USS *Yorktown* Remediation Plan
Final

Submitted to:

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List of Acronyms and Definitions

ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos-containing material
AFFF	aqueous fire-fighting foam
AIHA	American Industrial Hygiene Association
AL	Action Level
APP	Aft Perpendicular: A line drawn perpendicularly to the load line through the after side of
CIH	Certified Industrial Hygienist
EL	Excursion Limit
f/cc	fibers per cubic centimeter
FO	fuel oil
FPP	Forward Perpendicular: A vertical line passing through the intersection of the designed
FW	fresh water
HFO	heavy fuel oil
LBP	lead-based paint
LO	lube oil
LT	Long ton, equal to 2,240 pounds
mT	Metric ton, equal to 2,204.6 pounds
$\mu g/m^3$	micrograms per cubic meter
mg/cm^2	milligrams per square centimeter
NIOSH	National Institute for Occupational Safety and Health
O&M	Operations and Management
OSHA	U.S. Occupational Safety and Health Administration
OW	oily water
PCB(s)	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
PLM	Polarized Light Microscopy
ppt	parts per thousand
PACM	Presumed asbestos-containing material
REL	Recommended Exposure Limit
SAI	Scientific Analytical Institute, Inc.
SCDHE	South Carolina Department of Health and Environmental Control
sT	Short ton, equal to 2,000 pounds
STEL	Short-term Exposure Limit
Super	Superstructure: Portion of the vessel that extends above the flight deck, also referred to as
SW	salt water
TEM	Transmission Electron Microscopy
TLV	threshold limit value
TWA	Time-Weighted Average
USEPA	U.S. Environmental Protection Agency
XRF	X-ray fluorescence: A non-destructive analytical technique used to determine the elemental composition of materials.

Chapter 1: Introduction to the USS *Yorktown* Remediation Plan

The South Carolina Office of Resilience (SCOR) commissioned an environmental assessment of the USS *Yorktown* in November 2022, with Research Planning, Inc. (RPI) as the prime contractor and T&T Salvage, LLC (T&T), Johnson, Mirmiran & Thompson, Inc. (JMT), and GEL Laboratories LLC (GEL) as subcontractors to RPI.

The USS *Yorktown* is an Essex-class aircraft carrier first commissioned in 1943. She was converted under the SCB-27A program as an attack aircraft carrier, CVA-10, in the 1950s. This conversion included the addition of blister tanks, faired into the existing hull. An angled deck was added in 1955. She was converted to an anti-submarine aircraft carrier in 1957, redesignated CVS-10. She was decommissioned in 1970. The USS *Yorktown* was donated to Patriots Point Development Authority in 1975, relocated to Charleston, and has remained the centerpiece of Patriots Point Naval & Maritime Museum since then. In the U.S. Navy donation contract, the State of South Carolina indicated its intention to preserve and exhibit the vessel and committed to making and keeping the USS *Yorktown* safe and presentable for public exhibition. Several undocumented modifications have been made to the vessel since 1975.

The USS *Yorktown* is currently moored in Charleston harbor with the keel buried to a depth of approximately 28 feet in soft bottom silt. Above the silt line, there is open water on the port side and tidal marsh on the starboard side, and the ship's hull is subjected to tidal ebb and flow. Localized areas of the ship's hull, particularly in the tidal splash zone, have experienced extensive corrosion with significant through-hull penetration. It is anticipated that the USS *Yorktown* will require significant repairs for it to remain a viable museum for the foreseeable future.

At the time of the deactivation of the USS *Yorktown*, the extensive procedures prescribed by the Navy today, S9086-BS-STM-010 [0910-LP-104-3949, rev 3], were not in place. The U.S. Navy made the USS *Yorktown* available to South Carolina "as is" and "without warranty." Consequently, the USS *Yorktown* still contains significant quantities of potentially hazardous materials. The objectives of the environmental assessment for the USS *Yorktown* are to comprehensively identify and inventory the types and quantities of these materials currently on the vessel, provide current remediation cost estimates, and prepare drawings and specifications for a future remediation and environmental cleanup bid, should funding become available. This assessment is important because of the very high sensitivity of the animals and habitats in the Cooper and Wando Rivers, adjacent tidal creeks, and outer beaches that would be affected by a release of oil and other contaminants from the USS *Yorktown*, particularly considering the deteriorating condition of the hull.

The project was divided into the following tasks and subtasks:

- Task 1. Project Administration and Stakeholder Meetings
- Task 2. Data Gathering, Analysis, and Report
    - 2.1. Catalogue all areas, tanks, and compartments within the USS *Yorktown*;

2.2. Identify all areas, tanks, and compartments that may be contaminated and provide a plan detailing how to access all areas;
2.3. Identify all environmental contaminants presently found or likely to be found on the USS *Yorktown*;
2.4. Prioritize the hazards of each contaminant to the environment and people; and
2.5. Provide a preliminary updated cost estimate to mitigate each type of contaminant.
2.6. Submit the Study to SCOR

Task 3. Environmental Report, Permitting, and Bid Documents
3.1. Prepared an Environmental Document pursuant to the National Environmental Protection Act;
3.2. Prepare Bid Documents Pursuant to the South Carolina Office of State Engineer Manual;
3.3. Prepare a detailed cost estimate for the mitigation; and
3.4. Identify necessary permits for the mitigation.

This report provides the results of the work performed under Tasks 2.1 to 2.4. These results will be used to inform regulatory agencies and stakeholders about the proposed remediation plans and to prepare costs estimates, bid documents, and the environmental reports, which will also identify the required permits for remediation activities.

This report consists of five chapters:

Chapter 1 is the introduction to the project;
Chapter 2 is a summary of the field survey conducted to identify the contaminants onboard the USS *Yorktown*;
Chapter 3 is the environmental risk assessment;
Chapter 4 is the human health risk assessment; and
Chapter 5 is a summary of proposed remediation plan.

All of the survey data and photographs collected by the survey teams using the Esri® application Survey123, the raw spreadsheets for these data, the AutoCAD drawings for each deck and the Liquid Loads that were generated by the survey team, consolidated spreadsheets of all the laboratory results provided by GEL, the HELSALV Condition report and definitions used therein, and a spreadsheet with the non-structural tank data collected by the survey team. In addition, the certifications for the GEL Certified Industrial Hygienist, asbestos license, and lead training certifications are also provided. These attachments contain all of the data, photographs, and work products of the study.

Chapter 2: Results of the Field Study of the USS *Yorktown*

2.1 Background Information

T&T was the lead on for the on-site survey of the USS *Yorktown*. A preliminary survey was completed in November 2022, for the team to become familiar with the general arrangement, Patriots Point Naval and Maritime Museum facilities, and general hazards, and plan accordingly. A catalogue of areas, tanks, and compartments, based on the drawings available, was developed prior to conducting the on-site survey. The work to complete the on-site survey began on 11 January 2023, mobilizing personnel and equipment to the site, with all personnel demobilized on 28 February 2023. GEL provided services for contaminant sample collection and testing, assessment, and human risk assessment guidance from a Certified Industrial Hygienist (CIH).

Field observations were recorded on two platforms: 1) a mobile survey application using ArcGIS Survey123 Esri® that was developed and supported by RPI; and 2) a vessel loading program, HECSALV by Herbert-ABS. Tank contents and loads were calculated and reported in the HECSALV application, and all other spaces were recorded in the Survey123 application. Sample collection information was recorded in Survey123, as well as lead paint detection records performed by GEL.

Personnel were organized into three survey teams, two focusing on sounding and sampling structural tanks, and a third team focusing on compartments, engineering spaces, and systems. As the survey progressed and the structural tank assessment was completed, the teams were reorganized to cover compartments, flooded extents, and non-structural tank surveys. The on-site personnel consisted of:

- (1) Project Manager
- (1) Salvage Master
- (2) Salvage Officers
- (2) Naval Architects
- (1) Marine Engineer
- (5) Salvage Technicians
- (1) Logistics Coordinator

The survey and field data have been compiled and summarized in this chapter. Detailed reports are available as appendices or attachments. Preliminary mitigation measures for the removal of hydrocarbons are recommended here. These recommendations are based solely on experience and previous T&T projects in the maritime industry.

2.2 Vessel References

During the pre-survey visit in November 2022, T&T was provided the AutoCAD 2006 blueprints. The drawings contained errors with respect to scale, frame references, and other details. Museum staff provided electronic and physical copies of Damage Control plates for all decks and piping systems. A Booklet of General Plans (1953) and lightship weight distribution was obtained from the U.S. National Archives in College Park, MD. A pre-survey compartment catalog was created from various drawing sources. Comprehensive post-service modification records are unavailable. Naming convention conflicts were observed between physical nameplates, compartment bullseyes, and drawings. The drawings were referenced in the following preferential order for the survey and reporting:

1. 1955 Booklet of General Plans, Complete
2. 1962 Booklet of General Plans, Incomplete
3. 1968 Corrected Damage Control Plates, Complete
4. 2006 AutoCAD Blueprints

The set of 2006 AutoCAD drawings were revised, making corrections to scale and longitudinal references. The intended use of the drawings is for the purpose of the survey, to record and illustrate the areas of interest. The drawings will be made available to SCOR and the park staff. Please note the drawings are not presented as-built or warranted regarding content. There are modifications throughout the vessel that are not represented in the drawings.

2.3 Preliminary Catalogue/Hydrostatics Model

Prior to the survey, a catalogue of spaces was generated from the review of the plans listed above. Approximately 800 spaces, areas, and compartments were identified (Table 2-1).

Table 2-1. Number of compartments by deck level.

03-010	Island/ Superstructure	50
02	Gallery Deck	146
01	Forecastle Deck	42
	Main Deck	64
2nd		166
3rd		101
4th		113
5th	1st Platform	56
6th	2nd Platform	32
7th	Hold	19
	Main Eng. Spaces	10
	Total	799

During the survey, several spaces were observed to be modified or were found to be different than the representation on drawings. The modifications include but are not limited to spaces being combined by removing bulkheads or structure and or further subdivision through the addition of partitions or exhibits.

An interactive model of the hull and structural tanks was developed. Rhino3D was used to develop a 3-dimensional hull surface, which was then imported into General Hydrostatics Software (GHS) to create tank boundaries. This geometry file was then imported into HECSALV, a loading program, which was used throughout the survey for recording the tank fluid levels.

A loaded condition report groups the tanks according to contents, providing the quantities of fluid in each tank. The report includes information typical to normal conditions such as displacement, ground reaction, forward and aft drafts, heel, and trim, along with additional information.

The hydrostatic model is comprised of 420 individual tanks and a hull form. Including the compartments, the total estimated number of spaces onboard, prior to the survey, was 1,219. Figure 2-1 shows the geometry of the hull below the main deck and structural tanks, as modeled.

