

PRELIMINARY ENGINEERING ASSESSMENT

for the

REHABILITATION OF THE LIGHTSHIP NO. 83

Northwest Seaport

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EXECUTIVE SUMMARY

This Preliminary Engineering Assessment (PEA) was prepared for a rehabilitation project funded by a federal Transportation Enhancement Act grant. The grant was awarded to Northwest Seaport, a non-profit maritime heritage and preservation group, for rehabilitating its historic vessel the Lightship No. 83. Old Tacoma Marine Inc was selected as a contractor to assess the vessel's current condition and make recommendations for priority rehabilitation projects.

OTM Inc reviewed previous restoration projects and conducted a condition survey, which determined that the main agent of deterioration affecting the vessel is rain water infiltrating from leaks in the deck. It then consulted with both NWS and marine repair companies to determine restoration priorities for the vessel. The two main priorities identified through this process are to replace the wooden deck and to begin repairing the steel hull.

OTM Inc was asked to evaluate three deck replacement choices for the PEA: a traditional planked and caulked deck, a plywood composite deck and a steel deck. The company determined that the traditional planked and caulked option is the best, for its authenticity, durability, suitability to the unique properties of the Lightship No. 83, and ease of maintenance and repair.

OTM Inc also evaluated restoration options for the Lightship No. 83's steel hull. Three audio-gauge tests have been performed on the hull within the past two decades, each of which showed the steel plates in stable condition. Through previous experience with historic steel hulls and consultation with industry experts, OTM Inc determined that restoration of the hull is best accomplished through planned long-term repair and maintenance, consisting of systematic scaling and patching. The beginning of this repair process should be accomplished at the end of this rehabilitation project.

OTM Inc identified three other priorities for the rehabilitation project: enhancing the basic safety of the Lightship No. 83, abating hazardous substances such as asbestos and lead, and restoring key onboard systems. Addressing these issues will contribute to making the vessel accessible and authentic to visitors, as befits its status as a heritage vessel and National Historic Landmark, and facilitate future restoration projects.

OTM Inc has designed the recommendations described in this document to build on each other, with one recommended project supporting the next. Northwest Seaport will need to determine the exact sequence of these events, but the recommendations will mediate known hazards for safe access to the Lightship No. 83, restore some shipboard systems, replace the deck, and begin the long-term restoration of the hull.

At the end of this Preliminary Engineering Assessment, OTM Inc includes recommendations for projects following the rehabilitation project. These recommendations are made with both vessel preservation and NWS's mission in mind. The most important recommendation is a long-term maintenance plan, to preserve the work accomplished by the rehabilitation project.

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INTRODUCTION

Northwest Seaport (NWS) hired Old Tacoma Marine Inc (OTM Inc) to prepare a preliminary engineering assessment (PEA) on the historic Lightship No. 83. This PEA is conducted as part of Phase One of a federal Transportation Enhancement Act (TEA) grant disbursed through the Washington State Department of Transportation (WSDOT). The grant's stated purpose is "to rehabilitate the Lightship No. 83 for use as a heritage vessel and to provide public programming."

The results of this PEA are to be used as guidance by NWS and future consultants for decision-making on how to conduct rehabilitation activities of the Lightship No. 83 and to prioritize shipyard work. This PEA was prepared with the Secretary of the Interior's Standards for Historic Vessel Preservation Projects as a guideline for maintaining the vessel's authenticity and significance.

The objectives of this PEA are to:

- Review grant documents and the preservation approach for the Lightship No. 83 to become familiar with project goals
- Review past work such as audio-gauge tests for plate thickness and conduct an assessment of the current condition of the vessel and its parts relevant to the grant
- Create a prioritized list of work items to be completed under grant commensurate with vessel stability, preservation, restoration and safety
- Consider preservation of as much historic fabric as is possible and in accordance with federal, state and Seattle standards for historic landmark preservation
- Recommend a course of action on how work items should be accomplished and describe recommended methods and provide estimates of labor and materials

SCOPE OF WORK

The recommendations within this PEA follow an assessment of the vessel's current condition, its major agents of deterioration and NWS's stated mission of preservation, interpretation, and educational programs. They are designed to accomplish major restoration projects under the federal TEA grant and do not take into account the necessary maintenance and programming important to long-term preservation.

The price estimates attached to these recommendations are based on current prices listed by local companies and contractors. OTM Inc feels that these are representative of local market values, but did not conduct an extensive price comparison. The company also did not perform any investigation into or planning for inflation or raising prices of materials, as the recommendations in this document are designed to be used immediately.

METHODS

OTM Inc prepared this Preliminary Engineering Assessment using several sources of information, including:

- A review of the *Secretary of the Interior's Standards for historic Vessel Preservation Projects with Guidelines for Applying the Standards*
- A review of previous restoration activities aboard the Lightship No. 83, using NWS's archival materials and other resources
- Consultations with NWS representatives to determine organizational goals and priorities for restoration and preservation activities
- Creating a condition report of the Lightship No. 83 noting the current condition and needle-scaling sample areas of the hull for an accurate determination of corrosion
- Consultations with community experts in marine repair to determine priorities and methods for preservation and restoration

OTM Inc's consultants included:

- Dan Grinstead of Ace Tugboat LLC, Seattle
- Shipwrights Brian Johnson and Kristin Stahl-Johnson of Ocean Bay Marine Inc
- Executive Director Dierk Yochim of Northwest Schooner Society
- Marine electrician Mike Harding of Omega Marine Electric Inc
- Building inspector Bruce Thoreen of JT Environmental
- Kevin and Frank of Alexander Gow Inc
- Manager Doug Dixon and foreman Chris Johnson of Pacific Fisherman Inc
- Foreman Ed Ehler of Northlake Shipyard
- President Peter Kelley of Northlake Shipyard
- Welder Glen MacDonald of General Specialties Inc
- Marine surveyor Lee Earhart of Havorn Marine Inc
- Jim Stansfeld of Big Claw Maritime
- Michael Vlahovich of Coastal Heritage Alliance
- Steam Engineer Keith Sternberg
- Carpenter Jonathan Kinsey
- Fireman Gary Frankel of the *Virginia V* Foundation
- Estimators Bill Thornton and Turbo Ruiz of One-Step Environmental Abatement LLC.

OTM Inc used this information and its previous experiences in major marine repair and historic ship restoration projects to create a prioritized list of rehabilitation activities for the Lightship No. 83.

BACKGROUND OF LIGHTSHIP NO. 83

The Lightship No. 83, owned by NWS, is one of only a few remaining vessels that represent a past era of navigation technology. The United States Lighthouse Service and later the United States Coast Guard built over 150 lightships in a 165-year span. According to the Harbour Lights Archives (<http://www.harbourlightsarchives.com/lightships/index.htm>), only 15 American lightships remain afloat, most of them in museum collections. As a museum ship, the Lightship No. 83 is a valuable artifact to preserve and interpret for future generations. This section gives a brief background of the vessel's history and the restoration activities it has undergone since being decommissioned in 1960, using resources in NWS's archives.

Also, a brief note on naming: nearly all lightships have had numerous different designations during their careers that reflect changes in assigned stations. The Lightship No. 83 carried the designations *Blunts Reef*, *San Francisco*, and *Relief* during its working career, and is now designated as *Swiftsure* to reflect the closest lightship station to its moorage in Seattle. Additionally, many lightships had two numerical designations, one assigned by the United States Lighthouse Board and one by the United States Coast Guard after the agencies merged in 1939. In an attempt to eliminate confusion, NWS's lightship is referred to in this report as Lightship No. 83, the original unique number assigned to the vessel by the United States Lighthouse Board in 1904.

SIGNIFICANCE

As with any recognized historic vessel, the Lightship No. 83 has a number of unique characteristics that make it highly significant to local and regional history. These characteristics are recognized and reinforced by its 1989 designation as a National Historic Landmark.

During the National Historic Landmark examination process, the Lightship No. 83 was found to be the best example of the second generation, steam-propelled lightships produced in the early 20th century. It is the last remaining American lightship to retain its original steam engine, as other surviving lightships were converted to diesel power.

The Lightship No. 83 also served at all five of the West Coast lightship stations: Blunts Reef and the San Francisco Bar as the primary lightship, and at the Swiftsure Bank, Umatilla Reef, and the Columbia River Bar as a Relief vessel.

HISTORY

A key part of any historic ship is its individual history. A detailed description of the Lightship No. 83's career is given in the March 1996 issue of the *Sea Chest*, the journal of the Puget Sound Maritime Historical Society. What follows here is a brief summary of its 103-year history.

BUILT

The Lightship No. 83 was built by the New York Shipbuilding Co. in Camden, New Jersey in 1904, for a cost of \$90,000. It was one of five vessels built to the same specifications, clipper-bowed

with riding sails to stabilize the ship in rough seas. These second-generation steam lightships used vertical, surface condensing compound steam engines with 16- and 31-inch bores and 24-inch strokes. The vessels displaced approximately 600 tons, with a fuel capacity of 150 tons of coal.

After being launched, the Lightship No. 83 made the 110-day voyage around Cape Horn with sister ship #76, arriving in June 1905 at the new Blunts Reef lightship station north of San Francisco.

SERVED

During its years at the Blunts Reef station, the Lightship No. 83 was dragged off post in severe weather several times before being fitted with a new anchor, rescued 155 survivors from the liner *Bear* when it was driven onto the rocks at Cape Mendocino in 1916, and rammed by the steam schooner *Del Norte* in 1920. During this time, it was also electrified, replacing its original whale-oil lamps and receiving a radio set in 1918, and getting a radio fog signal installed in 1923.

The Lightship No. 83 served at Blunts Reef until 1929, when it was re-designated and moved to the San Francisco Bar station, replacing the deteriorating Lightship #70. In 1934, its original coal-fired steam boilers were replaced by oil-fired boilers, while in 1936 a powerful steam-powered diaphone fog horn replaced its original steam whistle. This diaphone was later converted to run on compressed air to conserve water, and in 1937 its old lamp houses and pilot houses were replaced with a radio house and new pilot house and master's cabin. In 1939, the United States Coast Guard assumed management of the lightship fleet. The Lightship No. 83 was re-designated WAL #508 to reflect this change, though it continued to serve at the San Francisco lightship station.

In the face of Japanese hostilities after the bombing of Pearl Harbor, the Coast Guard blacked out its coastal navigation aids and withdrew its lightships from their stations. The Lightship No. 83 was assigned to the Navy and designated as an "examination vessel" used for training and inspection out of San Francisco. Its bell and lights were removed and replaced with a 3" gun on its forward deck, .50 caliber machine guns on its bridge and fantail, and a Y-gun on its afterdeck to fire depth charges. At the same time, it was outfitted to carry a crew of 40—much larger than it carried as a lightship. While the Lightship No. 83 was assigned to week-long patrols in the Farallon Islands, it did not see any action during the war.

After the war ended in 1945, it was returned to the Coast Guard and refitted as a lightship, then continued to serve at the San Francisco lightship station. In 1951, it was replaced at that post by a newer lightship in better condition, and reassigned to the 13th Coast Guard District based in Seattle. It was re-designated as a relief vessel for the three lightship posts in that district: the Swiftsure Bank, the Umatilla Reef, and the Columbia River bar. While not on these stations, it spent its time in Seattle on the Coast Guard's ship canal base.

In 1959, the Lightship No. 83 suffered severe damage during a winter assignment. The Coast Guard deemed the vessel not cost-effective to repair, and it was decommissioned on July 18, 1960.

RETIRED, DONATED, SOLD

After decommissioning, the Lightship No. 83 became eligible for donation to non-profit maritime heritage groups. Among the groups that expressed interest was the San Francisco Maritime Park, but the group that was ultimately successful was the Relief Lightship Guild, Inc., specifically formed to preserve and interpret the Lightship No. 83. After a one-year probationary period to establish the organization's viability, the Coast Guard transferred title to the Guild in 1963.

