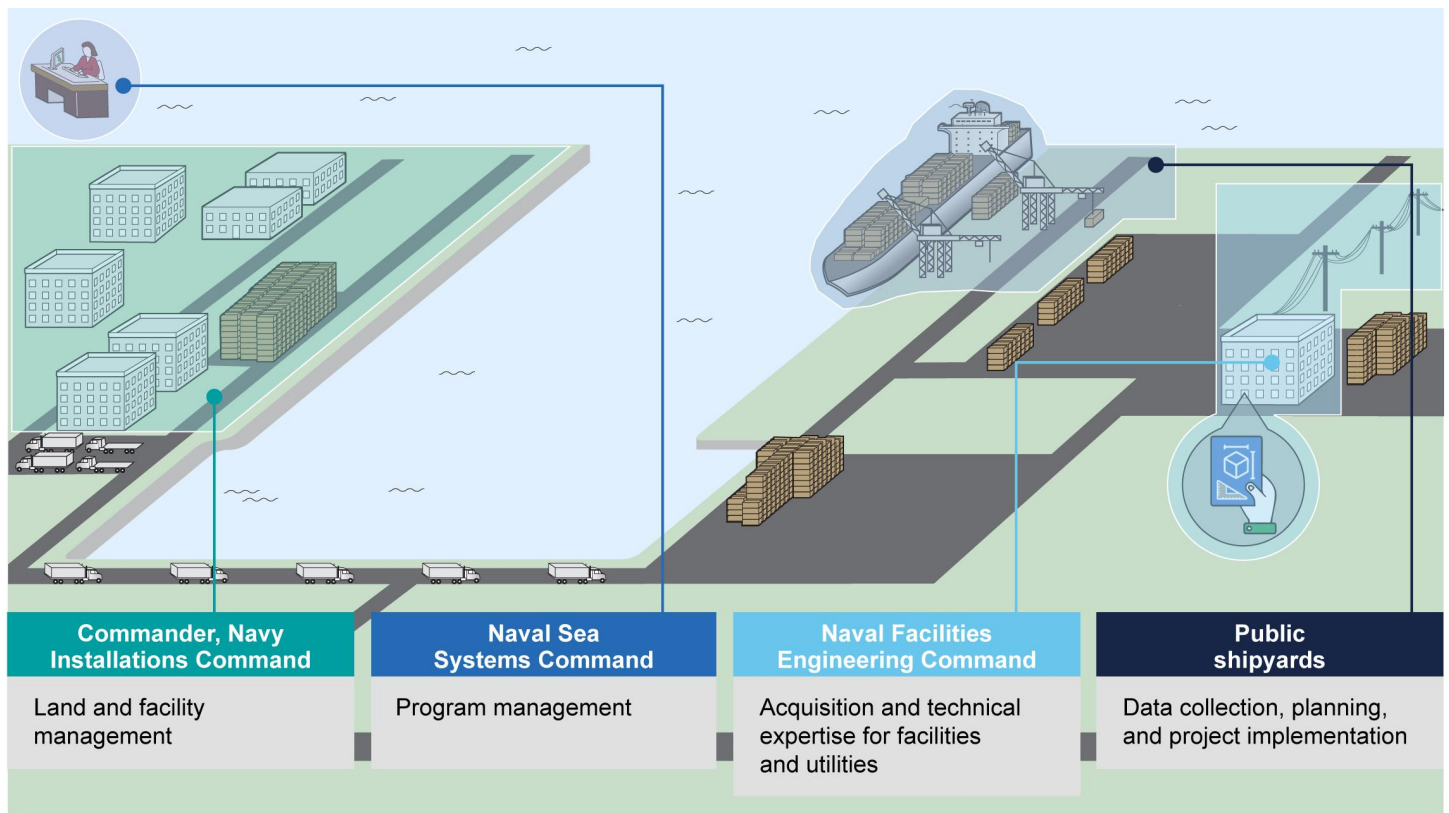
optimization effort did not fit all the characteristics of a formal acquisition program, its size and importance required the Navy to treat it as one. As a result, the newly created program office was designated as the acquisition lead for all efforts related to shipyard optimization. The program office was also required to report on its progress quarterly to an executive oversight council consisting of leadership representatives from a number of Navy organizations.²⁹