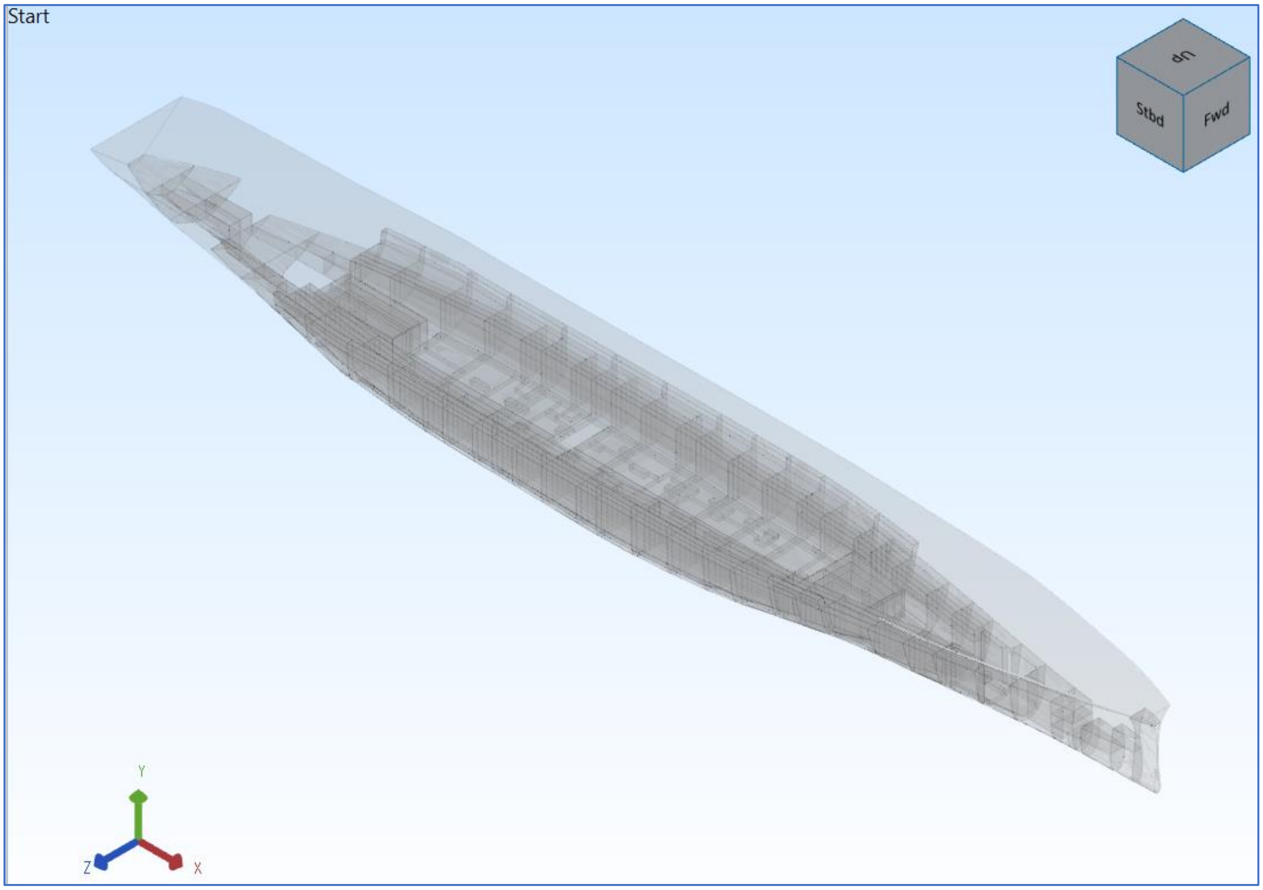


Figure 2-1. HECSALV model of structural tanks and hull form.

Figure 2-2 shows an elevation cross section of the USS Yorktown, with all of the decks labeled.

Figure 2-2. Elevation cross-section of the USS *Yorktown*.

2.4 Previous Surveys and References

Digital copies were provided of the "Structural Assessment of the USS *Yorktown* CV-10" prepared by Collins Engineers in 2014 (hereafter referred to as "Collins Report") and the 2013 "USS *Yorktown* Summary Report and Final Deliverables Package", prepared by Shaw Environmental and Infrastructure (hereafter referred to as "Shaw Report).

The Collins Report focuses on structural integrity below the waterline, noting the presence of contaminants. The Shaw Report focuses on the presence of hazardous materials referencing five categories:

1. Task 1, Structural Tanks
2. Task 2, Hydraulic Control Stations
3. Task 3, PCB Contaminated Material
4. Task 4, Miscellaneous Hazardous Material
5. Task 5, Non-Structural Tanks

2.5 Survey Plan for Contaminant Source Sampling

2.5.1 Potential Sources of Polychlorinated Biphenyls (PCB) Contamination

Potential PCB surface sources included:

- Rubber and felt gasket material.
- Thermal insulation material including fiberglass, felt, foam, and cork
- Voltage regulators, switches, reclosers, bushings, and electromagnets
- Electronic equipment, switchboards, and consoles
- Adhesives and tapes
- Oil-based paint
- Caulking
- Rubber isolation mounts
- Foundation mounts
- Pipe hangers
- Plastics
- Flight deck wood

Potential PCB liquids included:

- Oil used in electrical equipment and motors, anchor windlasses, hydraulic systems, and leaks and spills from the same.

Potential PCB encapsulated sources included:

- Transformers, capacitors, and electronic equipment with capacitors and transformers
- Fluorescent light ballasts
- Armored electrical cable
- Installed flight deck wood

Survey teams noted the presence of the following items:

- Hydraulic systems
- Machinery, motors, and equipment
- Transformers
- Thermal insulation
- Electronic equipment

The teams quantified the volume of hydraulic fluids in the reservoir/storage tanks of systems where leaks or evidence of a leak is observed and in systems of significant quantities.
The following items were found throughout the vessel except for inside tanks, voids (U.S. Coast Guard definition):

- Pipe hangers
- Wire cables (electrical)
- Caulking
- Electrical distribution panels
- Fluorescent lighting

Abnormalities, deficiencies, damaged or leaking systems were noted, and spaces flagged for remediation and wipe sampling, as follows:

- Bulk samples collected where accessible.
- Wipe samples were taken by GEL representatives from machinery and system fluids/ lubricants where directly accessible and or are observed to be leaking.
- Blueprints
- Flight deck wood that is not encapsulated

2.5.2 Potential Sources of Asbestos Contamination

Sources of asbestos on the USS *Yorktown* included:

- Floor tile
- Insulation (all types: wall, ceiling, piping, reg backing, fire hose jacket, brick, ducting, mastic, insulation wrap)
- Wire insulation

The survey team noted the presence of lagging, insulation, and floor tiles. Deficiencies or damage to the insulation or suspected asbestos-containing materials (ACM) was documented for review by the CIH. Quantities will be reported for the extents of the damaged areas only.
Electrical wiring and distribution panels are found throughout the vessel, except for voids. The survey team identified spaces where the wiring has been cut or the distribution panel or switchboard is damaged. Discrepancy logs were recorded in the Survey 123 application.
Type and damaged sampling was conducted for each of the documented materials found in preliminary surveys. These include (per advice from GEL):

- Hard cover, hard core pipe insulation
- Hard cover, soft core insulation
- Textile wrap, soft core insulation
- Repaired locations – textile wrap, mastic
- Bulkhead (wallboard) insulation
- Overhead insulation
- Fire hose jacket
- Armored electrical wires (1.5”, 1”, 5/8”)
- Asbestos tiles (all 9” x9” colors or patterns encountered)
- Texture paint

GEL was responsible for identification and selection of sites for sampling for both type and damaged.

2.5.3 Potential Sources of Lead-based Paint Contamination

Lead-based paint is suspected throughout the entire vessel. Topcoats and or undercoats may not contain lead. An XRF Analyzer was used to test both the intact coating system and flaking paint. The extent of testing was to a level of effort that satisfies the Industrial Hygienist, with a goal of testing all representative coating systems, and with 100% *type* coverage in public areas. The sampling locations were logged using the Survey123 app, including the results of the positive tests.

2.5.4 Other Contamination Sources

Containers, buckets, and drums suspected to contain hazardous contaminants that are no longer in use will be flagged for removal.
The items listed below will be addressed in a general guidance statement regarding risk and appropriate action based on the locations where they are found.

- Fluorescent lights
- Mercury switches
- Batteries
- Orphaned containers
- Unknown or other (to be determined and evaluated as discovered)

2.6 Survey Methods

2.6.1 Types of Survey Areas

Four types of spaces on the USS *Yorktown* were defined for sampling as follows:

1. Public – Tour routes, exhibits and spaces used for hosting organizations or used for events.
2. Administrative – Office spaces and or other places frequented by staff and volunteers.
3. Maintenance and storage areas – Controlled areas entered routinely by maintenance staff and curators.

4. Restricted Areas – Posted and controlled areas, including areas that require a permit for entry.

Public spaces include tour routes, the overnight program accommodation areas, or areas dedicated for special events and hosting the public. Administrative areas are generally closed to the public and accessed by park staff or subcontractors only. These include all administration offices and curatorial spaces. Maintenance spaces are typically secured by means of a lock or access control, including hatches, grating, museum displays, and removable bulkheads. Restricted spaces are controlled areas that are posted with warnings and known to have hazardous conditions present. Table 2-2 shows the area of each of these types of spaces by deck level.

Table 2-2. Area of space types by deck level.

AREAS IN SQUARE FEET				
No.	Deck	Public	Admin.	Maint.
01	Forecastle Deck	12,731	3,685	5,589
02	Gallery Deck	18,862	19,674	30,359
	Main Deck	51,139	4,637	7,825
2	Second Deck	31,019	2,313	40,323
3	Third Deck	14,770	3,713	46,339
4	Fourth Deck	252	4,567	52,758
5	First Platform	4,421		26,883
6	Second Platform	4,421		17,028
7	Hold			15,395
	Totals	137,616	38,589	242,500

Please refer to the AutoCAD drawing/pdf print set of revised 2006 Blueprints dated March 2023 for detailed illustration of areas.

2.6.2 Compartments

Compartments were categorized and evaluated for contaminants per the directives outlined above. Teams noted the presence of physical hazards, such as broken ladders, open electrical panels, or general discrepancies with regards to safety. The presence of contaminants, and discrepancies/damage were noted in the Survey123 app. Photos were taken to provide a record of the conditions present and document findings. Quantitative values were noted for damaged insulation and floor tile as well as estimations of spill volumes and or affected area.

2.6.3 Tank Contents and Soundings

Soundings of fluid levels in tanks were recorded by measuring the ullage, or distance from a known reference point down to the fluid surface. References points were typically the tank top, or top of the sounding tube. If the contents of the surface were observed to be oil, an interface detection device was used to determine if water was present beneath the oil, measuring the ullage of the interface. Several tanks had a small quantity of heavy fuel tank on top of water. A bubbling device was used to verify this along with agitating the contents to reveal the underlying water. The measurable depth of the tank was recorded for reference. The depth measurement may provide an indication of sludge or sediment in some cases but may also indicate obstruction or curvature of the hull and or framing. Oil absorbents and test strips were used in tanks observed to contain water to detect the presence of oil. A refractometer was used to determine the specific gravity and corresponding salinity (in parts per thousand, ppt) of water contents.

2.6.4 Structural Tanks and Sampling

Tanks were grouped according to the contents, with the following observed types:

- Dry – Tank relatively empty; residuals may be present.
- HFO – Heavy fuel oil with "free water" present beneath the oil in all except for one tank.
- FW – Fresh water; reading up to 5.0 ppm salinity when tested in a refractometer.
- Brackish – Water tanks observed to have a salinity between 5.1-19.9 ppt.
- SW – Salt water; tanks observed to have a salinity of 20.0 ppm or greater.
- OW – Oily water; Tanks that contain water with a noticeable amount of light oil or sheen.
- LO – Lube oil tanks.
- FO – Fuel oil tanks.
- Damaged – Flooded or tidal influenced tanks.

The software program ArcGIS Survey 123 was used for field data collection, review, and reporting. Three survey formats were used to record the field data. The initial format was intended to be all encompassing; however, a clarification of sampling directives warranted a revision of the format and "modified" survey. Tank soundings, samplings, and contaminant sampling records remain in the first data set. General compartment surveys are in the modified data set, and a separate survey was created solely for lead-based paint detection records. In all there are 2,357 records comprised of:

- 560 tank entries, 168 of which are sample records;
- 412 original and 1,192 revised or modified compartment entries, 96 of which are sample records; and
- 193 lead-based paint detection entries.