Almost immediately, the Guild encountered difficulty in securing funding for restoration and long-term maintenance. After the Guild failed to pay several of its bills, the Nordby Supply Company filed suit against the corporation. While the Guild made plans to lease the Lightship No. 83 to an organization called Save Our Ships (an organization founded to restore and interpret historic ships, later renamed NWS), ultimately the vessel was seized by the U. S. Marshals and auctioned off to pay its debts.

At auction, Save Our Ships was able to obtain the Lightship No. 83 with the help of a C. Daniel Palzer, Jr. Together they purchased the vessel for \$2,931 on April 4, 1966.

HERITAGE VESSEL & NATIONAL HISTORIC LANDMARK

Save Our Ships moored the Lightship No. 83 at Pier 54 on Seattle's downtown waterfront. In 1968, it joined the three-masted Pacific Schooner *Wawona* as a floating maritime history exhibit. Later, the organization acquired the historic wooden tugboat *Arthur Foss*, forming a fleet of historic vessels open to the public. The vessel was designated a Seattle City Landmark in 1977, reflecting its significance to the city and Puget Sound region.

The organization later changed its name to NWS and later moved its historic fleet to Kirkland, on the northeast shore of Lake Washington. Here, the boats remained open to the public on a limited basis, and underwent volunteer-led restoration projects.

In 1989, NWS's historic fleet was moved to the Naval Reserve Building on Seattle's Lake Union, the site of a planned maritime heritage center. The ships, including the Lightship No. 83, remained open to the public and undergoing periodic restoration at the new site. In the same year, the Lightship No. 83 and the *Arthur Foss* were designated National Historic Landmarks, confirming their historic significance to the region and the nation. NWS also entered into a partnership with the Coast Guard Auxiliary to use the vessel for official purposes such as meetings and classroom space, in exchange for supervising restoration activities and providing volunteers.

In the early 1990s, NWS launched a major campaign in partnership with the Seattle Yacht Club, the MARCO Shipyard, and other organizations to restore the Lightship No. 83. This plan centered on the famous Swiftsure Yacht Race held annually in the Strait of Juan de Fuca that used the Swiftsure lightship as a marker for one leg of its race. As the only remaining lightship that served on the Swiftsure station (while designated as the *Relief*), the Lightship No. 83 would be fully restored, re-designated *Swiftsure*, and used as a mobile maritime museum in the greater Puget Sound region.

In order to attract attention to the campaign, NWS changed the Lightship No. 83's station designation to *Swiftsure* and recognized the re-designation in a Coast Guard ceremony held on September 17, 1995. However, the partner organizations failed to attract the funding necessary to continue the plan, as NWS and other maritime heritage groups focused their attention on establishing a permanent center for maritime heritage around the Naval Reserve Building.

In 2003, the heritage wharf at South Lake Union Park became a permanent home to the Lightship No. 83. It has been moored there since the wharf was completed.

PREVIOUS PRESERVATION ACTIVITY

There have been several different preservation and restoration projects proposed and performed on the Lightship No. 83 since being acquired by NWS (formerly Save Our Ships). None of these projects are well-recorded with detailed descriptions and photographs, but documents in NWS's archives give a general idea of the work performed. Additionally, several major projects were proposed but never implemented. This section is an attempt to provide a brief background of previous work performed on the Lightship No. 83.

1969 – DUWAMISH SHIPYARD WORK

The Lightship No. 83 was dry-docked at the Duwamish Shipyard in Seattle in October 1969, in the first recorded preservation work performed on the vessel since its retirement. For this work, Duwamish Shipyard provided the labor, equipment, and material to:

- Perform an underwater survey and repairs
- Sandblast and paint the hull bottom
- Remove the propeller and install a cap on the stern tube
- Install three doublers over damaged portions of the hull
- Remove two freezers from the vessel

These repairs are documented in a Duwamish Shipyard invoice and in the 1987 condition survey performed by Harold D. Huycke, both available in the NWS archives.

While the Lightship No. 83's propeller remained at the Duwamish Shipyard for many years after its removal, the shipyard closed in 2007. The propeller's current location is unknown.

1977 – VOLUNTEER RESTORATION

The next recorded restoration work performed on the Lightship No. 83 was a major volunteer-led effort coordinated by volunteer John Snow, the first in the vessel's history. This project began by thoroughly cleaning the vessel, removing dust and cobwebs, and ultimately accomplished the following between 1977 and 1979:

- Installed new smokestack cover
- Painted hull
- Ran main diesel compressor to provide air for chipping rust
- Redid roof of pilothouse and captain's cabin, fixing leaks
- Refinished inside of pilothouse

- Scraped and painted two forward heads and shower room
- Painted galley and mess deck
- Scraped and painted one display companionway,
- Scraped and painted half of other companionway
- Cleaned and scraped inside hull of engine room
- Finished one quarter of the radio shack
- Finished deck winch almost done and rear skylight

Additionally, all extra gear from the schooner *Wawona* was stored below decks on the Lightship No. 83 at this time. This restoration period is documented by a newspaper article profiling Snow's work on the lightship, and by a NWS report, both available in the organization's archives.

1987 – CONDITION SURVEY

In 1987, NWS hired Harold D. Huycke, a local marine surveyor, to perform a condition survey of the Lightship No. 83 and make recommendations to improve the safety of the vessel at its Kirkland moorage.

The full condition survey is located in NWS's archives. Briefly, Huycke found that:

- The hull appeared in generally good condition, though weather-beaten and worn, with scattered areas of flaked paint
- The condition of the deck planking was generally poor, with very rotted planks scattered fore and aft, port and starboard
- There was evidence of extensive leaking in the shelter deck area.
- All cabins, lockers, and compartments below the main deck were generally intact
- There was extensive deterioration beneath leaking portions of the main deck, with rotted paneling, molding, and decorative woodwork
- The equipment was generally intact, though the machinery had not been operated (aside from one diesel auxiliary generator on the starboard side)
- The bilge pumps were reportedly operational, but had not been operated or tested recently
- The fire extinguishers and smoke alarms were out of date and had not been serviced
- Asbestos was used for the lagging (insulation) in all engine room hot piping
- The vessel lacked a suitable gangway for visitor access

Additionally, Huycke noted that the decks were made from caulked planking laid over steel beams.

Huycke then made several recommendations. The most relevant to mention are:

- The vessel should be dry docked at earliest convenience for a complete underbody survey and audio-gauge tests
- The vessel should have bilge pumps installed in the lowest accessible bilges of each of three compartments

- The vessel should have existing fire extinguishers and fire detectors serviced and new ones installed
- The vessel should have signs warning of the asbestos present
- The wooden main deck should be covered with marine grade 3/8" plywood as temporary covering until major and extensive repairs are accomplished
- The vessel should have a suitable gangway constructed and installed

1988 – HULL SURVEY

In 1988, local diver Matt Kramer tested the Lightship No. 83's underwater hull thickness with audio-gauge equipment. He reported that the hull plates seem to have originally been 3/8 (.375) of an inch thick, and that they now appeared to average approximately 5/16 (.313) inches thick. He also noted that the hull appeared sound under a thin layer of corrosion.

This summary is available in NWS's archives. A more detailed version of the findings was not found.

1989 – LIGHTHOUSE 50/50 GRANT

In 1989, NWS received a \$7,200 federal grant from the Historic Preservation Fund Lighthouse Program, which commemorated the United States Lighthouse bicentennial, to begin restoring the Lightship No. 83. NWS matched this grant with \$9,595 in private contributions, for a total budget of \$16,795. Following Huycke's recommendations, the project goals were to:

- Waterproof the weather deck and deck houses
- Seal or remove the asbestos in the engine room
- Outfit the vessel for shore power
- Install bilge pumps

At the end of the project, NWS had spent \$23,028.73 and successfully:

- Sealed "probably 99%" of the weather deck leaks
- Built new roofs for the deck houses, making them water tight
- Restored the skylights, preventing the need for plastic covers in rainy weather
- Identified and encapsulated or removed asbestos in the engine room
- Repaired electrical systems to eliminate unsafe wiring
- Installed an emergency bilge pump and alarm system

These repairs are documented in the original grant application and a 1989 report in NWS's archives. A more detailed final report mentioned in the folder was not found.

1990 – FOSS SHIPYARD WORK

In 1990, NWS was awarded a \$22,000 grant from the State of Washington Department of Community Development Office of Archaeology and Historic Preservation for further restoration of the Lightship No. 83. The organization matched these funds with \$7,540 contributed labor, \$4,000 contributed management, and \$11,221 contributed private funds, and received a bid from Foss Maritime Company to perform the following work:

- Dry-dock the vessel
- Sandblast and paint the vessel's bottom
- Sandblast and paint the vessel's sides
- Perform an audio-gauge thickness test
- Remove and clean display anchor chain
- Open, inspect, hand-lap, reassemble, and repack two 4" gate valves and one 1" gate valve on the port sea chest, and two 3" gate valves on the starboard sea chest
- Possibly blank off sea valves no longer in use with a welded plate at the hull shell

The grant application and acceptance letters, as well as the bid from Foss Maritime, are located in NWS's archives. OTM Inc obtained the final invoice for the work performed by Foss Maritime (valued at \$32,779) from the company's archives. It lists the work as:

- Towing from the Salmon Bay USCG base to Foss Shipyard and back
- Dry-docking the vessel
- Inspecting the hull prior to pressure-washing
- Sandblasting, patching the hull in areas deemed badly deteriorated by the hull inspection and painting the bottom with anticorrosive paint
- Audio-gauge testing to determine "as found" thickness of the hull shell plate thickness
- Opening, inspection, hand-lapping, reassembly and repacking of two 4" gate valves and one 1" gate valve on the port sea chest, and two 3" gate valves on the starboard sea chest

The invoice also includes a note regarding the bottom patching that reads: "Inspection revealed hull to be badly deteriorated; repairs were made to the hull that were comprised of patching the leaking rivets and holes in the plate with Marine Tex; note: this was not the recommended method (as stated in the attached letter) but was accomplished according to specific instructions from the customer's representative." The recommended method was to patch the hull using welded doublers as had been used during the Duwamish Shipyard work in 1969. No reason is given for why the recommended method was discarded in favor of using Marine Tex.

The invoice does not address the above-the-waterline painting, removing and cleaning anchor chain, and blanking off of the sea valves mentioned in the original bid appear. No further documentation of this work, such as a final report or photographs, were found.

1996 – SWIFTSURE REBORN

In 1996, the Lightship No. 83 underwent minor work in preparation for the anticipated \$300,000 "Swiftsure Reborn" campaign. The project proposed the following work:

- Remove deck houses and rebuild to their 1950-1959 configuration
- Tow vessel to MARCO shipyard for cleaning, repairs, and painting
- Repair deck support beams
- Install new weather deck
- Change hull lettering from *Relief* to *Swiftsure*

- Attract skilled and unskilled volunteers to perform more work
- Build museum displays around the themes of sailing, lightships, and the coast guard services

While the proposed major restoration was never accomplished, MARCO shipyards performed an audio-gauge hull thickness survey in 40 locations and found the hull “adequate” for undertaking the work. Additionally, the hull lettering was changed from *Relief* to *Swiftsure*. Detailed proposals and marketing materials for the Swiftsure Reborn campaign is located in NWS’s archives.

1998 – PARTIAL DECK REPLACEMENT

In 1998, NWS replaced the aft 34 feet of the Lightship No. 83’s deck. The project bid submitted by staff shipwright Bill White states that the existing aft deck had been removed and the replacement material cut to specification. It further lists the goals of the project as to:

- Prepare the existing deck support beams
- Remove rivet ends from beams
- Create new holes to fasten decking to support structure
- Rabbit 100 plus pieces of 4x4 deck material to specification
- Align and install galvanized lag bolts into the underside of deck material (4-7 per deck plank)
- Join deck planks via a scarf between existing deck support beams.
- Install 32 pieces of pre-cut curved or angled deck material abutting the ship’s bulwarks, each with 2 to 5 lag bolts installed from the underside.
- Caulk the deck with oakum and pitch
- Sand the deck flush to finish surface specification

This project bid is located in NWS’s archives. No final report or photographs of this work was found, but a laborer hired on the project describes the work as using 4” by 4” hemlock beams. As the original deck used 3” x 3” fir planking, new bolt holes were drilled in the metal frames for fastening. The planks were attached to the frames using a modern marine-grade adhesive compound, and then the deck was caulked with oakum and hot tar as described in the proposal.