This program office includes representatives from Navy organizations that would necessarily be involved in shipyard construction, including Navy Installations Command and Naval Facilities Engineering Command.³⁰ Navy officials explained that NAVSEA is managing the implementation of the plan through the program office; Navy Installations Command provides installation support through management of shipyard land and facilities; Naval Facilities Engineering Command provides acquisition and technical expertise for real estate, facilities, and related environmental studies; and the shipyards implement the plan's activities (see fig. 8).

²⁹Assistant Secretary of the Navy for Research, Development, and Acquisition Memorandum, *Establishment of PMS 555 as Acquisition Lead for Public Shipyard Infrastructure Plan* (Sept. 28, 2018).

³⁰For example, constructing a new facility generally requires planning from Naval Facilities Command, land management from Navy Installations Command, funding from Naval Sea Systems Command (NAVSEA), and oversight from local shipyard personnel.

Figure 8: Roles of Navy Organizations



Source: GAO analysis of Navy documents and discussions with Navy officials. | GAO-20-64

In the year since its creation, the program office told us they have begun taking steps to prioritize shipyard projects and complete the modeling and simulation of the existing shipyards. The office has also developed its internal organizational structure, which includes describing its relationships to essential stakeholders such as Navy Installations Command and Naval Facilities Engineering Command.

However, the program office has not yet formally clarified the extent to which it will interact with the shipyards or its expectations of support from the shipyards. For example, officials with the program office have stated that they plan to locate new staff both in Washington, D.C., and at field offices at each of the shipyards. However, neither the program office nor the shipyards yet know where the field offices will fall in the shipyards' reporting structures—including the chain of command—or precisely what their roles will be. According to program office representatives, the Navy

is in the process of developing documentation, including a memorandum of agreement, to formally codify roles and responsibilities for executing the plan among the program office and its field offices, the shipyards, and other Navy organizations to accomplish these tasks, but did not provide an estimated time frame for when these roles and responsibilities would be determined. Officials said their current plan is for field offices to serve as extensions of the program office and that they will help the shipyards to oversee the execution of the plan. Program office representatives intend for shipyard personnel to help define project requirements, collect data, provide input on the digital shipyard models, and communicate the plan among the entire shipyard workforce. However, the development of the memorandum of agreement has been extended.

Standards for Internal Control in the Federal Government states that management should establish an organizational structure, assign responsibility, and delegate authority to achieve the entity's objectives.³¹ Shipyard officials told us that the current lack of clarity has created concerns and confusion about what their roles should be during implementation. For example, shipyard officials were uncertain in what fiscal years certain positions would be needed for implementing the plan, and shipyard officials were not always involved with planning efforts. In addition, according to NAVSEA officials, the lack of clear roles and responsibilities has hampered several long-term planning efforts, including identifying and tracking performance metrics. According to Navy officials, the program office has since received funding that it intends to use to hire additional staff, and they intend to embed some of those staff members at the shipyards to coordinate with shipyard personnel. However, at present, shipyard personnel have stated that they are generally left to interpret and enact implementation activities, which could lead to inefficient or duplicative efforts. Given the time frames of the plan, even minor delays due to inefficiency could result in projects being postponed and critical ship maintenance being deferred. Establishing clear roles and responsibilities for the shipyards would better position the Navy to effectively implement the plan.

³¹ [GAO-14-704G](#).