The following types of samples were collected during the survey:

- Structural tank fluid samples (135):
    - 39 water samples from tanks containing water, tested for metals;
    - 54 water samples from tanks containing water, tested for diesel range organics;
    - 27 water samples from tanks containing oil and water, tested for diesel range organics;
    - 12 oil samples, from tanks containing oil and water, tested for diesel range organics;
    - 2 water samples from tanks containing oil and water, tested for metals; and
    - 1 oil sample from a tank containing oil, tested for diesel range organics.

- 5 bulk samples from hydraulic systems, tested for PCBs.
- 95 wipes were collected from various locations and tested for PCBs.

- 3 samples of armored electrical cable were collected to test for PCBs.
- 39 physical samples of materials were collected and tested for asbestos.

Please refer to the excel file log for details on the above. All samples were delivered to the GEL laboratory under chain of custody.

2.7 Contaminant Identification

2.7.1 Introduction

This section is a summary the findings of the over 2,000 field data entries collected. As the data set is quite large, sorting the data into generalized categories and or grouping may lead to inherent exceptions or inconsistency. We strongly encourage the referencing of the original records to determine the conditions at the time of the survey and resolve what appear to be discrepancies within the report summary and other forms of data. Many compartments have unique conditions, requiring specific mitigation measures and or evaluation. This information is intended to be used to evaluate the condition and develop a methodology for mitigation and or remediation, for budgetary planning.

The major contaminants identified during the survey are categorized as:

- Hydrocarbons
- Metals (dissolved in fluids)
- Asbestos
- PCBs
- Lead-based paint coatings
- Other – encompassing a variety of contaminants.

2.7.2 Hydrocarbons in Structural Tanks

Hydrocarbons were observed in the following forms of various grades:

- Heavy fuel oil
- Light oil
- Hydraulic oil
- Lubricating oil
- Lubricating grease

Some of the oils tested positive for containing PCBs. The results of these tests are discussed in Chapter 4.

The tanks were grouped according to the contents and fluid loads entered in the loading program. A “lightship” weight of 35,431 long tons (LT) was assumed based on documentation. The vessel was placed aground by entering the observed drafts and adjusting to a tide level of 0.0 feet per tide datum. The number of tanks for each of the observed contents are:

- 56 Dry

- 187 Fresh Water (FW)
- 19 Brackish Water (Brackish)
- 12 Salt Water (SW)
- 14 Oily Water (OW)
- 100 Heavy Fuel Oil (HFO)
- 28 Observed or presumed to be flooded
- 4 Inaccessible

Figures 2-3 and 2-4 provide an indication of the distribution of the types of contents. These are shaded illustrations of the Damage Control Diagram 1 – Liquid Loading drawing. This drawing is used to reference the tanks typically used for storing fluids when the vessel was in service. The drawing mainly shows the tanks below the 4th deck and double bottom tanks. Full size pdf files are included in the appendices and attachments.

Not shown in the illustrations are the third bottom and other voids/ cofferdams considered as tanks. Please refer to the HECSALV report for details. Several tanks containing HFO are integral to the hull plating. Previous reports and observations indicate the tidal zone of the hull has deteriorated and needs repair in several areas.

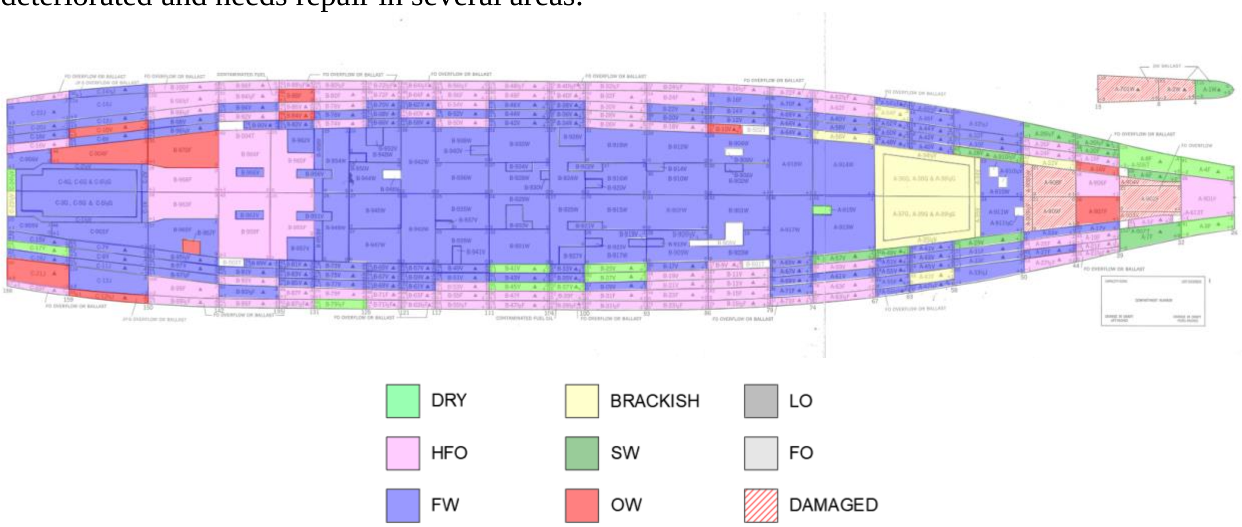


Figure 2-3. Distribution of tank content types per the Damage Control Diagram 1 - Liquid Loading drawing.

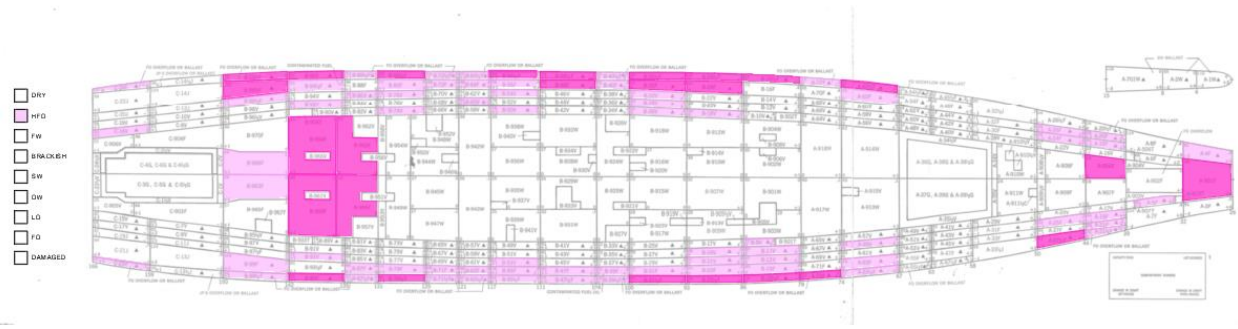


Figure 2-4. Tanks containing HFO (significant amounts in bold).

Figure 2-5 illustrates the distribution in an isometric view of the structural tank model. The quantity of each type of content observed is listed in Table 2-3.

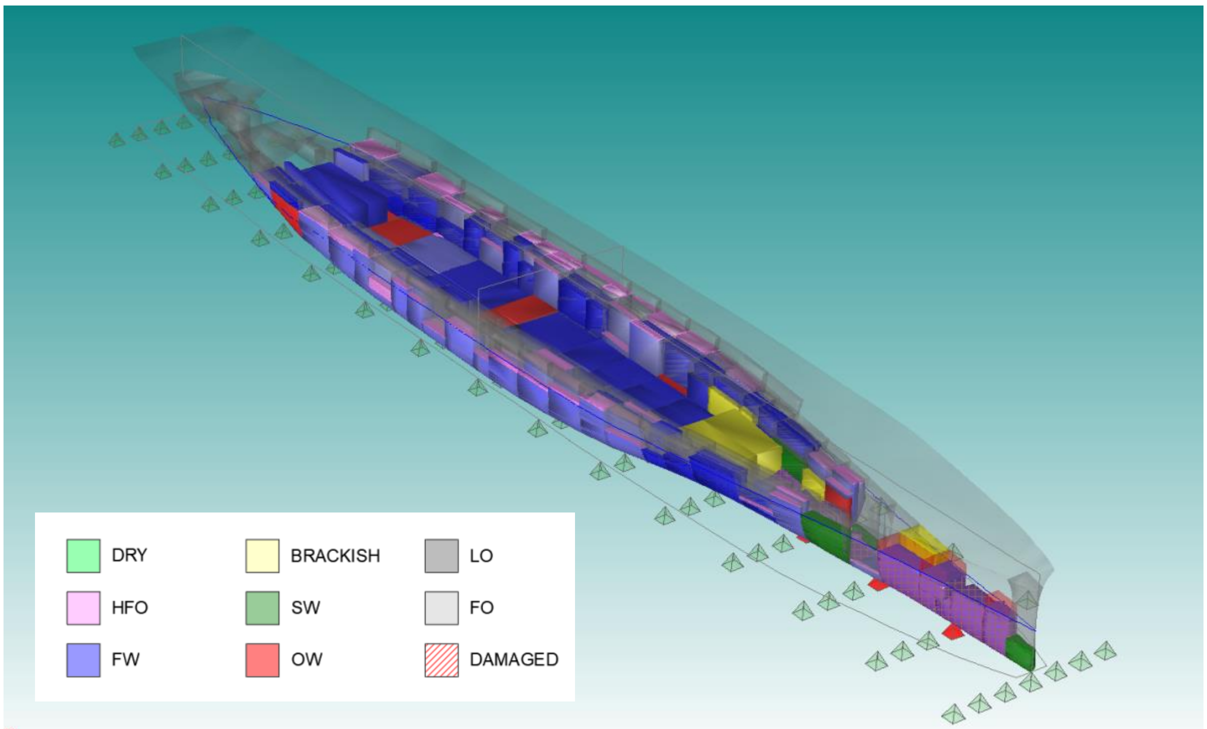


Figure 2-5. An isometric view of tank contents, shaded by type.

Table 2-3. Tank contents, reference pages 11 and 20 of the HECSALV report.

Group	Long Tons	U.S. gallons
Fresh Water	8,152	2,188,088
Brackish Water	1,141	301,224
Salt Water	577	152,328
Oily Water	421	111,144
Heavy Fuel Oil	244	65,390
Free Water	4,212	1,130,580
Flooded	1,177	308,374

Free water, for the purpose of this report, is the water in tanks which contain heavy fuel oil. The term is typically used in the oil and gas industry to refer to water that has separated from product. In addition to the quantities listed above and referenced in the HECSALV report (zero tidal reference), approximately 150,000 gallons of flooding in damaged compartments that were not represented in the structural tank model were observed (February 27, 2023). The volume is expected to vary with the tide and changing conditions on board. The estimate is based on the volume of the compartments forward of frame 26 (ref. Table 4), excluded from the structural tank model. The volume is adjusted for permeability and mean tide level. A sample was collected and tested for diesel range organics (A-521-W-01). Oil absorbent socks were observed in the access trunks. Pictures are available in the field logs.

A detailed HECSALV report is included for reference. To reference HFO, see the GOV column (Gross Oil Volume) under the HFO group of tanks. Please note GOV for other groups refers to intact volume of the contents, not additional oil. This is due to the unusual loading conditions evaluated. It is not typical to have HFO in ballast water or void tanks. It is common for tankers transporting crude oil to have relatively small amounts of free water in cargo tanks.

Access was gained to all the main gasoline tanks and surrounding cofferdams, except for A-618, which could not be accessed due to flooding. No traces of gasoline were found. A report from 1975 stated the gasoline systems had been flushed and pressed full of fresh water. The condition of the tanks supports this statement. A-618 contents are expected to be the same as the surrounding cofferdams, brackish.

Openings in the hull were noted above the tidal range during the survey but within the high high water range. Therefore, the extent of flooding is expected to increase or vary during seasonal high tide extremes.