However, the shipwrights working on the project found that the hemlock beams had been poorly cured and began to crack and warp shortly after installation. To seal the leaks that developed as a result, 1” plywood was laid over the newly planked decks and painted. OTM Inc was unable to determine what fastening technique was used to attach the plywood to the planks.

CONDITION REPORT

As part of the Preliminary Engineering Assessment process, OTM Inc. inspected the Lightship No. 83 and reviewed historic records to compile a general condition report to guide restoration recommendations.

WALKTHROUGH

OTM Inc performed the walkthrough on December 17 and 18, 2007, both rainy winter days. It started on the bow deck and worked aft, then into the lower levels from compartment to compartment. This walkthrough helped OTM Inc identify agents of deterioration, problem spots, and the general condition of different spaces, especially the decks, houses, and major interior compartments. The walkthrough did not focus on the rigging except for where it attaches to the deck, as useful information about the rigging can be obtained only through going aloft. As the rigging and masts are uninspected and cannot be presumed to be safe, OTM Inc did not go aloft.

The write-up given here is a general account of the walkthrough. A detailed, space-by-space breakdown is provided in the attached condition report video, available in both miniDV tapes and DVD format. The accompanying data DVD disk also contains digital photography to accompany this video footage.

DECKS

OTM Inc inspected the wooden main deck with shipwright Brian Johnson of Ocean Bay Marine Inc, who used his knowledge of traditional wooden construction and repair to make an informed assessment of deck condition.

This inspection and assessment found the deck is in poor condition despite the 1998 replacement of the aft third. The original deck (forward two thirds) is close-grained Douglas fir planks, calked and pitched in the traditional manner. These planks are now covered in layers of paint and patches made from canvas and plywood. The coverboards around the deckhouses and fixtures (such as the smokestack and vents) and marginboards around the perimeter are very, very decayed. Many of these have been patched with lead sheets. The gutter around the deck is made from steel, which is severely wasted in many areas.

From below, the damage to the deck is very visible, as several areas are rotted through and covered with plywood. During the rainy days of the walkthrough, water visibly and audibly leaked through the original deck in countless areas. This water collected in any depression on the lower decks and in the different compartments.

The original deck is painted on the underside with grey lead-based paint. The metal frames to which the planks are fastened seem largely solid, but have layers of peeling paint and extensive surface rust built up in several areas.

The aft third of the deck, replaced in 1998, is in better condition than the original deck, but the hemlock planks show splitting and warping. Additionally, the plywood covering this

replacement is rotted and delaminating near the steering mechanism. Despite these issues, the Officers' Quarters beneath the replacement section shows no evidence of leaks.

DECKHOUSES

The Lightship No. 83 has two deckhouses: an original structure containing the Wheelhouse and Captain's Cabin, and a Radio Shack built after the 1998 deck replacement (no documentation of this process was found in the NWS archives).

The Wheelhouse has extensive scraped and peeling paint. The Captain's Cabin has evidence of water damage, as well as extensive mold and mildew on the walls and ceiling. Several of the corner posts and carlins (wooden foundations set onto the planked deck) have extensively rotted portions, and several areas in bottom edge of the walls are rotted away. Below the wheelhouse is a steering compartment floored with the original deck. This portion of the deck appears to be in good condition, despite evidence of water leaks, and can be knitted into a replacement deck if it is structurally sound.

The Radio Shack is constructed from pine studs and plywood. The walls and ceiling are in fair condition, but the carlins supporting the walls rest directly on the steel frames, detracting from the deckhouse's authenticity and putting the seams at risk for leaks. The deck beneath the Radio Shack contains the junction between the original and replacement deck; a large hole between the two sections is located in the forward starboard side of the structure. The Radio Shack also contains accumulated trash and equipment.

Despite several areas in poor condition, neither of these structures is in poor enough condition to warrant total replacement. The corner pieces and carlins can be replaced while stabilizing them for the deck replacement. The Wheelhouse especially retains a degree of authenticity that should not be demolished unless it becomes unrecoverable.

RIGGING

As explained previously, the rigging is mostly un-inspected. OTM Inc found no record of maintenance activities, now or during the vessel's working career. The splices and cables in the shrouds are in good condition at the deck level. For a better condition report, NWS will need to use a man-lift and cranes to inspect the rigging and perform necessary repairs.

DECK FIXTURES

The Lightship No. 83's deck has a variety of equipment affixed to it, including bollards, vents, steering gear, air lines, davits and winches. The current configuration of these fixtures was documented in September 2007 by the National Park Service's HAER Maritime Program. OTM Inc's inspection focused on evaluating both the deck fixtures' condition and the actions needed to replace the decks below them.

Some of this equipment, such as the bollards and winches, are attached to the top of the deck. Other pieces, such as the hatches, vents, and air lines, go through the deck and are surrounded by lumber coverboards in poor condition. From brief inspection, these pieces of equipment seem in generally good condition, as they were designed to withstand weathering and use.

The largest fixture, the smokestack, is secured with six guy wires to points on the deck and engine room vents. Two of these guy wires lay slack and were presumably removed to lay down the plywood reinforcing the deck. As the coverboards are in very poor condition, the stack may be unstable. The stack itself is in poor condition, with corrosion and weak places in the material.

Additionally, there is equipment lying disassembled on the deck. The steering cables and equipment, presumably removed during the 1998 partial deck replacement, are piled amidships on an escape hatch. Pieces of radio equipment removed from the Radio Shack during its undocumented replacement are wrapped in white plastic and placed on the bow.

RAILINGS & SCUPPERS

The Lightship No. 83's railings are made of metal bars and uprights, with some cut-out sections for ladders and other access to the deck. These sections can be secured with chain if needed. While most of the railings appear secure, portions of the railing have been removed, presumably to work on the aft deck. These have been temporarily replaced with rope strung between uprights.

The perimeter of the Lightship No. 83's wooden deck is framed by metal scuppers. A visual inspection of these showed water-related damage and deterioration, including corrosion and the growth of moss and lichen.

INTERIOR

The interior spaces of the Lightship No. 83 are in fair to poor condition, with accumulated objects and garbage, pools of standing water, peeling paint, rust, mold and other signs of decay. The individual spaces are described more thoroughly in the narrated video recording included with this report.

The Officers' Quarters at the stern are in slightly better condition than the rest of the below decks space. This space is covered by the aft portion of the deck replaced in 1998 and was mostly free of leaks during the walkthrough. There is also evidence of recent restoration efforts to the Officers' Quarters, including scraped paint and a lack of accumulated garbage.

SYSTEMS & MACHINERY

During the walkthrough, OTM Inc visually inspected several of the Lightship No. 83's onboard systems. The company did not conduct detailed inspections to determine the exact cause of problems found during the evaluation, as the labor required for such an inspection is almost as great as the labor required for a repair. Each system should ultimately be repaired by testing, inspecting and repairing the components as needed.

Electricity: The interior electrical system that provides power to light fixtures and outlets was not working at the time of the walkthrough. Minimal lighting is provided by shop lights plugged into extension cords, in turn plugged into a shore power cable on the Historic Ships' Wharf. According to former NWS volunteers and contractors, the electrical system worked in every interior space as recently as 2001. At the present time, no one that OTM Inc consulted with knew when the electricity stopped working or why. The main panel and other central electrical

equipment appear to be present and intact; however, the walkthrough showed damage to fixtures and wiring not present when OTM Inc representatives informally inspected the vessel in the late 1990s.

There is no record of when the portion of the electrical system providing power to the deck, rigging and navigation lights was last used. Its condition is unknown and will need to be inspected by using a man lift or going aloft once the rigging is secured.

Plumbing: The walkthrough identified three main plumbing systems to be discussed in this report, the potable water, graywater and blackwater systems. None of these systems work at the present time and there is no record of when they last worked.

Compressed Air: The condition of the compressed air system that powered the diaphone and horn is unknown. Representatives of OTM Inc witnessed the compressed air system function during an informal inspection in the late 1990s; however, there are no records of it being used since. The air receiver on the port main level companionway appears in good condition.

Steam: The steam system is uninspected and presumed not to work, as there is no record or evidence that it has been used since the late 1960s. The steam boilers are in very poor condition and the starboard boiler has been partially disassembled. The steam pipes that run through the vessel to power equipment such as the winches and capstan were not inspected and their condition is unknown.

Machinery: The engine room contains several pieces of machinery, including two diesel generators, two diesel-powered air compressors and the original double-expansion reciprocating steam plant.

During the walkthrough, the diesel generators were missing their generator portions and retained just the General Motors diesel engine portions. Additionally, these generators' exhaust systems were missing. The starboard air compressor, manufactured by Hercules, was partially disassembled. Its exhaust system is partially disassembled and its muffler was found to have insulation containing asbestos. The port air compressor, manufactured by General Motors, is intact and has been run within the past decade. It is likely still operable and would not be difficult to restore.

The reciprocating steam engine is in good condition despite not having been run in decades. It is not seized and was last oiled and turned over by hand during NWS's February 2007 Engineer for a Day high school course.

THROUGH-HULL FIXTURES

OTM Inc also inspected several through-hull fixtures in the engine room, as these areas are often the first parts of the hull to display signs of significant damage. The main through-hull fixtures in the Lightship No. 83 are two sea chests and several overboard discharge pipes. These fixtures are subject to more corrosion than other parts of the hull, as water can pool within them and create a corrosive environment.

The Lightship No. 83 has two sea chests, located on the port and starboard sides of the engine room. These consist of an opening in the hull that connects to pipes, which in turn connect to

flanges and valves that regulate the intake of water into the vessel. The pipes are typically the first components to develop leaks caused by the electrolytic wasting of metal exposed to seawater, as their walls are thinner than those of the sea chests.

OTM Inc's brief inspection found the starboard sea chest in good condition, with no apparent damage or leaks. The port sea chest has been previously patched with concrete and rebar, indicating a past leak. OTM Inc did not find evidence of current leaks in this sea chest, but concrete patches should always be considered a temporary solution.

OTM Inc also briefly inspected the overboard discharge pipes, which collect water from the deck and other areas and direct it overboard. The walkthrough showed that some of these are rusted out and need to be replaced, while others have temporary fiberglass patches applied over leaky areas.

None of the through-hull fixtures show evidence of currently allowing water to flow into the Lightship No. 83's hull.

ENVIRONMENTAL TESTING

Most vessels constructed before the 1970s contain a certain percentage of materials that have been found to be hazardous to human health, most commonly asbestos (used for insulation and heat shielding) and lead (used in paint). OTM Inc. consulted with an environmental abatement company to determine areas likely to contain these materials, then hired a licensed building inspector to sample and test the identified areas.

Bruce Thoreen of JT Environmental Inc tested six areas of the Lightship No. 83 for asbestos and five areas for lead, choosing specific sample sites he considered representative. The locations and test results of these samples are given in the tables below. The "main deck" is the space beneath the weather deck and above the engine room.

Table 1: Potential asbestos samples

Location	sample type	asbestos present	concentration
engine room	steam drum insulation	Yes	25 % amosite
engine room	steam pipe insulation ¹	Yes	20 % chrysotile
engine room	feed water heater insulation	Yes	17 % chrysotile
engine room	generator exhaust pipe insulation	Yes	5 % chrysotile 10 % amosite
main deck	cabin floor edging	No	-
main deck	floor finish	No	-

¹ encapsulated by 1980s volunteer-led restoration

Table 2: Potential lead paint samples

Location	sample type	lead present	concentration
engine room	hull (white paint)	Yes	2.80 %
engine room	Catwalk (red paint)	Yes	1.60 %
main deck	overhead frame (white paint)	Yes	26.00 %
main deck	berth wall (white paint)	Yes	15.00 %

weather deck	smoke stack (buff paint)	Yes	0.13 %
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As shown in table 1, asbestos was found in all of the engine room insulation tested. The steam pipe insulation, however, was encapsulated by 1980s volunteer effort detailed in a previous section. Both the building inspector and the environment abatement firm reported that this encapsulation was done well. They recommended an additional coat of paint be applied to the encapsulation during the restoration process as a touch-up, following industry standards.