Conclusions

The Navy's four public shipyards are critical for repairing and maintaining the Navy's nuclear fleet, and the Navy spends millions of dollars annually on facilities and equipment in order to sustain shipyard performance. Inefficient shipyards can lead to longer maintenance times, increased costs, and reduced readiness. Lack of adequate capacity can also result in critical parts of the fleet sitting idle awaiting maintenance, incurring hundreds of millions of dollars in operating and support costs without providing any operational benefit. We note that the shipyards are struggling to meet the Navy's current needs with inadequate facilities, aging equipment, poorly configured dry docks, and an ineffective management approach for addressing these issues. The Navy is attempting to address these concerns with its *Shipyard Infrastructure Optimization Plan*. However, the cost estimate for implementing this plan is preliminary and therefore likely under states the costs of what will be a decades-long effort. Because the Navy will be required to request funding from Congress over 20 years in order to implement this plan, the lack of a reliable cost estimate places the effort at risk. By developing a more complete cost estimate, the Navy could reduce the risk that it might request too little funding to achieve its desired outcome. Without high-quality estimates, agencies are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls. In addition, determining the roles and responsibilities of the organizations involved in implementing the plan would enhance the Navy's ability to successfully complete the effort by ensuring that all stakeholders clearly understand their roles and expectations.

Recommendations for Executive Action

We are making the following four recommendations to the Department of Defense:

The Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555) include all costs—such as costs for program office activities, utilities, roads, environmental remediation, historical preservation, and alternative workspace—when developing its second, more detailed, cost estimate. (Recommendation 1)

The Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555) use cost estimating best practices—as outlined

in the GAO Cost Estimating and Assessment Guide—in developing its second cost estimate, including a program baseline, work breakdown structure, a description of the methodology and key assumptions, inflation, fully addressing risk and uncertainty, and a sensitivity analysis. (Recommendation 2)

The Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555) obtain an independent cost estimate of the program prior to the start of its project prioritization effort. (Recommendation 3)

The Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555), in coordination with relevant stakeholders, establish clear roles and responsibilities for the shipyards involved in the *Shipyard Infrastructure Optimization Plan*. (Recommendation 4)

Agency Comments

We provided a draft of this report to DOD for review and comment. In written comments provided by the Navy (reproduced in appendix III), DOD concurred with our recommendations. The Navy also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretary of the Navy, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have questions about this report, please contact me at maurerd@gao.gov or (202) 512-9627. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.



Diana Maurer
Director
Defense Capabilities and Management

List of Committees

The Honorable James M. Inhofe
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Richard C. Shelby
Chairman
The Honorable Dick Durbin
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Adam Smith
Chairman
The Honorable Mac Thornberry
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Pete Visclosky
Chairman
The Honorable Ken Calvert
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Status of Recommendations from Naval Shipyards: Actions Needed to Improve Poor Conditions that Affect Operations (GAO-17-548) as of August 2019

Table 3: Status of Recommendations from Naval Shipyards: Actions Needed to Improve Poor Conditions that Affect Operations (GAO-17-548) as of August 2019

Recommendation	Recommendation status, concurrence, and comments
<p>Recommendation 1: The Secretary of the Navy should develop a comprehensive plan for shipyard capital investment that establishes:</p> <ul style="list-style-type: none">(1) the desired goal for the shipyards' condition and capabilities;(2) an estimate of the full costs to implement the plan, addressing all relevant requirements, external risk factors, and associated planning costs; and(3) metrics for assessing progress toward meeting the goal that include measuring the effectiveness of capital investments.	Status: Open—Priority Recommendation ^a
<p>Recommendation 1: The Secretary of the Navy should develop a comprehensive plan for shipyard capital investment that establishes:</p> <ul style="list-style-type: none">(1) the desired goal for the shipyards' condition and capabilities;(2) an estimate of the full costs to implement the plan, addressing all relevant requirements, external risk factors, and associated planning costs; and(3) metrics for assessing progress toward meeting the goal that include measuring the effectiveness of capital investments.	Concurrence: Yes