2.7.3 Hydrocarbons in Non-Structural Tanks

Lubricating oil, diesel oil, and various grades of hydraulic oil are present in non-structural tanks, systems, and containers. These have been identified by referencing:

1. Capacity Plan
2. Systems Inspections (catapult, airplane elevator…)
3. Compartment Surveys: containers found.

Approximately 14,115 gallons of hydrocarbons are estimated to be present in non-structural tanks and systems. Many of these systems are hydraulic systems known or suspected to contain PCBs including catapult, arresting gear, elevator, crane, and anchor windlass systems.
Main engine lube oil sumps are presumed to contain oil at their operating levels. The sump manhole covers in B-4-1 (Forward Engine Room) were inspected and found to contain oil. Sump level indicating systems are inoperative, and levels cannot be determined from the access cover. A volume of 1,050 gallons is referenced from the Piping Systems book.

Several tanks are in public areas or above public areas. Lube Oil Settling and Storage tanks in B-4-1 contain a total of 2,814 gallons of oil. The manhole covers on this tank are weeping oil into the public engine room on Tour 1. The Aviation Lube Oil Ready Service Tank on 02-114 starboard side is in an area that directly opens into the public hangar deck below. This tank volume (100 gal) is calculated by the level at which oil was observed to be weeping from the inspection cover. Piping connections below this tank are open and plugged with damage control plugs. Oil residue is present on the deck. The Nose Gear retracting tank at A-0205-T is adjacent to the open overhead of the hangar deck.

Tanks designated for air and water are not considered in this assessment. Non-structural tanks or containers smaller than 15 gallons of water are not considered in the quantities reported. The majority of these tanks will be comprised of steam system components. Air receivers, condensing tanks, potable water system tanks, as well as in-service water and sewer tanks are excluded, aligning with the objective of identifying and quantifying contaminants. The prevalence of small containers, primarily portable five-gallon buckets or similar is minimal, but they were excluded from the record. However, if a large quantity of portable containers were observed in one space, it would be in the record (for example 20, five-gallon buckets of engine oil in storage or an atypical location). Other system components that may contain hydrocarbons or residues include oil heaters and coolers, strainers, and similar system process components. The Shaw report references were used when verified and appropriate.

The detailed results of the survey may be referenced in the excel spreadsheets as separate attachments.

2.7.4 Asbestos

A total of 39 samples were collected and tested for asbestos. The selection and extent of testing was per the guidance of the CIH from GEL. As discussed in more detail in Chapter 4, all 9 inch x 9 inch floor tiling and associated mastic, armored cable wiring, and pipe insulation tests confirmed ACM and similar materials onboard should be presumed to be ACM.

Notably, 12 inch x 12 inch floor tiles and associated mastic, wall board, textured paint, ceiling tiles, and dust sample" tested negative. The dust sample was taken from a stairway leading into Fire Room #4, adjacent to the public area, with ventilation coming from a machinery space.

There is piping and machinery lagging or insulation throughout the vessel. Most of the overhead piping on all decks below the flight deck is insulated and falls in the category presumed to be asbestos containing material per the above. Several areas of the vessel, notably the uptakes, have been posted and are controlled due to ACM.

The following observations were made by the survey team:

- Approximately 8,000 square feet of damaged 9 inch x 9 inch tile. This is not a representation of the total area of the 9 inch x 9 inch tile areas, but only the damaged portion of those areas.
- 109 locations where pipe insulation appeared to be damaged or degraded.
- 12 locations where machinery lagging appeared to be damaged or degraded.
- 225 locations where armored wire cable appeared to be damaged.

2.7.5 PCBs

A total of 98 wipes were collected from throughout the vessel. Five bulk samples, taken directly from systems, were collected as well. All but six samples tested positive for PCBs above the detection level.

The PCBs test results for wipes collected in public areas were very low, just above the detectable limit, in most cases. Wipes collected near machinery and or systems containing hydraulic systems tended to be significantly higher. Per discussion with the GEL CIH, the PCBs in public spaces may be attributed to "track out"–the transport of residual quantities by way of contamination on clothing or objects brought into direct contact with a source and carried elsewhere.

All the samples of armored wire cable tested positive for PCBs**.** Several transformers, original (or with manufacturer dates prior to 1955) and in use were notably vibrating and or making noise. Information on the contents and or fluids that may be contained in these units is not available.

Samples of grease, taken from both machinery and wire cable lubricant, tested positive for PCBs. A prominent source of PCBs is known to be the hydraulic oils onboard. It is prudent to plan on the recovery of the bulk oil in storage tanks and reservoirs not in use. Areas where spills or leaks are exposed should be cleaned to reduce or prevent track-out. Strict measures for entering the areas where spills are present should be enforced.

2.7.6 Lead-based Paint

A total of 166 locations with positive detections of lead were recorded. Additional locations with no lead detected were not recorded in Survey123. There were 93 locations in public areas that tested positive for lead; 18 of those locations had areas where the coating was observed to be flaking. Some of the areas are significantly large, such as the Main Deck or Hangar Bay and the Forecastle forward of frame 26.

Lead-based paint is present in numerous areas throughout the vessel. Noteworthy are the high concentrations found in the yellow bulls-eye labels and portable emergency lights. Most of the red paint in the maintenance areas tested positive for lead.

2.7.7 Other Contaminants

Other contaminants noted in the survey include aqueous fire-fighting foam (AFFF) stations, AC/Reefer systems, batteries in battle lanterns, and miscellaneous items or materials referenced in the Collins and Shaw reports. The AFFF stations were noted to be empty, confirming the Shaw assessment of these systems. The survey teams did not find any thermometers containing mercury. Reports provided confirmed all radioactive materials had previously been removed.

A large portion of the wiring and electrical distribution systems, original at the time the ship was delivered to Patriots Point, are still in use. Evidence of a previous fire was observed at one electrical panel.

Also in the field data are 318 notes regarding general items recommended for removal. These include expired CO_2 extinguishers, used fluorescent tubes, paint cans, and other general housekeeping items not included in the categories above.

2.8 Tabularized Field Data Summary

Table 2-4 depicts the number of recorded entries and the occurrences of ***suspected*** contaminants observed to be present. An additional count is provided for discrepancies for compartments with contaminants suspected to contain PCBs. A discrepancy is defined as a potential for direct exposure to the source of the contaminant. “Other” contaminants are those listed in the previous paragraph.

Table 2-4. Compartment survey counts and observations.

	Observation	Asbestos	PCB		Other
Deck		Present	Present	Discrepancy	
Super	47	46	33	4	0
Flight	8	8	5	1	0
Gallery	242	240	150	31	2
Forecastle	57	57	26	0	0
Main	113	104	70	7	0
2nd	234	228	121	24	4
3rd	147	145	65	18	1
4th	132	131	53	22	2
1st Plat	54	51	23	19	0
2nd Plat	33	31	16	8	1
Hold	29	29	16	22	8
Total	1096	1070	578	156	18

	Observation	Asbestos	PCB		Other
Access		Present	Present	Discrepancy	
Public	186	179	105	17	4
Administrative	126	122	79	6	0
Maintenance	746	731	382	129	12
Restricted	38	38	12	4	2
Total	1096	1070	578	156	18

2.9 Structural & Watertight Integrity

Several compartments and tanks in the forward region of the vessel are subject to flooding or have had water ingress in the past. Tidal influences in flooded compartments were minimal during observations. Several tanks were observed to be brackish, measuring between 5 and 20 ppt. Tanks above 20 ppt are considered sea or saltwater with regards to grouping. Charts of the salinity in the adjacent water for the period of the survey and previous year are shown in Figures 2-6 and 2-7.

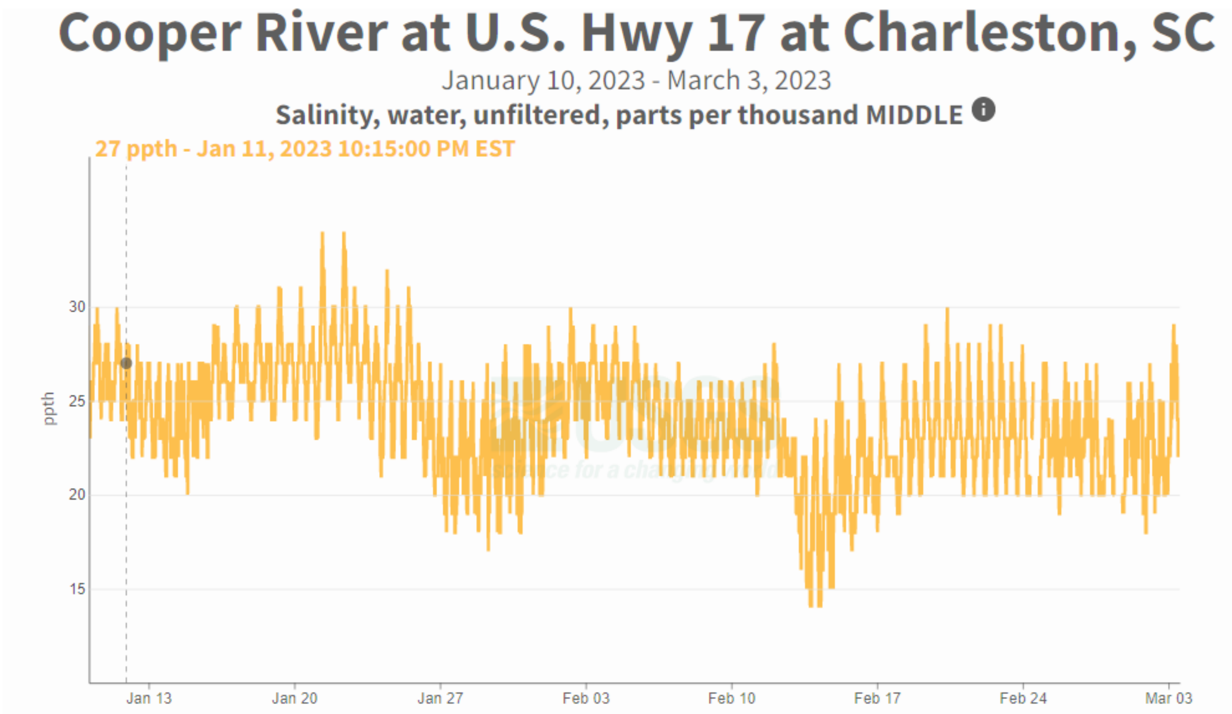


Figure 2-6. Salinity of Cooper River, January - February 2023.

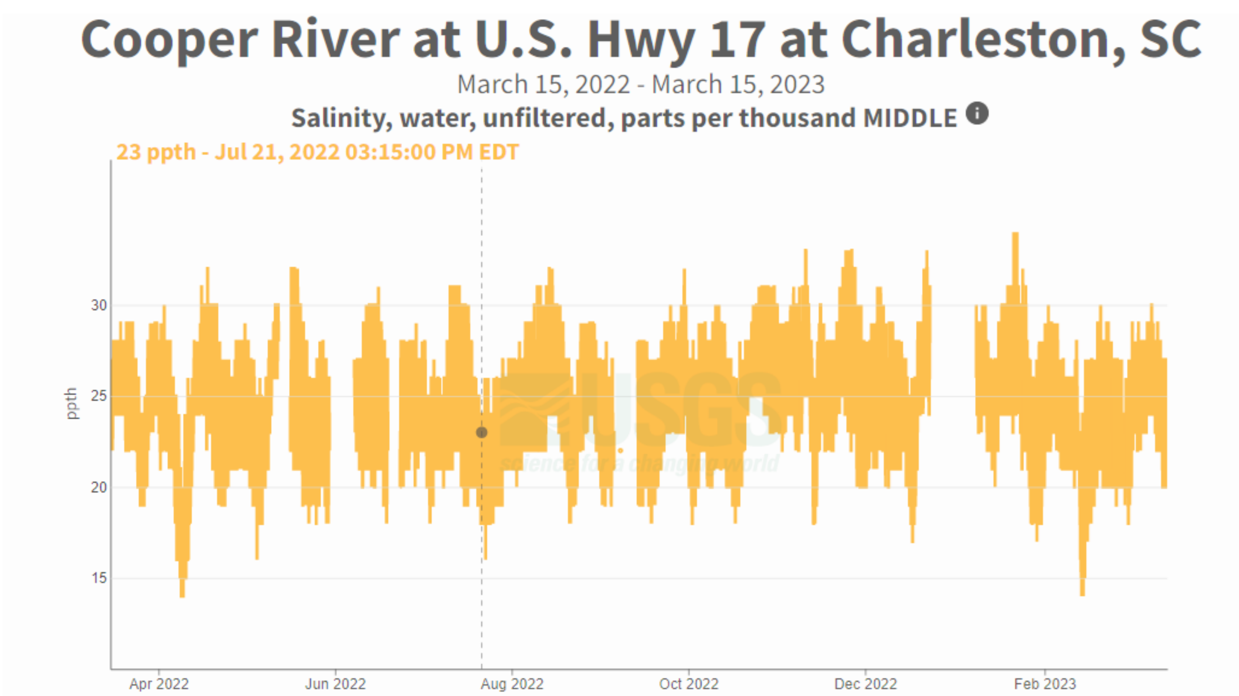


Figure 2-7. Salinity of Cooper River, April 2022 - February 2023.