In contrast, the asbestos in the steam drums, generator exhaust pipe insulation, feed water heater and fuel heater insulation is unabated and considered friable (easy to release into the air). This asbestos will need to be removed by abatement professionals. The process for this removal is described later in the *Recommended Projects* section of this document.

The floor tiles and finish in the Officers' Quarters was found to not contain asbestos and therefore do not pose an environmental hazard.

As shown in table 2, traces of lead were found in all paint samples taken. According to industry standards, lead paint should be sealed in by applying fresh non-lead paint to affected surfaces, described later in the *Recommended Projects* section of this document. Sealing it in this manner will remove the immediate danger posed by lead paint. It can later be removed in sections by stripping all the paint from an affected surface, disposing of the paint and applying new paint during other projects.

However, the highest concentration of lead (26%) was found in an overhead metal frame to which the deck planks are attached. The undersides of the deck planks are coated in the same paint as the frames; the top sides were not tested but can be presumed to also contain lead. As this is a significant level of lead (defined as over 25%), the deck removal must be performed by licensed abatement professionals due to the hazardous nature of the material. The process for this removal is described later in the *Recommended Projects* section of this document.

HULL CONDITION

According to NWS's records, little work other than cleaning and painting has been performed on the Lightship No. 83's hull outside the 1969 work at the Duwamish Shipyard and the 1990 work at the Foss Shipyard, both summarized in the *Previous Preservation Activity* subsection of this document. There have been three audio-gauge tests performed to determine hull plate wasting. All three tests found the hull plates to be in stable condition, with some wasting as expected from a 100-year-old hull. The most recent test (in 1996) found the hull in "adequate" condition for major restoration work. As the Lightship No. 83 has been moored in fresh water since the last test, OTM Inc did not perform an audio gauge test for this PEA.

OTM Inc also understands that audio-gauge tests do not provide a comprehensive assessment of true hull condition. Its experience with other historic metal hulls has shown that major deterioration is usually found in the lap joints, welds, riveting, and any other textured area that creates a place for water to collect and pool.

OTM Inc has found that a more accurate assessment of a metal hull's overall condition is to perform a visual inspection for agents of deterioration followed by selective needle-scaling to remove corrosion from areas that are likely to be damaged. Following the walkthrough condition report, OTM Inc visually inspected hull plates visible in the engine room and selected two areas to needle-scale for a more detailed assessment of the hull condition.

HULL PLATE WASTING

The most commonly-used method to assess hull plate condition is audio-gauge tests, which are performed using a specialized tool to bounce sound waves through a metal hull plate. A meter on the tool measures the sound waves' return to gauge the thickness of the hull plate. This process can be conducted while the vessel is in dry-dock or by a diver while the vessel is in the water.

Northwest Seaport has previously commissioned three audio-gauge tests to assess the thickness of the Lightship No. 83's steel hull plates. The first audio-gauge test was in 1988 at its Kirkland moorage. The test was performed by a local diver as described in the *Previous Preservation Activities* subsection of this document. This test found the hull plates to be an average of approximately 5/16 (.313) inches thick. The survey reported that the plates were probably 3/8 (.375) of an inch thick when the vessel was built and that the hull appeared sound under a thin layer of corrosion.

The second audio-gauge was performed in 1990 during the shipyard work by Foss Shipyard, during dry-dock period. The invoice of the work obtained by OTM Inc states that audio-gauge testing was performed on the hull "to determine 'as found' thickness of the shell plating; the hull shell plate was audio-gauged on both sides of the keel, at the waterline and at two girth belts. A written report of the gauging was provided to Northwest Seaport." However, OTM Inc did not find the written report of this audio-gauge test in NWS's archives. The exact results of the test are unknown, but OTM Inc assumes that it found the hull in similar condition as it was during the 1988 survey.

The third audio-gauge test was performed in 1996 by MARCO Shipyard as part of *Swiftsure Reborn* project. The test measured the hull in 40 locations and found it "adequate" for undertaking the restoration work proposed at the time. No written report or specific description of this audio-gauge test was found in NWS's archives.

OTM Inc chose not to perform a fourth audio-gauge test as part of the PEA, nor does it recommend NWS commission another test prior to undertaking the rehabilitation project. Doug Dixon, manager of the Pacific Fisherman Inc dry-dock in the Ballard neighborhood of Seattle, stated that the only reason to expect a difference in audio-gauge readings would be if the dock the Lightship No. 83 is moored at is "hot," meaning that an electrical system is releasing stray current into the water. This can cause electrolytic wasting of steel hull plates if left unchecked, in which molecules in the hull combine with molecules in the water and remove metal from the hull.

As the Lightship No. 83 is moored at the recently-constructed Historic Ships Wharf with only three to five other historic vessels, it is unlikely that there is stray electrical current in the water. However, even if the dock were "hot," electrolytic wasting is far more of a problem in

saltwater than it is in the freshwater environment of Lake Union. For these reasons, Dixon advised against an audio-gauge test and instead recommended that NWS monitor the Lightship No. 83's through-hull fixtures (such as the sea chests and overboard discharges) closely, since they usually develop leaks before any other part of a steel hull.

Following this advice, and because the 1996 audio-gauge test found no significant difference in hull plate condition since the 1988 audio-gauge test, OTM Inc believes that the Lightship No. 83's hull plates are in stable condition and that any further deterioration is taking place very slowly in the current freshwater moorage.

WALKTHROUGH OBSERVATIONS

As mentioned previously, OTM Inc performed its walkthrough assessment during rainy winter weather. Rainwater leaked through numerous places in the deck and seemed to be infiltrating through the vessel. OTM Inc found water running down walls, pooling in any depressions, and ultimately collecting in the bilge. It also found extensive condensation in several closed areas, such as the aft propeller shaft compartment.

Other inspections performed by OTM Inc indicate that hull itself is not taking on water and that the accumulation of water in the bilge is entirely through leaks in the deck. The vessel's bilges contained less water during the summer, when there is very little rain. Additionally, even small, slow leaks in the hull would be very noticeable despite the automatic bilge pump, as the constant inflow of water would cause the pump to run frequently during dry weather as well as rainy.

The freshwater infiltration has resulted in extensive corrosion on the Lightship No. 83's metal hull and frames. For the PEA, OTM Inc focused its visual inspection on the frames and hull plates in the engine room. As found on other historic vessels, the areas with the most extensive corrosion (expanding and breaking through the paint) were on the connections between frames and hull plates. The riveted lap joints that OTM Inc inspected in the engine room seemed to be in fair condition, with corrosion discoloring the paint but not breaking through it. OTM Inc also observed the paint bubbling on the engine room walls, indicating that the corrosion is from the inside rather than the outside.

OTM observed an additional agent of deterioration for the hull in the aft bilge compartment: large quantities of pig iron, railroad track segments and other scrap metal piled beside the disassembled propeller shaft. Dissimilar metals stored together in this manner create conditions for electrolytic wasting similar to the presence of stray electrical current in water described earlier. The presence of these metals could be causing damage to the steel hull through this exchange process.

NEEDLE-SCALE TESTING

After the visual inspection described above, OTM Inc used a compressed-air-powered needle-scaler to remove corrosion and inspect the hull in two locations: a frame on the port side of engine room abeam of the sea chest and the aft bulkhead of engine room just behind the ladder to the tool room. These locations were selected to provide representative samples of hull condition without boring holes in the hull.

On the port frame location, OTM Inc found extensive rust that had built up and begun to flake off and accumulate on a horizontal shelf. While the build-up looked solid, brief needle-scaling removed the rust and revealed solid metal. This portion of the frame appeared good after removing the corrosion, but the rivet was wasted away. Photographs of this location before and after the needle-scaling are provided in the *Appendix* of this document. If damage like this had been needle-scaled on the hull at a lap joint, the process may have created a hole in the hull.

On the aft bulkhead location, the visible corrosion did not appear as extensive as that on the frame. The process of needle-scaling removed both the visible rust and portions of the bulkhead that appeared solid until they crumbled, revealing extensive corrosion damage.

As the bilge water is likely attacking the hull in same way as it is the bulkheads, it can be assumed that the hull is deteriorating in the same way.

CASE STUDIES

Historic steel hulls like the Lightship No. 83's inevitably have weak places "held together by rust and paint," according to one industry consultant. Weak places are often found in the bilge compartments, as these areas typically have less attention paid to them than the rest of the hull and often lack a regularly-maintained barrier of paint or sealant to protect against corrosion from the inside. These weak places are usually stable and even watertight until disturbed and should be addressed as resources are available, rather than all at once. This is illustrated by contrasting two recent Seattle-area steel hull preservation and restoration projects.

The first case study is the classic yacht [REDACTED], which began an extensive hull restoration project in early 2007. The 1930 yacht has a riveted steel hull that now contains extensive pockets of corrosion. An inspection prior to the planned restoration went through a weak place in the hull, necessitating immediate repairs to the aft section of the hull. The vessel was dry-docked, then the interior sandblasted from the engine room aft to remove the corrosion. The sandblasting process revealed several more weak places in the hull that became holes once the corrosion was removed.

The owners of the [REDACTED] decided to repair all the holes in the hull at once by welding an entire second layer of steel over the historic hull, a process which took more than six months in a dry-dock. In addition to being a costly and time-consuming process, the properties of the historic hull have also changed, as the many of the original rivets and plates are encapsulated under the new welded skin.

The second case study is the historic tugboat [REDACTED], which was converted from a working vessel to a yacht in 2001. In 2005, a marine surveyor visually inspected the hull and performed an audio-gauge test to determine the hull thickness in 200 points on each side. This test determined that the plate thickness was good and that the hull was in excellent condition. Later in 2005, laborers cleaned the aft bilge compartment, which contained extensive saltwater-induced corrosion, with needle-scalers prior to painting the hull for poured ballast. While removing this corrosion, laborers bored several holes through the hull. These weak places had been missed by the external inspection and audio-gauge test, as they were located on joins and seams rather than the hull plates themselves.

The owner of the [REDACTED] decided to repair the holes in the hull as they were encountered. If laborers bored holes while cleaning the corrosion with needle scalers, they patched them temporarily with a wooden bung and quick-drying cement. Later, the tugboat was dry-docked and metal doublers welded over the weak spots from the exterior. This process is ongoing, with yearly needle-scaling and patching prior to dry-dock periods. It has also proven to be a cost- and time-effective way to repair the [REDACTED]'s hull, as steel corrosion holds together until disturbed or very advanced.

When Northwest Seaport begins to restore the Lightship No. 83's hull, the organization will likely find similar deterioration. The 1990 audio-gauge test found the hull plates in adequate condition, but a visual inspection performed at the same time "revealed hull to be badly deteriorated," with "leaking rivets and holes in the plate."

OTM Inc considers the approach used on the [REDACTED] as the most advisable method for Northwest Seaport to restore the Lightship No. 83's hull, as it addresses deterioration in discrete sections. As the [REDACTED] is owned by a large corporation with its own shipyard and dry-docks, it was able to undergo a more comprehensive restoration not feasible for organizations in the non-profit sector.

FINDINGS

The main agent of deterioration currently faced by the Lightship No. 83 is freshwater infiltration due to the leaking decks. This freshwater infiltration affects the interior spaces, the remaining deck, and the steel hull. As such, OTM Inc has identified replacing the deck as the highest priority of the federally-funded rehabilitation project, as the damage to the interior will continue until the freshwater infiltration is stopped. After this has been accomplished, NWS can begin the long-term hull repair through systematically removing corrosion and patching the resulting holes.