**Appendix I: Status of Recommendations from
Naval Shipyards: Actions Needed to Improve
Poor Conditions that Affect Operations (GAO-
17-548) as of August 2019**

Recommendation	Recommendation status, concurrence, and comments
<p>Recommendation 1: The Secretary of the Navy should develop a comprehensive plan for shipyard capital investment that establishes:</p> <ul style="list-style-type: none"> (1) the desired goal for the shipyards' condition and capabilities; (2) an estimate of the full costs to implement the plan, addressing all relevant requirements, external risk factors, and associated planning costs; and (3) metrics for assessing progress toward meeting the goal that include measuring the effectiveness of capital investments. 	<p>Comments: Naval Sea Systems Command produced a <i>Shipyard Infrastructure Optimization Plan</i> in February 2018 to guide the overhaul and improvement of the naval shipyards. This plan includes some of the recommended elements but not others.</p> <ul style="list-style-type: none"> (1) The plan includes some goals for the desired shipyard condition and capabilities including to: recover almost 70 maintenance periods over the next 20 years, modernize capital equipment to industry standards, optimize facilities, and reduce travel time. Navy officials stated the program office is in the process of creating digital maps of the yards to use in modeling facility layouts to identify the optimal layout. The Navy states that the optimal layout will recover 328,000 man days per year, a 65 percent reduction of travel and movement. (2) The report includes a preliminary cost estimate, but work is under way to determine the full costs to address all relevant requirements, risk factors, and planning costs. The plan identifies risks that could increase costs, but does not identify solutions to address those risks. Program officials said they will develop plans to address the risks in subsequent phases of the planning effort. The risks Navy officials identified included historical preservation, environmental regulations, and the need for extra capacity. (3) The plan did not include metrics for assessing progress toward meeting each of the goals. Navy officials stated that they intend to develop metrics to meet this element during a second phase that will be complete in fiscal year 2020. <p>To fully implement this recommendation, the Navy should complete its optimization plan, develop a reliable cost estimate addressing all relevant requirements, risks, and planning costs, and develop metrics to help it assess progress towards meeting its goal that include measuring the effectiveness of capital investments.</p>
<p>Recommendation 2: The Secretary of the Navy should conduct regular management reviews that include all relevant stakeholders to oversee implementation of the plan, review metrics, assess the progress made toward the goal, and make adjustments, as necessary, to ensure that the goal is attained.</p>	<p>Status: Open—Priority Recommendation</p>
<p>Recommendation 2: The Secretary of the Navy should conduct regular management reviews that include all relevant stakeholders to oversee implementation of the plan, review metrics, assess the progress made toward the goal, and make adjustments, as necessary, to ensure that the goal is attained.</p>	<p>Concurrence: Yes</p>

**Appendix I: Status of Recommendations from
Naval Shipyards: Actions Needed to Improve
Poor Conditions that Affect Operations (GAO-
17-548) as of August 2019**