A list of flooded or damaged tanks, compartments and spaces, and spaces adjacent to or accessed through these areas are listed in Table 2-5. The watertight integrity of the area forward of frame 26 will need to be restored to survey the spaces listed. The spaces will need to be dewatered and made safe for entry. Based on observation, the type and intended use of the spaces in this area, atypical contents are not suspected.

Table 2-5. Flooded, damaged, or prone to flood tanks and compartments, and spaces obstructed by conditions present.

A-2W	A-607-E	A706LUB
A-501A	A-608.5-A	A-706QLUB
A-501-A	A-608-M	A-707-T
A-502-A	A-609.5-T	A-708-E
A-503	A-609-T	A-709-M
A-503-A	A-610-M	A-711-T
A-504-A	A-611-M	A-712-T
A-507-T	A-612-M	A-713-E
A-508-T	A-613-ET	A-803V
A-5HL	A-613-ET	A-804V
A-601E	A-615-M	A-805V
A-601-E	A-617-E	A-806V
A-602-A	A-701W	A-902F
A-602-A	A-702	A-903V
A-603	A-702-A	A-904V
A-603-A	A-703.5-A	A-908F
A-604-T	A-703-A	A-908HV
A-605.5-M	A-705HLUB	A-909F
A-605.5-T	A-705LUB	A-909HV
A-605-A	A-705QLUB	A-916V
A-606.5-T	A-706HLUB	A-9-E

2.10 Recommended Additional Surveys

To properly evaluate the risk of flooding and communication between tanks and or compartments with the harbor, a structural and tank integrity survey is recommended, but outside of the scope of the current study. There is observable deterioration of both the external hull and internal bulkheads in areas prone to corrosion. Some tanks appear to be equalizing and or are being maintained at similar levels. Systematic pumping and or transferring of fluids internally may determine the extent of communication between tanks. Knowledge of the conditions between tanks will be vital in planning the mitigation or removal of contents.

2.11 Proposed Mitigation Measures (Hydrocarbons Only)

The below measures are not in order of priority or risk. They should be considered preliminary and preemptive of a formal comprehensive environmental and human risk assessment, respective of the contaminants identified and conditions present. Additional or alternative measures may be explored as the risks are communicated to all interested parties and authorities.

A. Repair the external hull and restore watertight integrity.
B. De-water the flooded compartments and survey the condition and contents. All water removed from compartments will be treated prior to being returned to compartments.
C. Remove recoverable bulk HFO and hydraulic oil from all tanks not in use, both structural and non-structural.
D. Remove fluids from tanks integral to the portion of the hull in vicinity of the tidal zone extremes +/- 4 feet (note fluid removal plans must consider maintaining a safe hydrostatic condition). Maintaining fresh water in double bottom tanks may be considered as an alternative.
E. After the removal of HFO, clean, restore, repair, or modify the tanks integral to the hull in the vicinity of the tidal zone to achieve and promote watertight integrity, isolated from systems, with means to monitor and maintain the space.
F. Remove fluids from either the double bottom or third bottom to maintain at least one dry, accessible, compartment between machinery spaces and the hull plating. This should include restoring the watertight boundary of the dry space in way of the access hatch and sounding tube. Due to conditions throughout the machinery space bilges, a substantial level of effort is needed to achieve conditions to facilitate these repairs.
G. Remove recoverable oil from accessible oily water tanks by using absorbents or other means.
H. Clean and remove hydrocarbons from machinery spaces that have previously flooded, are prone to, or at risk of, flooding in the future (for example: A-9E, elevator machinery room). Clean or isolate accessible machinery sumps in public or frequented areas, removing, isolating, or encapsulating hydrocarbons.
I. Install drip pans where isolation, encapsulation, or removal is not viable.
J. Clean hydrocarbon spills in accessible areas that are susceptible to track out.
K. Close off, isolate, and install access control measures in areas where contaminants exist but are not amenable to removal. Details in Chapter 4.
L. Isolate machinery and systems in public areas that are prone to minor leaks that may be hazardous (examples: hydraulic control stations, catapult, elevator machinery, etc.).
M. Clean all public and administrative areas, re-testing for hazardous contaminants as required or per the guidance of a CIH. Details in Chapter 4.

The above measures will leave existing and/or residual hydrocarbons in compartments and tanks that are inboard of the “barrier” spaces, integral to the hull. The barrier space can then be maintained and monitored to prevent flooding of spaces where contaminants remain. The extent of removal and or cleaning of bilge areas may be subject to the surrounding conditions, integrity, and risk of water ingress.

The extent of work involved with measures A, B, and F are costly and should be evaluated with respect to alternatives. The ability to maintain the primary barrier, the hull of the vessel, is vital to minimize the risk of contaminating the environment and creating conditions onboard the vessel that are prone to track out and exposure to the public. A secondary barrier or containment would reduce these risks and may offer a means to maintain the hull as the primary barrier. This could be facilitated through the installation of a cofferdam around the entire vessel. A cofferdam would provide the ability to maintain a waterline below the tidal zone, making proper repairs to the areas that have deteriorated. The cofferdam would also serve as a secondary barrier, containing an uncontrolled release of contaminants. The Army Corps of Engineers completed a study in 2011, detailing the feasibility of complete cofferdam concept, a cofferdam around just the bow, and a portable cofferdam.

A portable cofferdam was observed to be kept on the starboard bow area of the vessel. Details on the use, effectiveness or performance of the cofferdam were not provided to T&T.

2.12 Appendices and Attachments

ARCGIS Survey123 – Raw Data sets (Excel files)
- Lead Paint Survey Locked
- Original Survey Locked
- Modified Survey Locked

Consolidated Sample Results – Test results as received from GEL
Non-structural Tank Data (Excel file)
HECSALV Condition Report (March 2023)
HECSALV Definitions
AutoCAD Drawing SET
- (02) Gallery Deck
- (01) Forecastle Deck
- Main Deck
- Second Deck
- Third Deck
- Fourth Deck
- First Platform
- Second Platform
- Hold
- Liquid Load Survey

PDF Prints of AutoCAD drawing SET (Same as AutoCAD set)
ARCGIS Survey123 – (pdf reports and original picture files) will be forwarded when available.

Chapter 3: Environmental Hazard Assessment of the USS *Yorktown*

3.1 Introduction

The results of the survey of the USS *Yorktown* were evaluated in terms of the risks to environmental resources and human populations. The objective was to prioritize the hazards of each contaminant, to support development of the mitigation plan to reduce or minimize these hazards. Chapter 3 is the environmental hazard assessment and Chapter 4 is the health risk hazard assessment.

3.2 Sample Collection and Analytical Methods

The environmental hazard assessment is specific to the contents of the structural tanks and currently flooded compartments and the potential impacts from a release from these areas. Therefore, the first step is to characterize the fluids in these areas. However, the USS *Yorktown* is not a sound, liquid tight container. With that knowledge, dry compartments with contaminants that are subject to flooding (anything below the waterline) or rainwater ingress and potential communication with the harbor could also be a future, yet uncharacterized risk.

Water samples were collected from individual tanks and compartments using a Bacon bomb sampler. Care was taken to prevent contamination with floating oil by: 1) using sorbents around the base where the oil layer was thin; and 2) bubblers to create an oil-free area where the oil layer is thicker. The sampler was thoroughly cleaned after each sample was collected. A separate Bacon bomb sampler was used to collect oil samples. Water samples for diesel-range organics (DRO) was placed in pre-cleaned glass 1 liter (L) bottles; water samples for metals were placed in pre-cleaned 250 mL plastic bottles; oil samples were placed in pre-cleaned 40 mL bottles. All bottles were provided by the laboratory. Samples were stored in a refrigerator on site under chain of custody until transferred to the analytical laboratory, GEL Laboratories LLC. In total, 42 water samples were collected for metal analysis, 81 water samples were collected for DRO analysis, and 13 oil samples were collected for DRO analysis.

Water samples were analyzed by Method SW846 3005A/6020B for RCRA metals: Arsenic, Barium, Cadmium, Chromium, Selenium, Silver, and Lead; for Mercury by Method 7470 Cold Vapor Atomic Absorption; and for diesel range organics (DRO) by Method SW846 3580A/ 8015C. Oil samples were analyzed by Method SW846 3580A/ 8015C. All sample batches were run with the following Quality Control samples: matrix spike, matrix spike duplicate, method blank, and laboratory control samples. All water and oil sample results are provided separately as a spreadsheet, which also includes the Quality Control sample results for each batch.

3.3 Water Chemistry Analysis and Assessment

3.3.1 Metals in Water Assessment

Based on the surveys, there are 2,139,515 gallons of fresh water (0-5 parts per thousand, or ppt), 449,306 gallons of brackish water (between 5 and 20 ppt), and 1,530 gallons of salt water (>20 ppt) in water-only tanks on the USS *Yorktown*. There are 119,625 gallons of water in tanks that contain a thin layer of oil on the water, and 1,131,176 gallons of water in tanks that contain a thicker layer heavy fuel oil.

South Carolina Department of Health and Environmental Control (SCDHEC) Regulation 61-68, Water Classifications and Standards[1] for metals for protection of saltwater aquatic life are shown in Table 3-1. Two water quality standards are provided:

Criterion maximum concentration (CMC) means the highest instream concentration of a toxicant or an effluent to which the organisms can be exposed for a brief period of time without causing an acute effect. EPA derives acute criteria from 48 to 96 hour tests of lethality or immobilization.

Criterion continuous concentration (CCC) means the highest instream concentration of a toxicant or an effluent to which the organisms can be exposed to protect against chronic (long-term) effects. EPA derives chronic criteria from longer term (often greater than 28 days) tests that measure survival, growth, reproduction, and in some cases bioconcentration.

Table 3-1. SCDHEC saltwater quality standards for metal to protect aquatic life.

Pollutant	**CMC** µg/L	**CCC** µg/L
Arsenic	69	36
Barium		
Cadmium	43	9.3
Chromium	1100	50
Lead	220	8.5
Mercury	2.1	1.1
Selenium	290	71
Silver		2.3

The water concentrations for the tested metals are shown by tank and deck in Figures 3-1 to 3-8, with colored lines representing the CMC (red) and CCC (green) standards. The CMC is the most appropriate water quality standard to consider because any discharge of water from the tanks onboard the USS *Yorktown* would be a one-time release, rather than a continuous discharge. Most of the water in the tanks exceeds the SCDHEC CMC saltwater standards for the tested metals except for barium, selenium, and silver. Lead levels in multiple tanks exceed the saltwater standards by three orders of magnitude; chromium by a factor of 30; and mercury by a factor of 40. Therefore, any water removed from the USS *Yorktown* as part of the efforts to remove the bulk of the oil would require treatment prior to discharge into Charleston Harbor. Small releases of water from leaks through the hull would likely be rapidly mixed into the water column and diluted below the salt water quality standards. Therefore, it is not recommended to pump off any water as a mitigation option, other than to access tanks for oil removal or to establish and maintain watertight integrity. Any replaced water would leach metals from the tank walls and eventually reach similar concentrations.