In addition to these activities, OTM Inc recommends that safety issues be addressed, including asbestos and lead abatement, and servicing the overhead rig. OTM Inc also recommends restoring key onboard systems to provide both functionality and authenticity to the vessel.

RECOMMENDED PROJECTS

After performing the background research and the condition report. OTM Inc consulted with experts to create a prioritized plan for rehabilitating the Lightship No. 83 with the federal TEA grant money. As per NWS's mission of preserving, interpreting and presenting maritime heritage through educational programs, restoration efforts should be focused on stabilizing the vessel and making it safe for public access. OTM Inc believes that based on the estimates and the projected size of the grant, the projects recommended here are feasible for this rehabilitation project.

OTM identifies replacing the deck as a top priority for the federally-funded restoration project. This decision is based both on the determination that the main agent of deterioration faced by the vessel is rain water leakage, and that the deck must be stabilized in order for the vessel to be accessible to the public. Other major priorities include addressing safety issues by removing hazardous materials and stabilizing the overhead rig, and returning several of the onboard systems to operational condition.

While creating this recommended list of restoration projects, OTM Inc did not address greater organizational concerns, such as project management, ongoing documentation, or insurance. The recommended projects are listed in a roughly chronological order, but NWS will need to determine the exact sequence and structure of the rehabilitation project.

At the completion of these recommended projects, the Lightship No. 83 should be considered stabilized for visitor and volunteer access, and prepared for further restoration projects.

PRELIMINARY BUDGET

This preliminary budget was constructed using estimates from OTM Inc and its consultants. The estimated charges are for the materials, labor and other services required for completing each task. The estimates do not include figures for management, insurance, moorage (except for dry-dock lay days), project documentation, towing, storage or other associated expenses. These fees will be variable depending on NWS's organizational capabilities and the options available to non-profit groups in Seattle.

OTM Inc calculated the estimated sales tax, using the current Washington State rate of 8.9%. Unless NWS has a state sales tax exemption form, contractors hired for the project will charge sales tax for any goods or services rendered to the organization.

OTM Inc did not calculate a cost estimate for the initial documentation and inventory project, as this should be performed by NWS's own curatorial staff.

Finally, OTM Inc considered three deck replacement options at the request of NWS: a traditional planked-and-caulked deck, a plywood deck and a steel deck. The prices for each option are listed in the following table, but only the planked-and-caulked deck is included in the project total as it was deemed the best. The descriptions and evaluations of each deck replacement option are given in the *Deck Replacement* section.

Table 3: Preliminary Budget for Recommended Projects of the Lightship No. 83 Rehabilitation ¹

<i>Item</i>	<i>cost estimate</i>	<i>time estimate</i>
Preparation	\$ 7,000	
Preliminary Safety	\$ 4,000	1 week
Tools & Equipment	\$ 3,000	1 week
Documentation & Inventory ²		
Hazardous Substances	\$ 36,000	
Mold & Mildew – Cleaning	\$ 5,000	4 weeks
Lead – Painting	\$ 6,000	4 weeks
Asbestos	\$ 25,000	2 weeks
Systems	\$ 56,500	
Electrical	\$ 15,000	4 weeks
Master Alarm Panel	\$ 9,500	1 week
Potable Water	\$ 10,000	2 weeks
Graywater	\$ 4,000	1 week
Blackwater	\$ 10,000	2 weeks
Fire-Fighting	\$ 5,000	1 week
Compressed Air	\$ 3,000	1 week
Rigging & Stack	\$ 47,500	
Setup	\$ 4,000	2 weeks
Service Rigging	\$ 32,000	4 weeks
Service Deck Fixtures	\$ 4,500	3 weeks
Service Scuppers	\$ 7,000	2 weeks
Deck Removal	\$ 64,000	
Documentation	\$ 8,000	1 week
Removal of Original Deck	\$ 20,000	2 weeks
Removal of Replacement Deck	\$ 6,000	2 weeks
Deckhouse Stabilization	\$ 30,000	2 weeks
Deck Replacement	\$ 316,000	
Staging	\$ 6,000	2 weeks
Planked & Caulked (recommended)	\$ 310,000	12-16 weeks
Plywood (Option 2)	\$ 250,000 ³	8-12 weeks
Steel (Option 3)	\$ 600,000 ⁴	25-30 weeks
Hull	\$ 50,000	
Survey	\$ 5,000	1 week
Dry-dock	\$ 45,000	2 weeks
Subtotal	\$ 577,000	
<i>sales tax (8.9%)</i>	\$ 51,353	
Total	\$ 628,353	

¹ estimate does not include figures for management, insurance, moorage, documentation, towing, storage, or other expenses

² not priced

³ not included in subtotal

⁴ not included in subtotal

PREPARATION

Before performing major rehabilitation work on the Lightship No. 83, OTM Inc recommends addressing preliminary safety concerns, securing tools and equipment for projects, documenting the vessel's current condition, and performing an inventory of the objects currently onboard the vessel.

PRELIMINARY SAFETY

When OTM Inc conducted its condition survey of the Lightship No. 83, the vessel relied on daily checks made by NWS personnel, one automatic bilge pump in the engine room compartment, and several fire extinguishers for protection from fire and flooding.

The bilge pump was installed in spring 2007 and is powered by AC electricity from a dockside hookup. According to NWS, the bilge pump frequently "sticks" due to the low amperage of the electrical line it is powered by; this is solved by unplugging the shop lights from the same line. The bilge pump also services only one compartment in the bilge; additional compartments must be pumped with auxiliary equipment. There is also no high-water switch or alarm to alert personnel if the pump fails and the water level rises.

Several fire extinguishers are located throughout the Lightship No. 83; Northwest Seaport inspects them monthly and services them annually. OTM Inc consulted with a representative of the fire protection company Alexander Gow to determine the recommended extinguisher coverage on the vessel. The representative found many of the existing fire extinguishers to be BC CO₂ type, which are designed for electrical and liquid fires, and recommended that Northwest Seaport install ABC chemical type extinguishers to address the risk of wood and paper fires as well. He also recommended ensuring coverage by installing one ten-pound extinguisher on each level and at least one five-pound extinguishers in each space.

Prior to other work on the Lightship No. 83, NWS should address these basic safety concerns by installing additional bilge pumps and fire extinguishers. Further work on the safety systems, such as a master detection and alarm system and onboard fire-fighting capability, can be performed while servicing the main systems.

Work description:

- Install battery-powered automatic bilge pumps in each watertight compartment
- Install high-water switch and alarm with separate dry-cell battery power above waterline, with light and siren alarms installed on top of the wheelhouse and wired through existing wire channels
- Purchase and install ABC dry-chemical fire extinguishers following coverage plan recommended by Alexander Gow; continue inspection and service plan

Cost estimate: \$4,000, including new fire extinguishers and bilge pumps, wall mounts, alarm, wiring, and installation labor

Time estimate: 1 week

TOOLS & EQUIPMENT

In order to perform effective work during the federally-funded restoration project, NWS should ensure that the Lightship No. 83's workshop has sufficient tools and equipment. In addition to enabling NWS staff and volunteers to work on restoration projects, most contractors assume basic tools are available on the job site and will charge extra for providing them. While the vessel currently has some tools in its workshop, they are likely not complete or adequate for an extensive restoration project.

OTM Inc recommends ensuring that the Lightship No. 83's workshop includes wrenches, screwdrivers, hammers, drills, needle-scalers, grinders, and other tools. It should also include extension cords, hoses, movable lights, shop vacuums, and other equipment. Finally, the acquisition should include storage boxes to keep the tools dry, inventoried, and secure.

As the restoration project progresses, some of this equipment will need to be replaced due to breakage or regular wear. These costs are not included in the initial estimate and should be factored into future steps.

Work description:

- Inventory current tools and equipment in the Lightship No. 83's workshop and in other NWS facilities and develop list of needed acquisitions
- Purchase or secure donation of needed tools and equipment

Cost estimate: \$3,000, based on OTM Inc's brief inspection of the vessel's workshop and experience with other restoration projects

Time estimate: 1 week

DOCUMENTATION & INVENTORY

The Secretary of the Interior's Standards for Historic Vessel Preservation Projects repeatedly emphasizes the necessity of documenting all phases of a restoration project, especially the "as-is" condition prior to major work. As such, NWS should extensively document the Lightship No. 83 before, during, and upon completion of the federally-funded restoration work.

OTM Inc prepared a video walkthrough, photographs, and a general condition report of the lightship as part of this PEA, but this should be considered only a start. NWS should photograph, measure, and describe all spaces to be affected by the project. It should emphasize the areas that will be impacted during the restoration project, such as the wooden deck (discussed later in the *Deck Removal* subsection) and companionways, and also places where equipment will be removed. Some of this initial documentation has been accomplished through the National Park Service's HAER Maritime Program survey in 2007; NWS should plan to supplement this documentation through additional activities.

This kind of documentation should continue throughout the project, both to create internal records following the Secretary's Standards and to prepare progress reports and press releases.

After the initial documentation is complete, NWS should inventory the objects aboard the lightship and make decisions about storage and disposal. As shown in OTM Inc's video

walkthrough, the vessel contains large quantities of material in closets and on surfaces. Some of these objects are likely significant artifacts that should be preserved as part of the lightship collection, while many others are old supplies or garbage accumulated since its decommissioning. As many of these objects will need to be removed during the restoration project (such as the rigging and steering equipment on the deck, and the furniture on the main deck), this step must be performed before other major work.

Work description:

- Create a detailed “as-is” condition report of the entire vessel, using digital photographs, video recordings, and measurements; findings should be written up and included in NWS’s lightship archives
- Inventory objects for storage or disposal, following the organization’s collecting plan
- Remove artifacts and other objects worth saving for storage; consolidate objects to be disposed of while cleaning the vessel as described in the following section

The cost and time of this portion will depend on Northwest Seaport’s curatorial department’s resources and staffing.

HAZARDOUS SUBSTANCES

As is common in historic ships and buildings, the Lightship No. 83 contains hazardous substances once frequently used in construction and maintenance. OTM Inc hired JT Environmental to test the vessel for lead paint and asbestos insulation and found both in significant quantities, as described in the *Condition Report* section of this document.

OTM Inc then consulted with One-Step Environmental Abatement, LLC, a local company with a good record of removing hazardous material including asbestos and lead. One-Step provided estimates and descriptions of the actions needed to abate these substances.

Additionally, the vessel contains a significant amount of mold and mildew, due to damp conditions. While these are not necessarily toxic, they should be eliminated in the initial phases of the project for both health and preservation issues.

MOLD AND MILDEW

The Lightship No. 83 contains significant mold and mildew, especially on the walls and ceilings of the main deck and wheel house. In addition to facilitating decay, these may be hazardous for individuals sensitive to allergens. The air inside the vessel is very still and damp, as fans are not used due to the presence of friable asbestos, and has created an excellent environment for mold and mildew. It is especially evident in the Captain’s Cabin, but is present throughout the vessel.

Work description:

- Clean entire inside of Lightship No. 83 using liquid cleansers and sponges or rags to wipe or scrub all surfaces; sweep up dust and debris from floors
- Dispose of objects determined by curatorial staff to be not worth keeping

Cost estimate: \$5,000, including labor, supplies such as cleansers, rags and garbage bags, and disposal costs.

Time estimate: 4 weeks; can be accomplished simultaneously with the preliminary Documentation & Inventory, going room by room in the vessel

LEAD

As discussed in the Condition Report section of this document, JT Environmental found traces of lead paint in all surfaces tested. Aside from the underside of the deck, the lead paint levels were relatively low and can be abated by sealing the lead paint under modern paint. Abating the lead paint used in the deck paint is addressed in the later *Deck Removal* section.

OTM Inc does not advise removing all lead paint from the vessel during the initial rehabilitation project, as such an undertaking would be costly and may not be necessary to abate the hazard. NWS should research regulations governing the presence of lead paint within attractions open to the public, as sealing lead paint under modern lead-free paint is considered adequate abatement for many applications.

Painting the interior spaces will also work to prevent the return of the mold and mildew removed during the initial cleaning process.