Recommendation	Recommendation status, concurrence, and comments
<p>Recommendation 2: The Secretary of the Navy should conduct regular management reviews that include all relevant stakeholders to oversee implementation of the plan, review metrics, assess the progress made toward the goal, and make adjustments, as necessary, to ensure that the goal is attained.</p>	<p>Comments: To address this recommendation, the Navy issued NAVSEA Notice 5450 in June 2018. This notice established a new program management office responsible for planning, developing, scheduling, budgeting, and sustaining the replacement of shipyard facilities and equipment. By creating this office, the Navy has taken a first step toward establishing a result-oriented management approach and toward implementing our recommendation to conduct regular management reviews. In addition, the Assistant Secretary of the Navy for Research, Development, and Acquisition, in September 2018, required this new program office to provide regular updates to an Executive Oversight Council. These updates could serve as a foundation to address this recommendation.</p> <p>However, as noted in the report, the Navy has faced challenges involving all the relevant stakeholders in the plan’s implementation, namely the shipyards. In the absence of clear direction, the shipyards have worked with the program office to develop several informal collaboration mechanisms. For example, the program office and the shipyards have begun several shipyard-specific working groups and hold regular telephone calls. However, until the shipyards are formally involved in the implementation and assessment of the plan, the Navy will be unable to fully meet the direction of this recommendation to involve “all relevant stakeholders.”</p>
<p>Recommendation 3: The Secretary of the Navy should provide regular reporting to key decision makers and Congress on the progress the shipyards are making to meet the goal of the comprehensive plan, along with any challenges that hinder that progress, such as cost. This may include reporting on progress to reduce their facilities restoration and modernization backlogs, improve the condition and configuration of the shipyards, and recapitalize capital equipment.</p>	<p>Status: Open—Priority Recommendation</p>
<p>Recommendation 3: The Secretary of the Navy should provide regular reporting to key decision makers and Congress on the progress the shipyards are making to meet the goal of the comprehensive plan, along with any challenges that hinder that progress, such as cost. This may include reporting on progress to reduce their facilities restoration and modernization backlogs, improve the condition and configuration of the shipyards, and recapitalize capital equipment.</p>	<p>Concurrence: Yes</p>

**Appendix I: Status of Recommendations from
Naval Shipyards: Actions Needed to Improve
Poor Conditions that Affect Operations (GAO-
17-548) as of August 2019**

Recommendation	Recommendation status, concurrence, and comments
<p>Recommendation 3: The Secretary of the Navy should provide regular reporting to key decision makers and Congress on the progress the shipyards are making to meet the goal of the comprehensive plan, along with any challenges that hinder that progress, such as cost. This may include reporting on progress to reduce their facilities restoration and modernization backlogs, improve the condition and configuration of the shipyards, and recapitalize capital equipment.</p>	<p>Comments: DOD officials stated in October 2018 that the <i>Shipyards Infrastructure Optimization Plan</i>, along with the creation of the Readiness Reform Oversight Council, address this recommendation. While the Readiness Reform Oversight Council does appear to involve some of the key stakeholders who should be receiving the regular reporting, the Navy has already made clear that it sees the shipyard optimization process as a 20-year-long effort. Given that, regular reporting on progress cannot be achieved with a single disclosure at the beginning of the effort. Both Congress and DOD decision makers need to receive regular updates on the implementation of the shipyard optimization plan, and while it is possible that the newly created Shipyards Program Management Office will be able to provide such reporting, that organization is still being developed and, to date, no progress reporting has yet begun.</p>

Source: GAO analysis of Navy documentation and interviews with Navy officials. | GAO-20-64

^aPriority recommendations are designed to help agency heads focus on the most important challenges facing their departments. These recommendations have the greatest potential to help agencies accomplish vital missions, such as those involving public health and safety; save money; and address challenges highlighted by GAO's High Risk List and Overlap and Duplication work.

Appendix II: The Navy's Workload Management Plan Identifies Efforts to Address Shipyard Capacity Issues, but Success Depends on Optimistic Assumptions

The Navy's Workload Management Plan Includes Efforts to Address Capacity Issues at the Public Shipyards That Have Contributed to Maintenance Delays and Lost Operational Days

The Navy released a 5-year plan for depot maintenance on submarines in December 2018, for fiscal years 2020 through 2024.¹ The workload plan identifies efforts to address shipyard capacity issues across the nuclear-maintenance enterprise. According to the workload plan, the root cause of submarine idle time and associated loss of operational availability is largely that public shipyard capacity is not keeping pace with growing maintenance requirements. As a result, the public shipyards have historically struggled to complete maintenance on time, as shown in table 4.²

Table 4: Shipyards Completing Maintenance Periods Late, Fiscal Years 2007 through 2017

Percent

¹Secretary of the Navy, *Report to Congress on Submarine Depot Maintenance* (Dec. 27, 2018). The report was mandated in H.R. Rep. No. 115-769 (2018), accompanying a bill for the Department of Defense fiscal year 2019 appropriations.