[1] South Carolina State Register Vol. 44, Issue 6, June 26, 2020

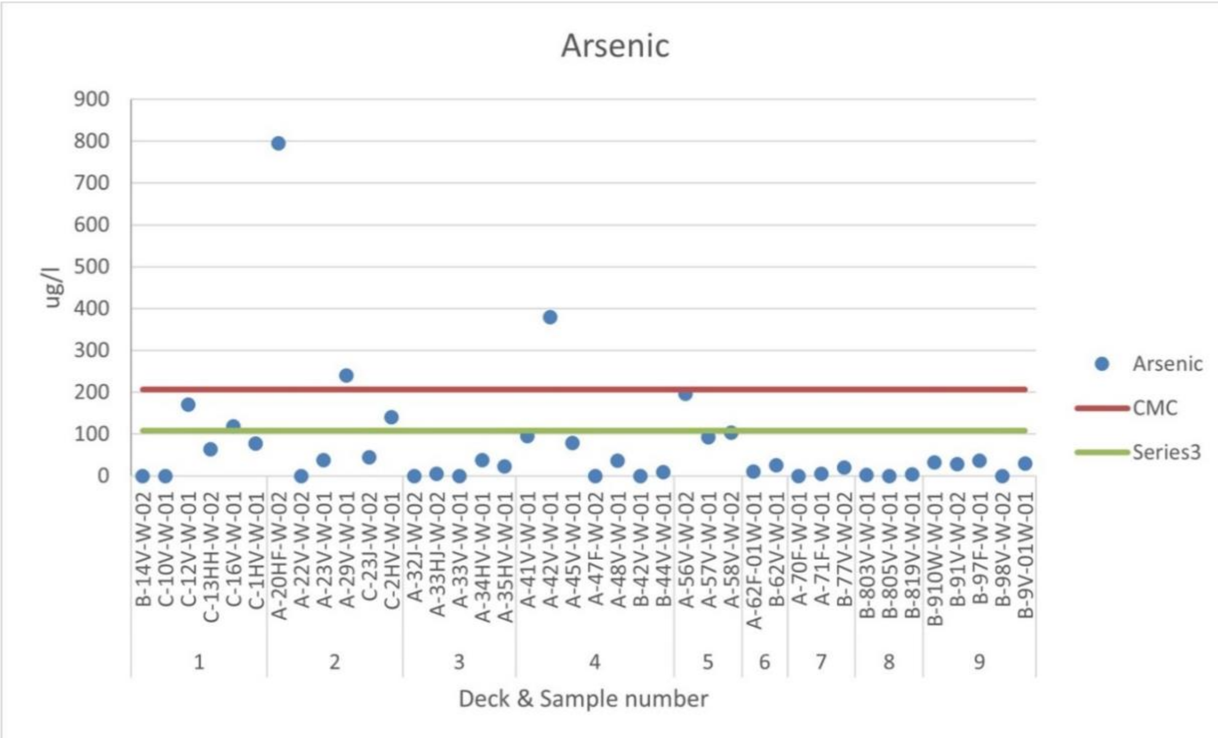


Figure 3-1. Concentration of arsenic in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

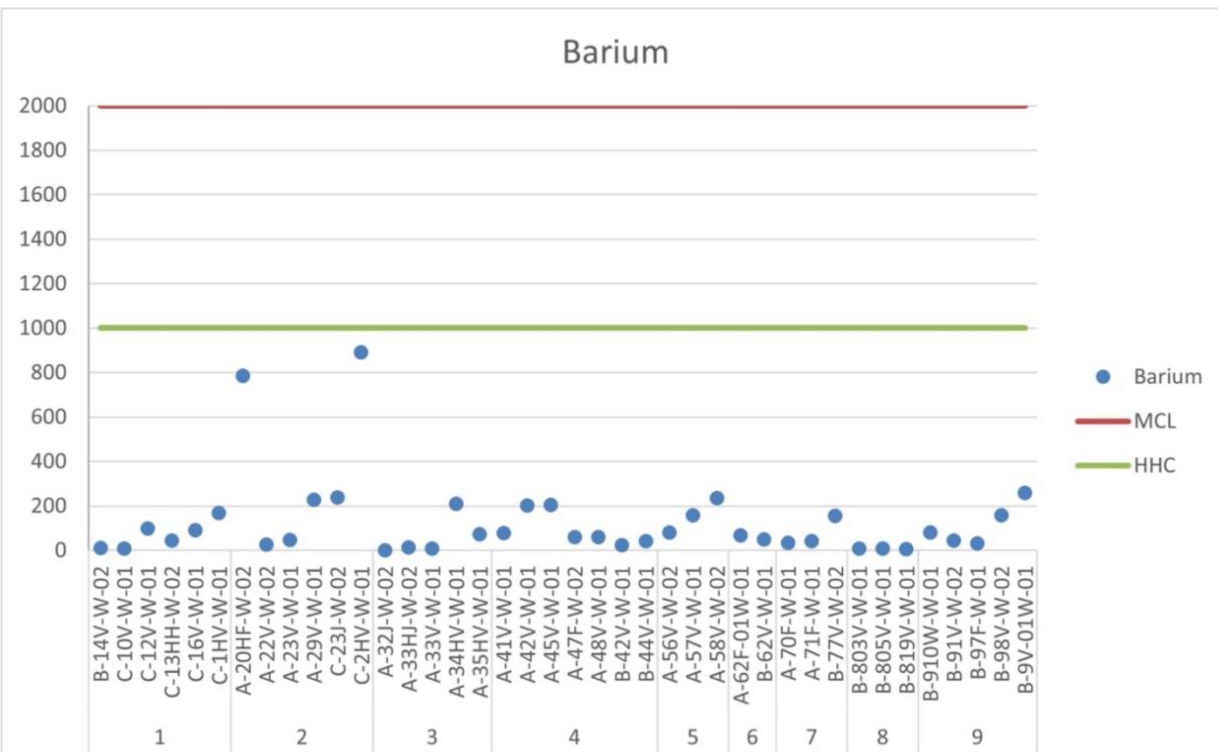


Figure 3-2. Concentration of barium in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

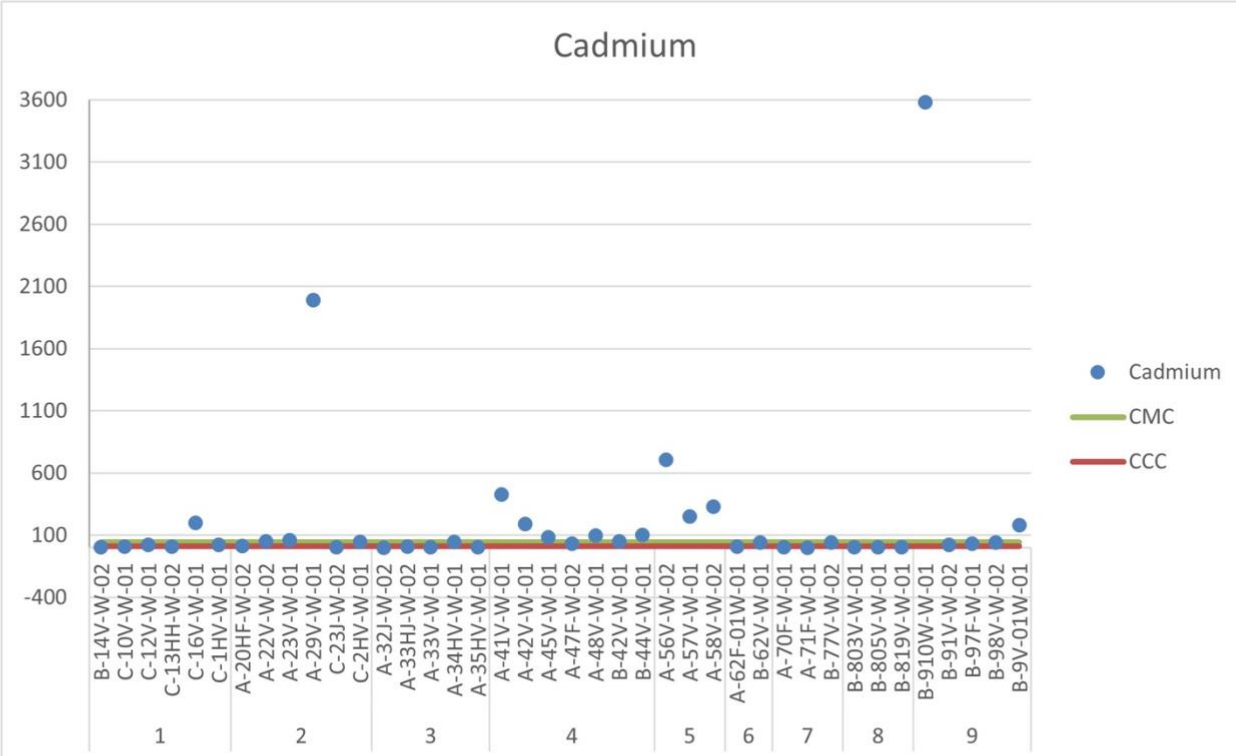


Figure 3-3. Concentration of cadmium in µg/L in water on the USS Yorktown, compared with SCDHEC salt water quality standard.

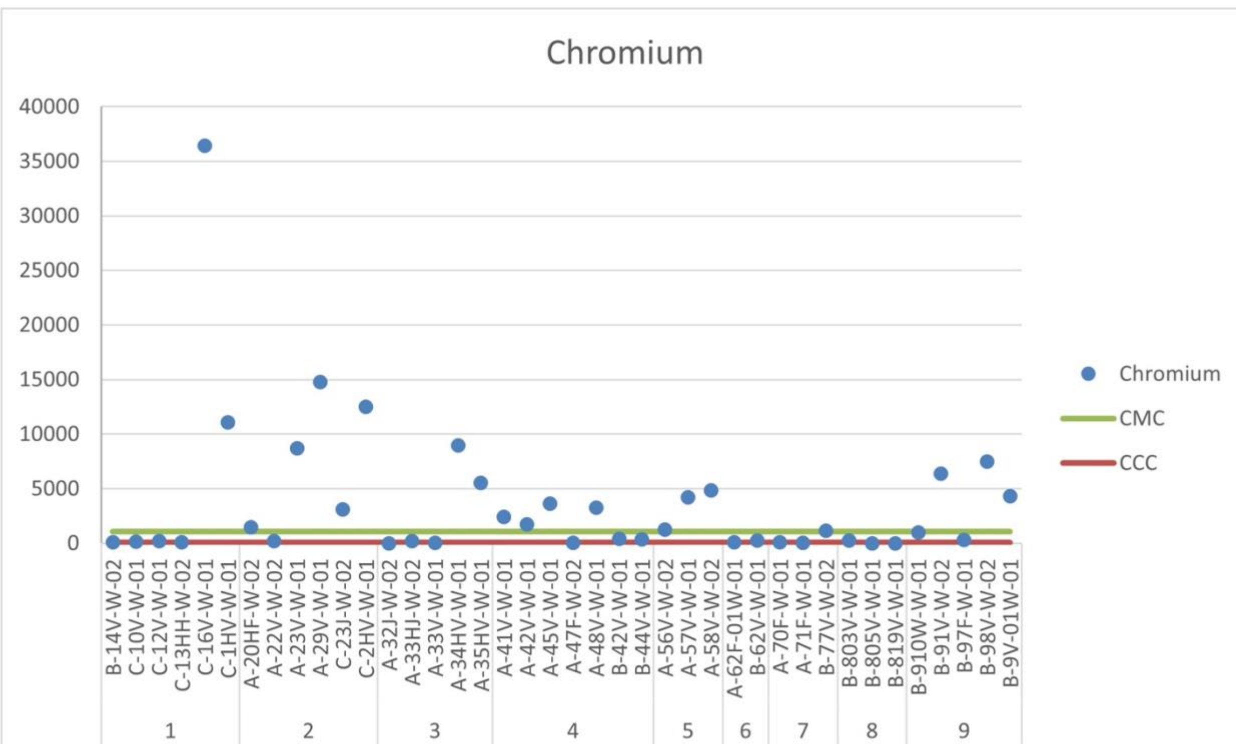


Figure 3-4. Concentration of chromium in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