OTM Inc recommends using a mildew-killing primer and a top coat of latex exterior paint for its durability, cost-effectiveness, and ease of application. Oil paint requires ventilation during application, but fans should not be used in the Lightship No. 83 until the friable asbestos is abated.

Work description:

- Paint every accessible surface in the vessel using a mildew-killing primer and a top coat of latex exterior paint, applied with rollers and brushes to the ceiling, walls, and floor of every compartment and space that can be reached

Cost estimate: \$6,000, including labor, paint, and supplies.

Time estimate: 4 weeks; can be accomplished simultaneously with the preliminary Documentation & Inventory and Cleaning steps, going room by room in the vessel

ASBESTOS

As discussed in the *Condition Report* section of this document, JT Environmental found abated asbestos in the steam pipe insulation and friable, un-abated asbestos in the insulation of the steam drums, feed water heating tank, the fuel heaters and the starboard air compressor (Hercules) muffler. After servicing the previously encapsulated asbestos, NWS should next address this unabated asbestos insulation.

Work description:

In accordance with industry regulations, the removal of the unabated asbestos must be performed by licensed abatement professionals. They will:

- Remove asbestos-bearing insulation from the steam drums over the main boilers

- Remove asbestos-bearing insulation from the fuel heaters and the feed water heating tank
- Remove the air compressor muffler, as it is too badly deteriorated to safely encapsulate the asbestos within it; NWS curatorial staff should document it through measurements, photographs and descriptions before disposal

Additionally, NWS should:

- Reseal asbestos encapsulation on steam pipe insulation by painting it with exterior latex paint; this process can be accomplished during the painting described in the previous section, as the previous encapsulation removes the need for abatement professionals to service the work

Cost estimate: \$25,000, including labor, materials, and equipment required for legal removal and disposal of asbestos-containing material, plus a PSCAA permit

Time estimate: 2 weeks; environmental abatement firms typically require no other shipboard activity to be conducted during the asbestos removal process

SYSTEMS

In addition to the major rehabilitation projects and addressing safety hazards, OTM Inc recommends restoring several of the Lightship No. 83's onboard systems to operating condition, including the electrical system, the plumbing system, and the compressed air system. Restoring these will allow the master fire alarm system and the onboard fire-fighting system to be easily returned to working order, further enhancing the vessel's safety.

This work will benefit both the rehabilitation project, as many contractors expect to be provided utilities and will charge extra to set them up themselves, and future accessibility to the vessel. It will also add authenticity to the Lightship No. 83 as an artifact representative of maritime heritage. Restoring the systems can be done bit by bit, restoring functionality to one space at a time as resources permit.

ELECTRICAL

As described in the *Condition Report* section of this document, the electrical system is untested and presumed not to work, but appears complete. Restoring the electrical system will consist mainly of testing the system to find the malfunctioning portions. The goal will be to restore electricity to the light fixtures and outlets. Additional outlets and fixtures may also be installed to bring the electrical system up to modern standards. This work should be performed by a licensed marine electrician.

In accordance with the Secretary of the Interior's Standards for Historic Vessel Preservation Projects, any new installations should be made with regard to the vessel's authenticity. Historically authentic fixtures are easily obtained, while most new wiring can be pulled through existing channels. While some new holes may need to be drilled for new outlets, these should be placed so as not to interfere with the historic appearance.

Work description:

- Test and inspect individual circuits to restore lighting and electrical outlets
- Restore the shore-power panel and connections
- Install new wiring, light fixtures and outlets as needed

Cost estimate: \$15,000, including labor, parts and materials such as armored electrical cable, light fixtures, outlets, and possibly a shorepower cable; this figure is an estimate only, as specific costs will vary depending on inspection results

Time estimate: four weeks

FIRE DETECTION & ALARM SYSTEM

Restoring the electrical system is also an opportunity for NWS to install a master fire alarm system using heat and smoke detectors throughout the vessel. Representatives of Alexander Gow recommended installing two heat detectors in the engine room, smoke detectors in other major areas of the vessels (such as the Crew's Mess and the Officers' Quarters), and two manual pulls for personnel to trigger the alarm if they observe a fire.

These detectors and pulls should be wired to a central panel that sets off audible and visual alarms in case of fire. The original main alarm panel is located in the Captain's Cabin. OTM Inc expects that a modern alarm panel can be installed within this original panel, preserving the authentic look of the system. This system can be wired by a marine electrician during the electrical restoration.

Work description:

- Install heat and smoke detectors and manual alarms in recommended spaces throughout the vessel
- Install audio and visual alarms in three locations: the Engine Room, the Main Deck level and on top of the Captain's Cabin
- Install main panel in Captain's Cabin

Cost estimate: \$9,500, including labor, detectors, alarms, a main alarm panel and materials

Time estimate: 1 week, with portions performed during restoration of main electrical system

PLUMBING

The plumbing system contains four subsystems: potable drinking water, graywater (from sinks and drains), blackwater (from marine heads), and fire-fighting capacity. These are separate systems that will need to be traced and repaired individually by pressurizing a section of the system, inspecting for leaks and other problems, and making repairs as needed. The potable water and blackwater systems will also need to have holding tanks serviced, replaced, or installed. This work can be accomplished piecemeal, depending on NWS's resources and desired level of use for the vessel.

Restoring the firefighting system will also assist NWS in receiving and maintaining a welding permit for work performed elsewhere on the vessel, as a pressurized hose is required.

POTABLE WATER

The potable drinking water system supplies sinks and fixtures with fresh water drawn from storage tanks within the Lightship No. 83. While already installed, these tanks will likely need to be serviced and re-coated to hold potable water without contaminating it.

Work description:

- Service or replace water pumps
- Pressurize plumbing systems, trace leaks and make repairs as necessary
- Clean and recoat potable water tanks

Cost estimate: \$10,000, including labor, parts, materials, , and tank refurbishment; this figure is an estimate only, as specific costs will vary depending on detailed inspection results

Time estimate: 2 weeks

GRAYWATER

The graywater system removes water from sinks and drains and directs the water over the side, as is typical of most vessels. The graywater system uses gravity rather than pumps.

Work description:

- Pressurize plumbing systems, trace leaks and make repairs as necessary

Cost estimate: \$5,000, including labor, parts, and materials; this figure is an estimate only, as specific costs will vary depending on detailed inspection results

Time estimate: 1 week

BLACKWATER

The blackwater system removes water and wastes from toilets and carries them to holding tanks within the vessel. OTM Inc was unable to determine if the Lightship No. 83 currently has a blackwater tank, as many older vessels were designed to discharge blackwater directly over the side (a practice now banned in all but open waters). If the vessel does not have a blackwater tank, NWS will need to either install a new tank or convert an existing tank to hold blackwater. The second option is a common practice in working boats and the vessel likely has at least one tank suitable for conversion.

Work description:

- Service or replace water pumps
- Pressurize plumbing systems, trace leaks and make repairs as necessary
- Install or convert existing tank to blackwater tank

Cost estimate: \$10,000, including labor, parts, materials, water pump service, and tank refurbishment; this figure is an estimate only, as specific costs will vary depending on detailed inspection results

Time estimate: 2 weeks

FIRE FIGHTING

The onboard fire-fighting system uses a separate set of pipes than the potable water system, drawing water from over the side through the starboard sea chest. This system directs water to several stations with fire hoses and other equipment. Restoring the onboard fire-fighting system consists of two steps: restoring the plumbing system in the same manner as the other plumbing systems and replacing or repairing the fire hoses and nozzles.

Work description:

- Service or replace pumps and connections to starboard sea chest
- Pressurize plumbing systems, trace leaks and make repairs as necessary
- Install new fire hoses and nozzles.

Cost estimate: \$5,000, including labor, parts and materials

Time estimate: 1 week

COMPRESSED AIR

Restoring the compressed air system is important for the rehabilitation project, as many tools used by marine contractors are powered by compressed air. As described in the *Condition Report* section of this document, the Lightship No. 83's compressed air system is currently powered by two stationary diesel compressors. While at least one of these compressors (the port one manufactured by GM) could be restored to operating condition, it is not a good power source for the rehabilitation project. This compressor was designed for large-scale compression and is loud and very inefficient when compared to modern air compressors.

Instead of using the installed air compressors, OTM Inc recommends purchasing a modern "portable" compressor to power tools from. This compressor could be installed wherever it was needed. This modern compressor can then be hooked into the Lightship No. 83's existing compressed air system and air receiver.

Work description:

- Purchase new air compressor and place in optimal location, such as in the main deck companionways or the engine room
- Connect new air compressor to Lightship No. 83's compressed air system; inspect system and repair as with other systems

Cost estimate: \$3,000, including labor, materials and a new air compressor

Time estimate: 1 week

RIGGING & DECK FIXTURES

As discussed in the Condition Report section of this document, the on-deck rigging has not been regularly serviced or maintained for some time and is uninspected. While the rig appears to be in fairly good condition from a deck-level assessment, it poses a potential safety issue for staff, contractors and visitors and should be inspected, serviced, and repaired using a man-lift to go aloft.

SETUP

Due to the potential safety issues in the rig, servicing and repairing it will need to be done from a man lift, as riggers cannot safely go aloft prior to the inspection and service. The deck will first need to be stabilized and then a shipyard crane used to lift the man-lift aboard.

Work description:

- Stabilize deck by laying 1" plywood on the deteriorated sections
- Use a shipyard crane to bring the man-lift aboard

Cost estimate: \$4,000, including labor, plywood, safety equipment and use of the shipyard crane; cost of the man lift rental is included later

Time estimate: 2 weeks, including ordering and delivery of plywood

MASTS & RIGGING

Once the setup is complete, two professional riggers should use the man lift to inspect, service and repair the rigging with the goal of stabilizing and preserving it. The Lightship No. 83's rigging contains many unique features such as intricate cable splices that are no longer performed due to the time and effort involved; as such, the riggers will prioritize preservation and repair over replacement. According to a rigging expert, many of the cables and hardware may simply need a coat of paint and fresh lubricant to be considered in good condition.

Servicing the rig is also an opportunity for marine electricians to restore the navigation lights, especially the beacon at the top of the forward mast.

Work description:

- Send two riggers aloft in a man lift to inspect, clean, paint, and lubricate cables and hardware
- Replace any cables or hardware (such as shackles and turnbuckles) needed, using a shipyard crane for lifting
- Replace ratlines according to original types used in period lightships
- Inspect masts and mast steps, clean and paint
- Restore electricity to the navigation lights by tracing wires and connections, as described earlier for the main electrical system

Cost estimate: \$32,000, including labor, parts, materials and man lift rental; specific costs will vary depending on inspection results

Time estimate: 4 weeks

DECK FIXTURES & SMOKESTACK

As discussed in the Condition Report section of this document, the Lightship No. 83 has a variety of deck fixtures and equipment that should be inspected, serviced and repaired, especially the smokestack. Some of these fixtures, such as the deck winches, bollards, and vents, should also be removed in preparation for the deck replacement and placed into a secure storage facility protected from weather.

Additionally, the smokestack should be inspected, serviced, and repaired. OTM Inc recommends welding a steel strap around the smokestack's base where the corrosion is worst.

Work description:

- Inspect smokestack and repair according to findings
- Remove deck fixtures for offsite storage during deck replacement using shipyard crane

Cost estimate: \$4,500, including labor, parts, materials, shipyard crane fees, welding equipment and permits

Time estimate: 3 weeks; portions of this step can probably be accomplished simultaneously with servicing the rig

SCUPPERS

The Lightship No. 83's deck is edged by steel scuppers. As discussed in the Condition Report section of this document, these seem in overall fair condition, but have patches of corrosion and other damage. OTM Inc recommends that a professional welder experienced in marine repair inspect the scuppers and repair them as necessary. Some areas of metal may need to be replaced entirely. This inspection and repair is also an opportunity to inspect the metal railings around the perimeter of the deck and determine if further repairs are needed.