²GAO, *Military Depots: Actions Needed to Improve Poor Conditions of Facilities and Equipment that Affect Maintenance Timeliness and Efficiency*, [GAO-19-242](#) (Washington, D.C.: Apr. 29, 2019).

Appendix II: The Navy's Workload Management Plan Identifies Efforts to Address Shipyard Capacity Issues, but Success Depends on Optimistic Assumptions

Shipyard	Percentage of maintenance periods completed late
Norfolk	64
Pearl Harbor	84
Portsmouth	71
Puget Sound	71

Source: GAO analysis of Navy data. | GAO-20-64

As we have previously reported, maintenance on ships and submarines may be delayed as a result of a number of factors, such as workforce gaps and inexperience, the poor condition of facilities and equipment, parts shortages, changes in planned maintenance work, and weather.

The Navy's workload plan discusses several efforts to improve maintenance performance at the public shipyards.

- **Increasing hiring for the public shipyards.** The Navy hired over 20,600 workers during fiscal years 2013 through 2018. After accounting for attrition, these hires increased total end strength from 29,400 to 36,700.
- **Accelerating training for new employees.** The effect of significant attrition and hiring resulted in approximately 56 percent of the shipyard production workforce having fewer than 5 years' experience. The public shipyards implemented new approaches for accelerating training to develop skills in a relatively inexperienced workforce.
- **Accounting for new employees' lower proficiency and productivity.** Shipyard officials have noted that employees with less than 5 years' experience are generally not as skilled or productive as more experienced personnel. The Navy has established more realistic maintenance planning parameters to account for the lower proficiency and productivity of recently hired, less experienced workers.
- **Improving the definition of workload requirements.** Naval Sea Systems Command (NAVSEA) evaluated technical and program maintenance requirements with stakeholders in the maintenance community to identify and address barriers to on-time completion. Among the areas evaluated were time and condition-based maintenance strategies; logistic strategies; work estimating processes; shipyard overtime levels; and technology strategies.
- **Improving material reliability and availability.** The Navy is taking actions such as updating class maintenance plans; identifying and tracking frequently needed parts to determine appropriate acquisition

strategies; creating an improved material forecasting tool; and moving material closer to the user.

- **Balancing the submarine maintenance workload across the public and private shipyards.** The Navy identified two submarines for which maintenance could be outsourced to Electric Boat or Huntington Ingalls over the next 5 years, in addition to the four submarines for which maintenance is currently outsourced.

The Success of the Navy's Submarine Workload Management Plan Depends on Optimistic Assumptions

The workload plan contains some optimistic assumptions which may jeopardize achieving the intended benefits. According to the Navy's workload plan, the Navy's efforts identified above are intended to eliminate all submarine idle time and fully address the submarine maintenance backlog by fiscal year 2023. However, success of the plan depends on the public and private shipyards and the Navy realizing improvements in their performance that they have not yet demonstrated. For example:

- **On-time completion of submarine maintenance, at both the public and private shipyards.** The workload plan states that on-time completion of submarine maintenance, at both the public and private shipyards, is critical to eliminating submarine idle time and the submarine maintenance backlog. However, this assumption may not be realistic in light of recent performance at public and private shipyards. As discussed above, on average the public shipyards have completed maintenance on time only about 26 percent of the time between fiscal years 2007 and 2017. Of the three submarine maintenance periods that were allocated to the private shipyards between fiscal years 2015 and 2018, all three are projected to be completed about a year late, according to Navy reports. Officials with both Electric Boat and Huntington Ingalls have acknowledged the delays, which they attribute to an inexperienced workforce, lack of capital investment, and the submarines being in worse condition than expected.³ These officials also stated that if the Navy were to provide them with regular submarine repair work, they would expect their repair times to improve as their planning process matures and their workforce gains experience.