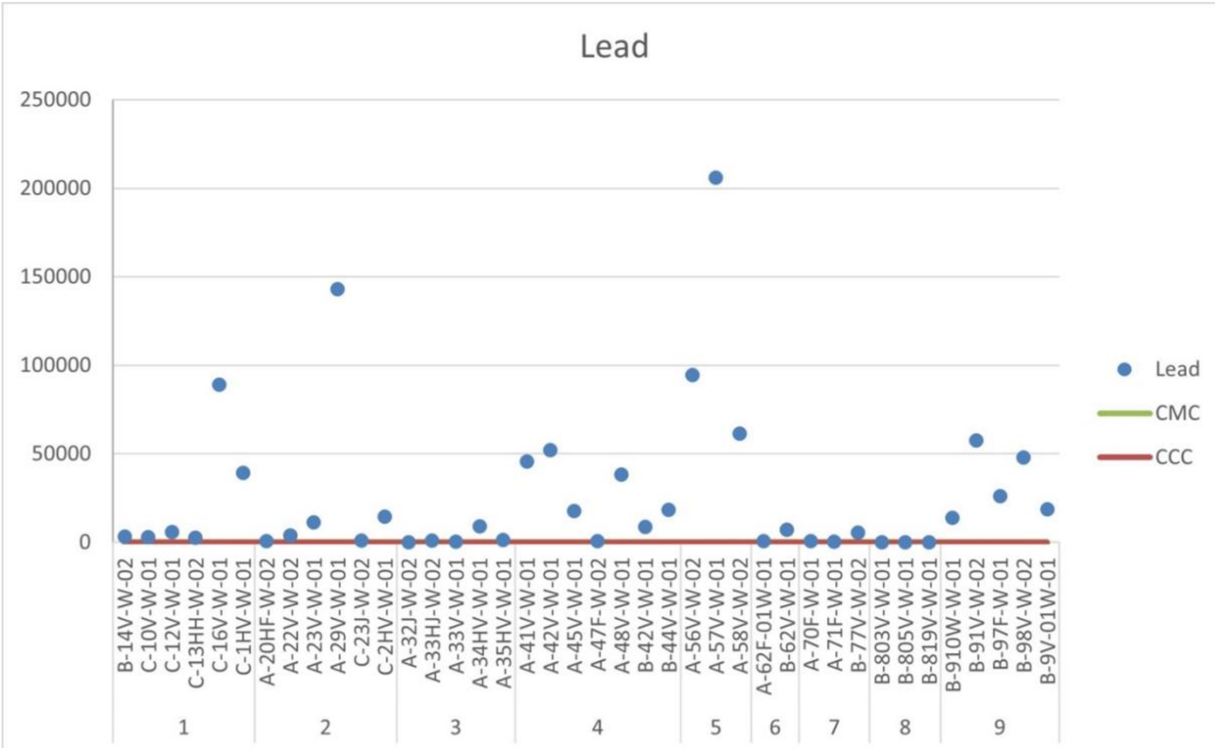


Figure 3-5. Concentration of lead in µg/L in water on the USS *Yorktown*, compared with SCDHEC water salt water standard. The CMC and CCC lines overlap at this scale.

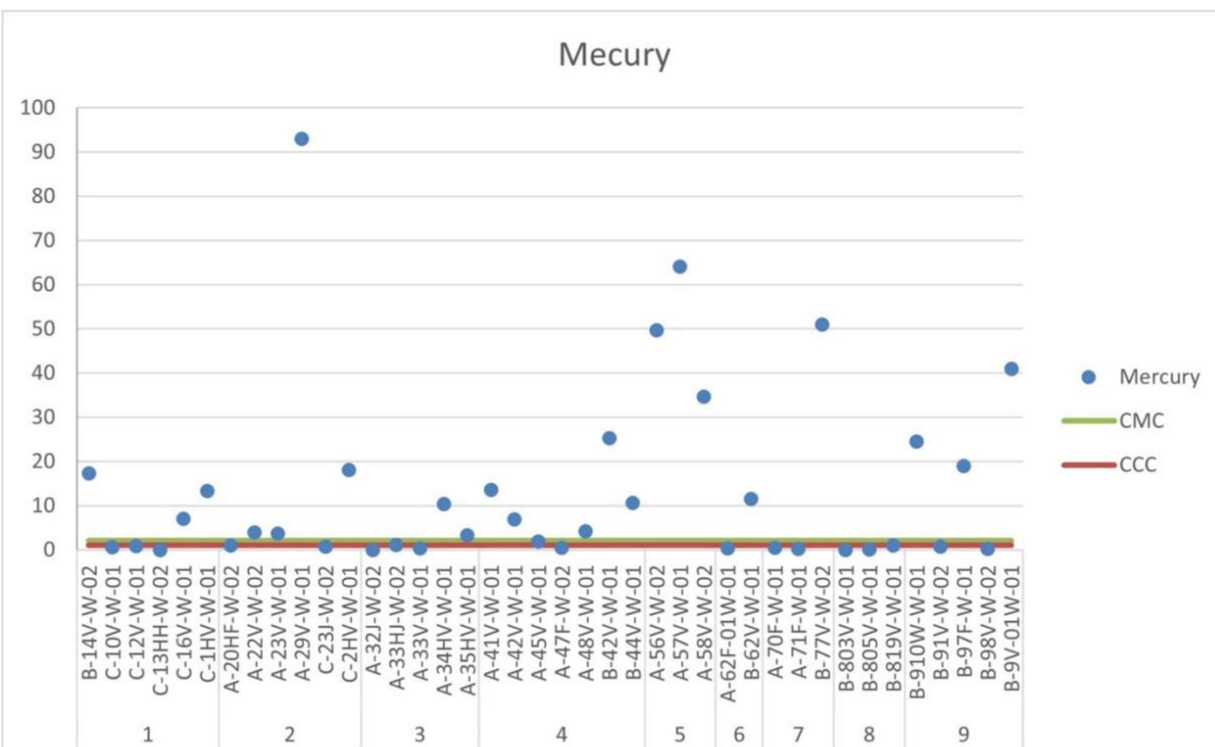


Figure 3-6. Concentration of mercury in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

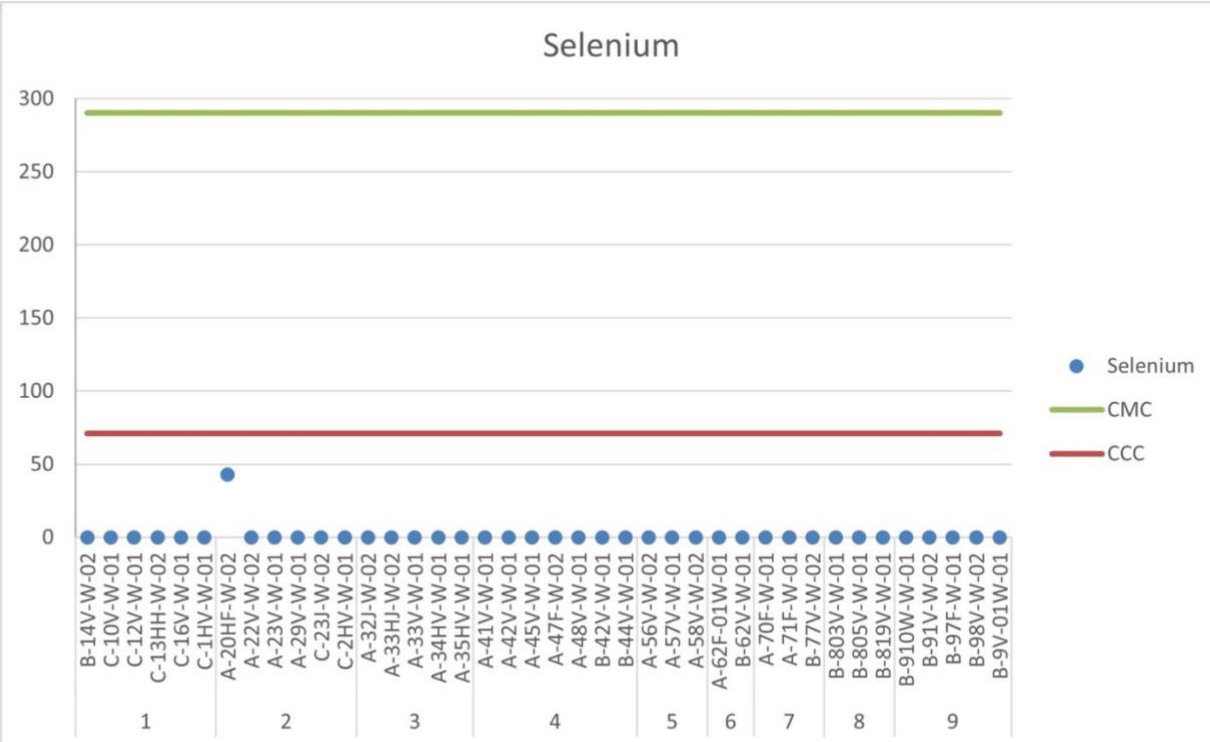


Figure 3-7. Concentration of selenium in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

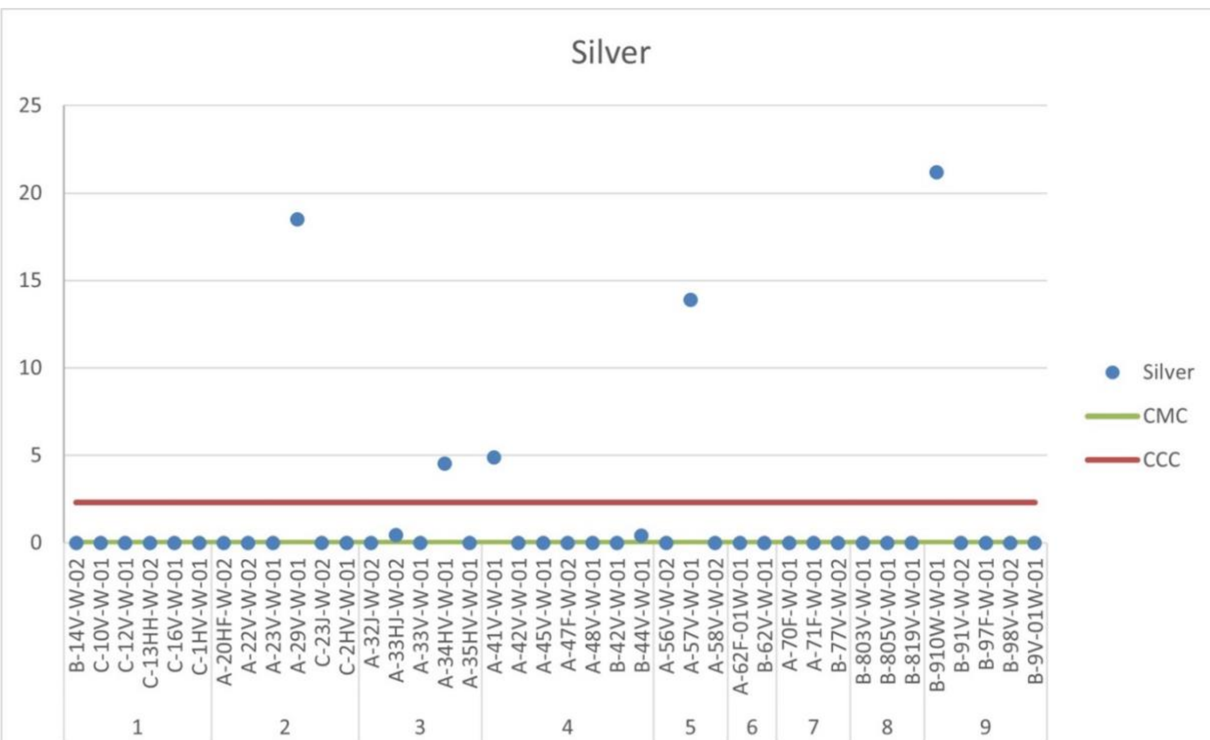


Figure 3-8. Concentration of silver in µg/L in water on the USS *Yorktown*, compared with SCDHEC salt water quality standard.