Work description:

- Inspect scuppers and repair as necessary
- Replace extensively damaged by welding new steel into scuppers

Cost estimate: \$7,000, including labor, materials and welding permits

Time estimate: 2 weeks

DECK REMOVAL

Prior to replacing the Lightship No. 83's deck, NWS will need to remove the existing deck. There are four significant factors to consider for this process.

First, the exact dimensions and characteristics of the original deck must be documented in order to replicate its original configuration.

Second, the removal and disposal of the original deck material must be undertaken by licensed environmental abatement professionals, due to the significant levels of lead paint used.

Third, the aft third of the deck was replaced in 1998 using 4" x 4" hemlock planks covered by layers of plywood. This replacement is not "original" and therefore does not need to be documented as stringently as the original deck, nor is it contaminated with lead paint necessitating environmental abatement. It will, however, require significant time and effort to remove due to the modern bedding compounds used.

Finally, the deckhouses must be stabilized during the removal and replacement process, and then reinstalled in such a way as to not adversely impact the new deck. OTM Inc recommends

“suspending” the deckhouses in place rather than raising them up, to create minimum disturbance in these structures.

As mentioned previously, OTM Inc evaluated three deck replacement options. As the rolled steel option was deemed a poor choice for reasons later outlined, and because the two other replacement options share many similarities, the deck removal projects are described in a way that would not be relevant to the rolled steel option.

DOCUMENTATION

The first step is to document the original deck both prior to demolition and during demolition process. This step is in addition to the documentation and inventory described previously in this document, as it requires precise measurements by professional shipwrights. These measurements should be of the original configuration of marginboards and coverboards, layout of the original planking, and the size and shape of wooden shims used to level the deck.

Marginboards and coverboards are the lengths of lumber that border the deck and the protrusions within it. Marginboards are laid around the perimeter of the deck, while coverboards frame the protrusions such as the smokestack, vents, hatches and other fixtures installed through the deck rather than on it. The placement of these marginboards and coverboards is important, as they help seal the protrusions and keep the deck from leaking.

The layout of the original planks is important to preserve the original character of the deck. When laying a deck, shipwrights naturally choose a starting point to work out from that determines the configuration of the planks.

A planked and caulked deck like the Lightship No. 83 also contains numerous wooden shims, small wooden wedges carefully cut and placed below the planks to make the deck precisely level. While most professional shipwrights are experienced in measuring and cutting new shims in new decks, measuring the original shims to replicate them in the new deck will save time and effort, as well as add to the authenticity of the new deck.

These shims will be needed to level the deck for both the planked and caulked traditional method and the plywood composite method. If the steel deck method is chosen, the shims will not be needed for the replacement, but the dimensions should be recorded regardless. NWS should also consider the feasibility of saving the original shims and other key pieces of the deck as part of its permanent collection.

There are several resources available to help in this documentation process. NWS recently partnered with the National Park Service’s HAER Maritime Program to document the deck’s current dimensions and configuration. Reproductions of the photographs and schematic drawings from this survey are available through the National Park Service and can form the base of this documentation phase.

Shipwrights anticipate two major documentation phases are needed while replacing the Lightship No. 83’s deck:

- after removing the layer of plywood currently installed over portions of the original fir decking, concentrating on dimensions and placement of wooden planks and fixtures

- as the decking is removed, measuring shims on steel frames and documenting the underside's construction detail

Measurements, photographs, and diagrams taken during this process should be cataloged and cross-referenced to measurements and notes then organized into 3-ring binders coordinated with large-scale schematic drawings.

Work description:

A shipwright and a photographer should work together both before and during the demolition to:

- Measure and visually record information needed about the original deck configuration, and take representative samples of the original material
- Organize the information by dividing the deck into sections and keying photographs, measurements and samples to the original location

Cost estimate: \$8,000, including labor and materials

Time estimate: One week prior to demolition, one week during demolition

ORIGINAL DECK REMOVAL

As discussed in the *Condition Report* section of this document, the paint on the metal frames that support the deck contains significant levels of lead, enough to require removal be performed by licensed environmental abatement professionals. Abatement professionals inspected and measured the Lightship No. 83's deck to prepare this estimate.

Work description:

In accordance with industry regulations, the removal of the lead paint must be performed by licensed abatement professionals, who will:

- Contain the areas to be removed with movable plastic tents
- Remove deck in stages by cutting the planks out
Portions of the deck will be retained for more precise demolition, such as a margin around each deckhouse. These will later be removed by shipwrights after consulting with the abatement professionals to determine the best course of action
- Clean paint from the metal frames the deck was affixed to
- Dispose of deck and removed lead paint

Cost estimate: \$20,000, including labor, materials and equipment required for legal removal and disposal of lead-containing material

Time estimate: 2 weeks; environmental abatement firms typically require no other shipboard activity to be conducted during the lead removal process.

REPLACEMENT DECK REMOVAL

As mentioned previously, the aft third of the deck was replaced in 1998, using a combination of traditional materials and modern materials. While this portion of the deck does not need to be

extensively documented as the original portion does, nor does it face the lead paint contamination issues, it will still require significant effort to remove. According to laborers who worked on the replacement, the planks were attached to the metal frames with galvanized lag bolts and a modern marine adhesive that will be difficult to remove. Oakum, cotton and hot tar were then used to caulk the seams between planks.

This portion of the deck should also be removed, as it is not in good condition and will not “knit” well with the new deck. However, it does not have the issues that complicate the original deck removal, as it does not need to be extensively documented and does not need to be disposed of by abatement professionals.

Work Description:

- Remove deck material in stages by cutting the planks and plywood out
- Clean bedding compounds from the metal frames the deck was affixed to using hand tools

Cost estimate: \$6,000, including labor, tools, materials and disposal

Time estimate: 2 weeks

DECKHOUSE STABILIZATION

At the beginning of the PEA process, OTM Inc was asked to investigate the possibility of replacing the radio shack and wheelhouse with new structures, due to the deterioration of the existing houses. Professional shipwrights and carpenters inspected the deckhouses and determined that they are in good enough condition to save and restore after the deck is replaced. However, they must be stabilized during the replacement process and treated to prevent the existing rot from affecting the new deck.

The deckhouses rest on foundation pieces called carlins, pieces of lumber attached to the deck planks. These are in poor condition and must be removed anyway to lay new planks. Replacing the carlins will also assist in preserving the Lightship No. 83 in two important ways. First, it will create a buffer between the rotted portions of the deckhouses and the new deck material. Second, it will allow the deckhouses to be suspended during the deck replacement process, rather than lifted up. Suspending the deckhouses is a less invasive method, as electrical, plumbing, steering and other systems will not need to be stretched or disconnected, and can instead remain relatively undisturbed.

Work description:

After removing most of the original and replacement deck, professional shipwrights will:

- Cut the remaining portions of the deck away
- Support the deckhouses with steel beams and an internal frame
- Remove existing carlins in preparation for building the deck underneath them

Cost estimate: \$30,000, including labor and materials to both stabilize the houses and replace the carlins; specific costs will vary according to the method developed by shipwrights

Time estimate: 2 weeks

DECK REPLACEMENT

As discussed in the Condition Report section of this document, the deck is in poor condition and replacing it should be the highest priority for the rehabilitation project. As requested, OTM Inc investigated three deck replacement options: a traditional planked and caulked deck, a plywood composite deck, and a rolled steel deck. Of these options, the traditional planked deck is the far superior option for its durability, ease of maintenance and repair, cost-effectiveness, and authenticity.

There are several properties of the Lightship No. 83 that must be considered during a deck replacement project. First, it employs a “hybrid” construction technique, with a steel hull and a planked wooden deck laid over steel frames. Second, the deck has many “protrusions” — fixtures and equipment that go through the deck, such as the smokestack, vents, diaphone air system, and hatches. These are all separately framed with “marginboards” as discussed in the *Documentation* section earlier. These are complicated pieces of the deck, as they are precisely measured and installed to prevent leaks around the protrusions. Third, portions of the original deck below the deckhouses may be in stable condition and are worth saving to illustrate the original construction techniques. If inspection deems it worth saving, these original planks can be “knitted” into the new deck, especially if the traditional planked and caulked method is chosen.

Additionally, there is evidence of a canvas covering over the original planked deck. While this may be an original feature of the vessel, OTM did not investigate the possibility of replacing it during the federally funded rehabilitation project. If the planked and caulked method is chosen, it is easy to maintain without a canvas covering and canvas can be added at a later date if NWS determines that it is more historically accurate than a bare deck. If the plywood method is chosen, the plywood will need to be covered with fiberglass that can be treated to resemble canvas.

STAGING

Prior to replacing the deck, the Lightship No. 83 must be prepared for the project. As discussed earlier, the preparation activities outlined here are only for the planked and caulked and the plywood replacement option, not for the rolled steel option.

Work description:

- Cover the Lightship No. 83 with a plastic wrapping to protect the worksite and prevent wind and water from complicating the work
- Install temporary catwalks, ramps and other supports for laborers and materials while installing the decks

Cost Estimate: \$6,000, including labor, materials and any necessary permits

Time estimate: 2 weeks. Portions of this step can be accomplished at the same time as other preparation steps

PLANKED & CAULKED DECK

The first replacement option that OTM Inc investigated is the traditional planked and caulked deck. In this method, fir or other softwood planks would be fastened to the steel frames with lag bolts, and then caulked with oakum and hot tar. With the proper maintenance, this method will last for decades and provide an authentic experience for visitors.

Work description:

- Prepare and remove the existing deck as discussed in previous sections
- Install timber marginboards around the perimeter and coverboards around protrusions
- Choose a center line on vessel and begin laying planking out towards the margins, fastening it to the metal frames with galvanized lag bolts
- Caulk the seams between each plank with oakum and hot tar
- Caulk the seams between planks and marginboards or coverboards with hot tar
- Implement a maintenance plan as soon as feasible, as keeping the decks sluiced and sauced will keep them watertight for a long time

Cost estimate: \$310,000, including labor, materials, supplies, tools and lumber.

Time estimate: 12 to 16 weeks, depending on number of shipwrights

Evaluation:

The advantages of a planked and caulked deck are:

- The deck will last from between 50 and 100 years with the proper maintenance
- Project costs are easy to predict since the price of lumber remains steady and labor follows a time-tested pattern
- The surface is durable and resistant to damage from foot traffic, as planks flex individually rather than as a section
- The individual planks or sections can be replaced easily
- Damage is easy to detect and repair, as all layers of the deck are visible
- The replacement process supports traditional shipwrights in Seattle's maritime industry community
- The ongoing maintenance and repair provides opportunities for educational programs, volunteer involvement and other interpretive functions
- It replicates the original techniques used when constructing the Lightship No. 83, upholding its authenticity as a museum ship and National Historic Landmark

The disadvantages of a planked and caulked deck are:

- Obtaining lumber in the quantity and quality needed for such a project can be difficult without knowledge of the market
- Lumber for the deck must be cut during the winter and stored for at least a year to ensure that it is cured properly and will not warp after installation
- Regular maintenance is required to maintain its integrity

PLYWOOD COMPOSITE DECK

The second replacement option that OTM Inc investigated is a plywood composite deck. In this method, three layers of 1" marine plywood would be fastened to the steel frames with lag bolts and marine adhesive compounds, and then covered with a fiberglass membrane. This method has been used successfully in several historic ship restoration projects, but it is not well suited to the unique properties of the Lightship No. 83.

Work description:

- Prepare and remove the existing deck as discussed in previous sections
- Install timber marginboards around the perimeter and coverboards around protrusions
- Lay first layer of plywood on steel frames, devise clamping system to hold it in place
- Lay second layer of plywood on first, using marine adhesive to bind the layers in place
- Lay third layer of plywood on second, using marine adhesive to bind the layers in place
- Bolt plywood to metal frames with galvanized lag bolts
- Lay fiberglass membrane over plywood and around protrusions

Cost estimate: \$250,000, including labor, materials, supplies, tools, lumber and plywood.

Time estimate: 8 to 12 weeks, depending on number of shipwrights contractor hires

Evaluation:

According to the shipwrights that OTM Inc consulted with, many advantages of a plywood deck are best made in comparison to the disadvantages of a planked and caulked deck.