³As we have noted in previous reports, these problems also cause delays at the public shipyards. See [GAO-17-548](#), [GAO-19-51](#), and [GAO-19-242](#).

- **Timely implementation of the Navy's Shipyard Infrastructure Optimization Plan.** Dry dock projects outlined in the *Shipyard Infrastructure Optimization Plan* must be completed on schedule, or else the Navy will not have the capacity to conduct some of its anticipated maintenance.⁴ This would in turn result in additional idle time and backlog. Some projects, such as the multimission dry dock project in Portsmouth, require the completion of earlier projects in order to proceed. Anything that disrupts the schedule of the earlier project could also affect the schedule of the later project. Given that the Shipyard Infrastructure Optimization Plan describes a 20-year-long effort that, at present, does not have clear organizational roles and responsibilities or a complete accounting of all the costs, it is possible that the gains it is intended to produce will take longer than expected to materialize.

⁴Naval Sea Systems Command, *Report to Congress: Shipyard Infrastructure Optimization Plan*, SEA 04 (Feb. 12, 2018).

Appendix III: Comments from the Department of Defense

Appendix III: Comments from the Department
of Defense



THE ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, DEVELOPMENT AND ACQUISITION)
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

NOV 18 2019

Ms. Diana Maurer
Director, Defense Capabilities Management
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Ms. Maurer,

This is the Navy's response to GAO Draft Report GAO-20-64SU, "Key Actions Remain to Improve Infrastructure to Better Support Navy Operations," dated September 17, 2019 (GAO Code 103070). The Navy has completed written comments, technical comments, and a security assessment for this draft report, each of which is included as an attachment to this letter.

My point of contact for this matter is B. Anderson, DASN Ships, (703) 697-1710, bilyana.anderson@navy.mil.

Sincerely,


James F. Geurts

Attachments:
As Stated

GAO DRAFT REPORT DATED SEPTEMBER 17, 2019
GAO-20-64SU (GAO CODE 103070)

“NAVY SHIPYARD: KEY ACTIONS REMAIN TO IMPROVE INFRASTRUCTURE
TO BETTER SUPPORT NAVY OPERATIONS”

DEPARTMENT OF DEFENSE WRITTEN COMMENTS
TO THE GAO RECOMMENDATION

RECOMMENDATION 1: The GAO recommends that the Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555) include all costs—such as costs for program office activities, utilities, roads, environmental remediation, historical preservation, and alternative workspace—when developing its second, more detailed, cost estimate.

DoD RESPONSE: Concur. The Navy is working parallel paths executing a modeling and simulation effort to develop a digital twin of the shipyards, as well as a review of all infrastructure requirements to include utilities, rail and crane trackage, roads, historic and cultural resources, environmental mitigation, swing space requirements, etc. These efforts will inform the shipyard Area Development Plans (ADP), integrating all costs associated with executing the Shipyard Infrastructure Optimization Plan (SIOP).

RECOMMENDATION 2: The GAO recommends that the Secretary of the Navy should ensure that the shipyard optimization program office (PMS 555) uses cost estimating best practices—as outlined in GAO’s Cost Estimating and Assessment Guide—in developing its second cost estimate, including program baseline, work breakdown structure, a description of the methodology and key assumptions, inflation, fully address risk and uncertainty, and a sensitivity analysis.

DoD RESPONSE: Concur. As the program continues to mature, so will the complexity, detail, and accuracy of the program cost estimate. The second program estimate will be completed in conjunction with the ADPs, and follow cost estimating best practices.

RECOMMENDATION 3: The GAO recommends that the Secretary of the Navy should ensure that the Shipyard Optimization Program Office (PMS 555) obtains an independent cost estimate of the program prior to the start of its project prioritization effort.

DoD RESPONSE: Concur. The Navy agrees with the intent of completing an independent cost estimate/review prior to starting project prioritization efforts.