The advantages of a plywood composite deck are:

- Most materials can be purchased immediately prior to installation
- It is easier to ensure the quality of materials, as they are highly processed and commercially sold
- Less labor is required during installation
- The long-term maintenance for a plywood deck consists mostly of inspection and sweeping.

The disadvantages of a plywood composite deck are:

- The deck will last for approximately 10 to 20 years with the proper maintenance
- The deck cannot be replaced in sections, as the layering and adhesive process makes it effectively a single piece
- Damage is difficult to detect, as water leaks can spread between plywood layers and cause extensive damage before it becomes visible
- The deck protrusions are difficult to seal, as fiberglass is less pliable than oakum and tar
- The original deck planks that can be retained will be difficult to knit into the plywood composite
- Project costs are difficult to estimate, as plywood costs rise and fall in response to market demands

ROLLED STEEL DECK

The third replacement option that OTM Inc investigated is a rolled steel deck. In this method, sheets of steel are shaped and welded onto the metal frames, creating a shell that replicates the curve of the original deck. As discussed below, this option is considered a very poor choice for the Lightship No. 83—so poor that the shipwrights and shipyard managers that OTM Inc consulted with were extremely reluctant to even prepare a bid or describe the process.

Despite these opinions, the rolled steel option is described here so that NWS may make its own decision regarding the best deck replacement option for the Lightship No. 83.

Work description:

- Remove *all* fixtures above the level of the deck, including the skylights, hatches, steering equipment, deckhouses, masts and rigging, and store offsite for the duration of the deck replacement
- Sandblast metal frames to remove all traces of paint and sealant in preparation for welding; evaluate replacing frames themselves if unable to clean them sufficiently
- Roll and shape sheets of steel, fit to deck shape and weld to frames with metal shims
- Cut holes in laid deck and replace deck fixtures such as masts and deckhouses
- Apply nonstick finish to metal deck

Cost estimate: \$600,000, including labor, materials, welding permits and supplies

Time estimate: The consultants OTM Inc spoke to regarding the rolled steel option were unwilling to provide a time estimate, as the timing depends on so many disparate factors

Evaluation:

The advantages of a steel deck are:

- Durability
- Little maintenance required other than yearly paint
- Leaks are rare and easy to repair and prevent

The disadvantages of a steel deck are:

- The process is very expensive due to the setup required
- Welding requires that the materials be very clean and in excellent condition, especially due to the presence of lead paint
- Shims to level the deck will need to be made from steel, rather than wood, adding to time and expense
- The shell created by the steel plates will be hollow-sounding and have a flex not present in a planked or plywood composite deck
- Retaining portions of the original deck as is possible with both the planked and caulked or plywood composite replacement options would be impossible
- The authenticity of the vessel would be greatly sacrificed on many levels, from the deck's appearance and character to the vessel's status as a "hybrid" steel-and-wood vessel

While a steel and wood composite option, in which a veneer resembling planks is laid over a steel deck, was briefly discussed, this option would be preventatively expensive and include many disadvantages inherent to the plywood composite deck, such as water infiltrating and pooling between layers.

RECOMMENDATION

After reviewing these three deck replacement options, OTM Inc strongly recommends that NWS use the traditional planked and caulked method. Discarding the rolled steel deck as unfeasible for the reasons given above, this section will focus on comparing the planked and caulked option with the plywood composite option.

Price: The main advantage that the plywood composite option has over the planked and caulked option is an initial lower price and lower installation time. However, according to professional shipwrights, the most time- and labor-intensive process of the deck replacement will be shaping and installing the marginboards and coverboards—a process required for both options.

Additionally, this cost and time advantage are only in the estimate. As stated previously, the price of plywood fluctuates much more than does the price of lumber. If NWS chooses to replace the deck at a time that the price of plywood happens to be high, the difference in cost between the two options may be smaller than presented in this document.

Durability: Plywood composite decks have been used successfully in some applications such as the top of houses and low-traffic upper decks, creating durable surfaces for a significantly lower cost. However, these successful plywood decks have been installed in areas that do not have the complicated protrusions that are a feature of the Lightship No. 83, and that are not subject to the repeated flexing and bending caused by footsteps. Protrusions also necessitate the installation of coverboards as discussed previously, and are the area of the deck most likely to develop leaks.

Authenticity: As a museum ship and National Historic Landmark, authenticity is a vital property of any restoration technique used on the Lightship No. 83. As the vessel originally had a planked and caulked deck, this is considered the best replacement option to retain its authenticity

Long-Term Maintenance: A traditional planked and caulked deck can be higher-maintenance than a plywood composite deck, as it requires ongoing inspection, sluicing with water and oils, and other activities. However, with these ongoing activities, planked and caulked decks can last for decades, while a plywood deck enjoys a much shorter functional life.

Use: A final consideration is the Lightship No. 83's use. As a museum ship, it is to be open to the public and used as a platform for educational programs. It is therefore desirable to use both the most durable option and the option that enables the most programming opportunities. A planked and caulked deck is not only more durable and repairable than a plywood composite deck, but it creates numerous programming opportunities. These range from a volunteer-managed maintenance program to caulking demonstrations and workshops.

HULL

Following the deck replacement, OTM Inc recommends beginning the long-term restoration of the Lightship No. 83's steel hull. As discussed in the Condition Report section of this document, the hull is deteriorated but can be considered in stable condition. Restoration should be undertaken in discrete projects, addressing one section of the hull at a time. This process can be started by conducting a preliminary survey and needle-scaling of the worst areas in of the hull, then dry-docking the vessel and welding doubler patches onto temporarily patched areas. This dry-dock period will also be a chance to clean and paint the hull, service the through-hull fixtures, and reinstall the deck fixtures removed prior to the deck replacement.

Following the dry-dock period, OTM Inc recommends developing a long-term hull restoration plan for the vessel to be accomplished as resources allow.

SURVEY

OTM Inc recommends beginning the hull restoration with a survey to determine the areas of the hull in the worst condition. This survey will both allow NWS to create a long-term plan for which areas to restore and address the worst areas during the initial dry-dock period.

Work description:

- Conduct a visual inspection of the vessel's bilge compartments and identify areas at risk for extensive corrosion
- Needle-scale selected areas and apply temporary bung-and-cement patches to any holes bored in the hull
- Document location of temporary patches to plan for permanent doubler patches

Cost estimate: \$5,000, including labor, materials, and equipment

Time estimate: 1 week

HAUL-OUT

Following the survey and temporary patching, OTM Inc recommends dry-docking the Lightship No. 83. In addition to welding permanent doubler patches to the hull, this dry-dock period will allow NWS to accomplish a variety of maintenance and restoration activities on the vessel.

Work description:

- Dry-dock the Lightship No. 83
- Inspect and service starboard sea chest and overboard discharge pipes, replacing sections as necessary
- Remove temporary concrete patch from port sea chest, inspect, and make repairs as necessary
- Reinstall deck fixtures removed for deck replacement
- Pressure-wash and inspect the exterior of the hull, paying attention to overall condition, previous repairs, and visibly deteriorated areas
- Weld doubler patches over temporary patches
- Install new zincs to slow electrolytic wasting

Cost estimate: \$45,000, including shipyard fees, labor, materials, and equipment rentals

Time estimate: 2 weeks

LONG-TERM RESTORATION & MAINTENANCE

After completing the dry-dock period, OTM Inc recommends implementing a long-term restoration plan for the hull following the method used for the *Maris Pearl* of inspecting, patching, and repairing specific parts of the hull described in the *Case Studies* subsection of this document. This process can be considered ongoing for the duration of the Lightship No. 83's lifespan, and can be accomplished as NWS's resources allow.

ADDITIONAL RECOMMENDATIONS

During its research and consultations, OTM Inc found several additional projects and activities that enhance those performed during the rehabilitation period.

MAINTENANCE PLAN

OTM Inc strongly recommends that NWS develops and implements a detailed, regular maintenance plan for the Lightship No. 83 as soon as possible. This maintenance plan should include yearly activities such as painting the exterior fixtures and structures, exercising the equipment and systems, and cleaning the deck and compartments. The maintenance plan should change and expand as portions of the vessel are restored, ensuring that the work performed during the rehabilitation period is most effective.

Implementing a maintenance plan is also an opportunity for NWS to create programming, volunteer tasks, and work exchanges that enhance the vessel's use as a museum attraction.

ONGOING HULL WORK

As discussed in the previous *Hull* section, the most efficient and effective way to restore and maintain a riveted steel hull is through continual needle-scaling, painting, and patching. OTM Inc recommends developing and implementing a long-term restoration plan in which discrete sections of the hull are scaled and painted on a routine basis. This restoration plan should also set a regular schedule for dry-docking the vessel to apply the permanent welded doubler patches.

GANGWAY

To support the Lightship No. 83 as a heritage vessel and museum ship open to the public, OTM Inc strongly recommends installing a sturdy and permanent gangway to access the vessel from the dock. As the lightship has high sides and rises above the Historic Ships Wharf where it is permanently moored, it can be difficult for mobility-impaired visitors to access. The current gangway is adequate for staff, contractor, and agile visitor access, but will be a barrier for access by a broad museum audience.

OTM Inc recommends that NWS consult with the administrators of the Historic Ships Wharf and Lake Union Park to determine a gangway option more suitable for the vessel's use as a museum ship.

RESTORATION PROJECTS

After replacing the deck and addressing the other projects recommended in this document, OTM Inc recommends planning additional discrete restoration projects. The projects may include renovating interior spaces, such as the Officer's Quarters and Crew Mess, restoring the radio equipment to working condition, or stabilizing and restoring the Wheelhouse.

EQUIPMENT SERVICE

OTM Inc also recommends servicing the equipment aboard the Lightship No. 83, including the steam plant, diesel air compressor, and siren. These pieces of equipment should be easy to restore to working order and maintain. The air compressor and siren can be used and tested on their own power, while the steam plant can be turned over on compressed air or steam from an external source.

Farther into the future, NWS may consider repairing the disassembled diesel air compressor and generators and restoring the systems that connect them to the vessel. Additionally, the organization may consider restoring the steam boilers, though this will be an extensive undertaking that should be carefully planned and evaluated for feasibility and benefit.

PROGRAMMING OPPORTUNITIES

Finally, OTM Inc recommends that NWS investigate opportunities that use the Lightship No. 83 as a platform for educational and experiential programs. The organization has an excellent precedent in its Diesel Engine Theory workshop series and Hull Survey Workshop that utilize the tugboat *Arthur Foss*, and in the Engineer for a Day programs aboard all four National Historic Landmark vessels (including the Lightship No. 83) at the Historic Ships Wharf.

In addition to these restoration and engineering programs, the Lightship No. 83 can be a platform for a unique programming opportunity: a riveting workshop. While maritime and even broad American culture has an awareness of riveted hull construction due to the extensive WWII production of vessels and airplanes, this technique is becoming a lost art. OTM Inc is not aware of any other institutions in the United States offering courses on riveted steel hull construction, which allows NWS to pioneer a potentially ground-breaking program.

APPENDIX: SAMPLE NEEDLE-SCALING

Figure 1: Aft engine room bulkhead before sample needle scaling



OTM Inc selected an area on the aft engine room bulkhead, just behind the ladder access to the workshop space, for sample needle-scaling. The bulkhead showed visible corrosion, but appeared solid beneath damage to the paint.

Figure 2: Aft engine room bulkhead after sample needle scaling



OTM Inc discovered through sample needle-scaling this area that the corrosion extended beneath the surface of the bulkhead and that damage to the metal was more extensive than visible before needle-scaling. However, after removing the corrosion with the needle-scaler, the remaining metal seemed in good condition.

As the water pooling in the Lightship No. 83 is attacking the vessel's hull in the same manner as its bulkheads, this demonstrates that while portions of the hull may be in poor condition, there are likely far larger portions that are in good condition and can be patched, following the systematic system used on the tugboat *Maris Pearl*.