RECOMMENDATION 4: The GAO recommends that the Secretary of the Navy should ensure that the Shipyard Optimization Program Office (PMS 555) in coordination with relevant stakeholders, establishes clear roles and responsibilities for the shipyards involved in the Shipyard Infrastructure Optimization Plan.

Attachment (I)

DoD RESPONSE: Concur. The establishment of roles and responsibilities will be a recurring coordinated process. The PMO approval package establishes business rules and includes roles and responsibilities for the shipyards, Program Office and the PMOs.

Technical Correction: In its draft report, GAO states the following on page 29: “The program office has since hired 30 new staff members”

The Navy recommends rewording the sentence to read: “The program office has received funding in Fiscal Year 2020 (FY20) to begin hiring personnel to strengthen the headquarters staff. In FY20, each PMO will be able to hire personnel to establish an initial capability at each naval shipyard. As the program matures, resources will be reevaluated and adjusted to fulfill the established roles and responsibilities and execute projects at each of the four naval shipyards.

Attachment (I)

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Diana Maurer, (202) 512-9627 or maurerd@gao.gov

Staff Acknowledgments

In addition to the individual named above, key contributors to this report are Suzanne Wren, (Assistant Director), James Lackey and Cody Raysinger (Analysts-in-Charge), A. Steven Bagley, Anna Irvine, Jennifer Leotta, Amie Lesser, Felicia Lopez, Carol Petersen, Michael Silver, and William Tedrick.

Appendix V: Accessible Data

Data Table

Accessible Data for Figure 5: Comparison of the Projected Inventory of Nuclear-Powered Ships under the Navy's 2017 and 2020 Shipbuilding Plans

Fiscal year	2017 plan	2020 plan
2017	81	na
2018	82	na
2019	81	na
2020	81	81
2021	80	82
2022	78	81
2023	79	80
2024	78	76
2025	76	72
2026	72	70
2027	69	65
2028	66	65
2029	64	66
2030	64	67
2031	65	69
2032	64	70
2033	65	72
2034	66	74
2035	67	75
2036	68	77
2037	69	78
2038	68	77
2039	68	78
2040	67	78
2041	68	80
2042	71	82
2043	71	83
2044	72	84
2045	72	86

Fiscal year	2017 plan	2020 plan
2046	73	87
2047	na	88
2048	na	89
2049	na	92

Agency Comment Letter

Accessible Text for Appendix III Comments from the Department of Defense

Page 1

NOV 18 2019

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Director, Defense Capabilities Management

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James F. Geurts

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As Stated

Page 2

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(GAO CODE 103070)

"NAVY SHIPYARD: KEY ACTIONS REMAIN TO IMPROVE
INFRASTRUCTURE TO BETTER SUPPORT NAVY OPERATIONS"

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Page 3

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Related GAO Products

Military Depots: Actions Needed to Improve Poor Conditions of Facilities and Equipment That Affect Maintenance Timeliness and Efficiency. [GAO-19-242](#). Washington, D.C.: April 29, 2019.

DOD Depot Workforce: Services Need to Assess the Effectiveness of Their Initiatives to Maintain Critical Skills. [GAO-19-51](#). Washington, D.C.: December 14, 2018.

Navy and Marine Corps: Rebuilding Ship, Submarine, and Aviation Readiness Will Require Time and Sustained Management Attention. [GAO-19-225T](#). Washington, D.C.: December 12, 2018.

Navy Readiness: Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet. [GAO-19-229](#). Washington, D.C.: November 19, 2018.

Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments. [GAO-18-238SP](#). Washington, D.C.: June 6, 2018.

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Naval Shipyards: Actions Needed to Improve Poor Conditions that Affect Operations. [GAO-17-548](#). Washington, D.C.: September 12, 2017.

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DOD's 2010 Comprehensive Inventory Management Improvement Plan Addressed Statutory Requirements, But Faces Implementation Challenges. [GAO-11-240R](#). Washington, D.C.: January 7, 2011.

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