3.3.2 Petroleum Hydrocarbons in Water Assessment

SCDHEC water quality standards for oils for Class SB tidal salt waters (defined as suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora) is "none allowed." Under other regulations, discharges to water may not exceed 15 mg/L (15,000 µg/L), which is set to prevent the formation of sheens.

Figure 3-9 shows the diesel range organics (DRO) concentrations in water samples from the USS Yorktown tanks for concentrations up to 180,000 µg/L. Figure 3-10 shows the DRO concentrations in water samples from the USS Yorktown tanks for concentrations up to 10,000 µg/L to provide more visualization of the lower concentrations. Two water samples, with concentrations of 414,000 µg/L (C-13HH-W-01) and 606,000 µg/L (B-811V-OW-01) were not plotted on either figure, again to improve visualization. Twelve of the 54 water samples from the water only tanks exceeded 15,000 µg/L. Three of the 27 water samples from the tanks that contained water plus a thin layer of oil exceeded 15,000 µg/L.

Figure 3-11 shows the species sensitivity distribution plot for all the available aquatic toxicity data in the National Oceanic and Atmospheric Administration (NOAA) Chemical Aquatic Fate and Effects (CAFE) database[2]. The lowest 96-hour LC_{50} (concentration that resulted in 50% lethal effects) is 5,100 µg/L for a copepod test. The LC_{50} for Atlantic silversides is 130,000 µg/L, and for a diatom is 160,000 µg/L. The release of water from one or more of the tanks with DRO concentrations above 5,000 µg/L on the USS Yorktown would likely cause temporary impacts in the immediate area of the release; with the strong tidal currents in Charleston Harbor, oil concentrations would be rapidly mixed into the water column and diluted below effects levels.

According to the survey results, there would be an estimated 200,000 gallons of oily water that would be removed during oil removal, with contingencies for additional ingress of water during removal efforts. This volume does not include any wastewater generated during equipment decontamination, cleaning of bilges, residuals in tanks., or other works; it is based on solely the bulk removal. presuming heating system or summer operation.

Any water removed from the USS *Yorktown* as part of the efforts to remove the recoverable oil would require treatment prior to discharge into Charleston Harbor. Removal of the thinner layers of oil in the water tanks would likely reduce the amount of dissolved oil in the underlying water over time, as the volatile fractions would evaporate over time. Also, there would be much less oil available to re-equilibrate with the water. Therefore, bulk removal of water, other than that needed to access oil removal, is not recommended. However, the mitigation plan does recommend that, after removing the recoverable oil, all fluids from the outer most tanks be removed, creating the ability to maintain and monitor the space for ingress. These fluids will require treatment prior to disposal.

[2] https://cafe.orr.noaa.gov

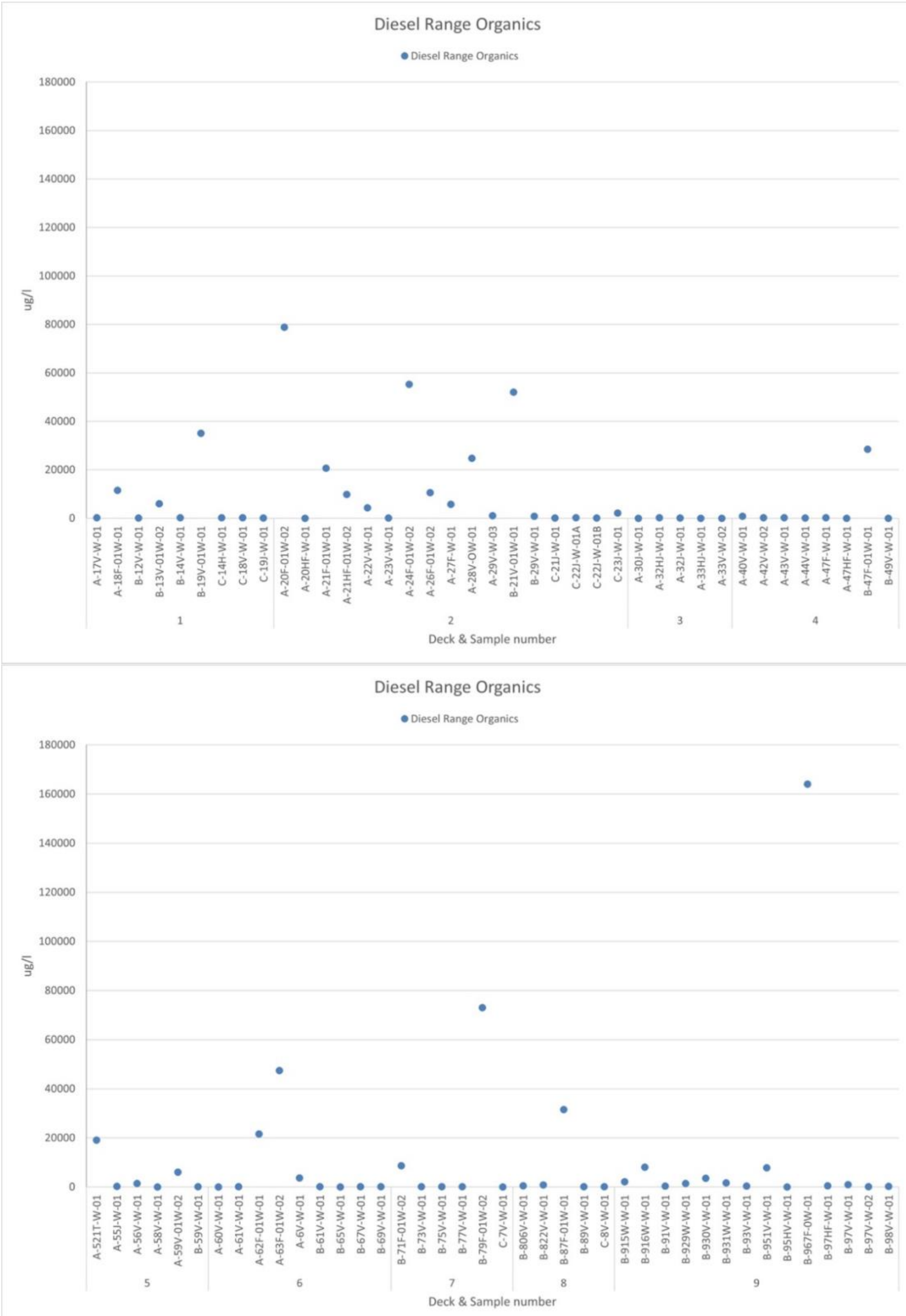


Figure 3-9. Concentration of diesel range organics (DRO) in water on the USS *Yorktown*, for values up to 180,000 µg/L for decks 1-4 (top) and 5-9 (bottom).

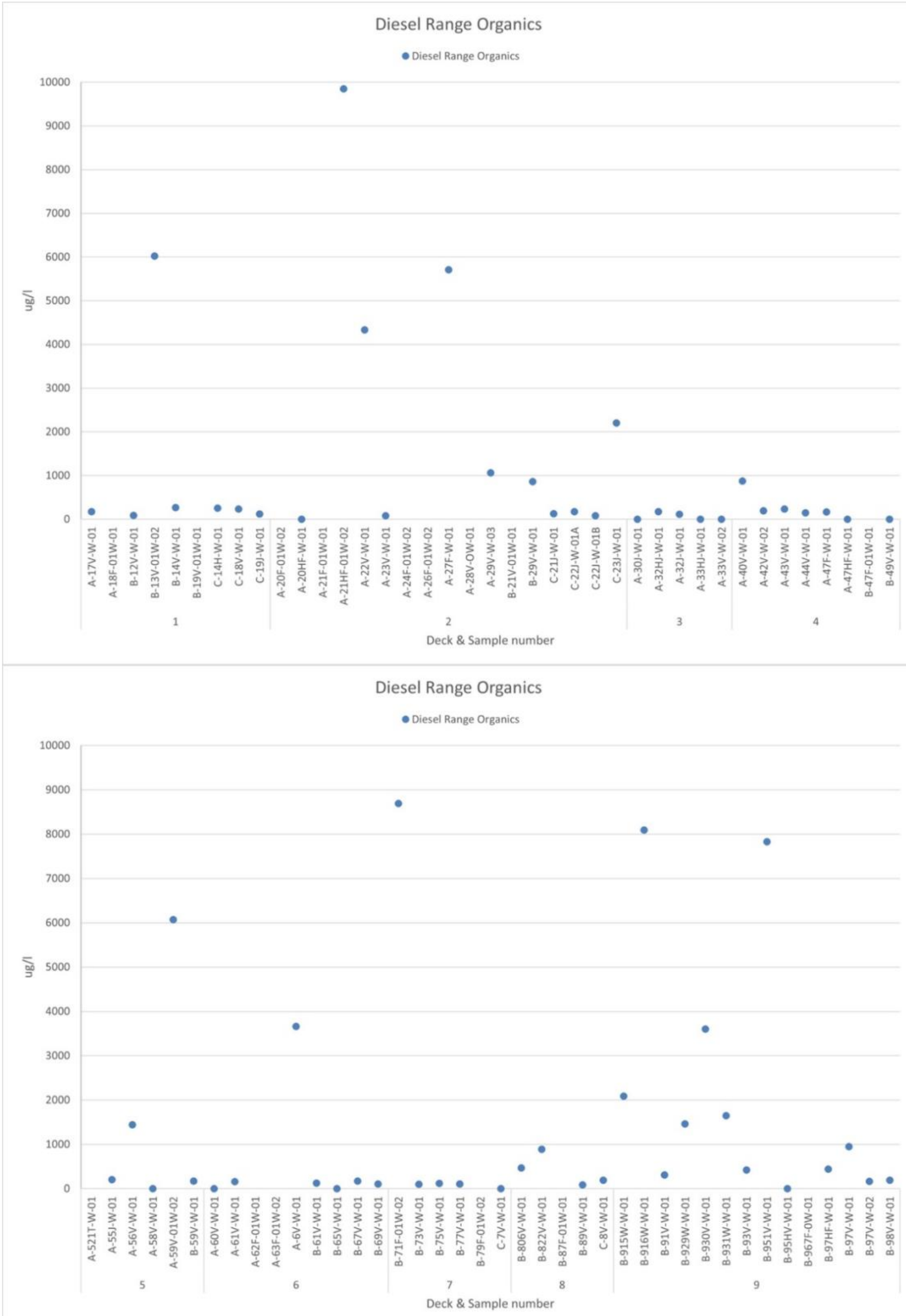
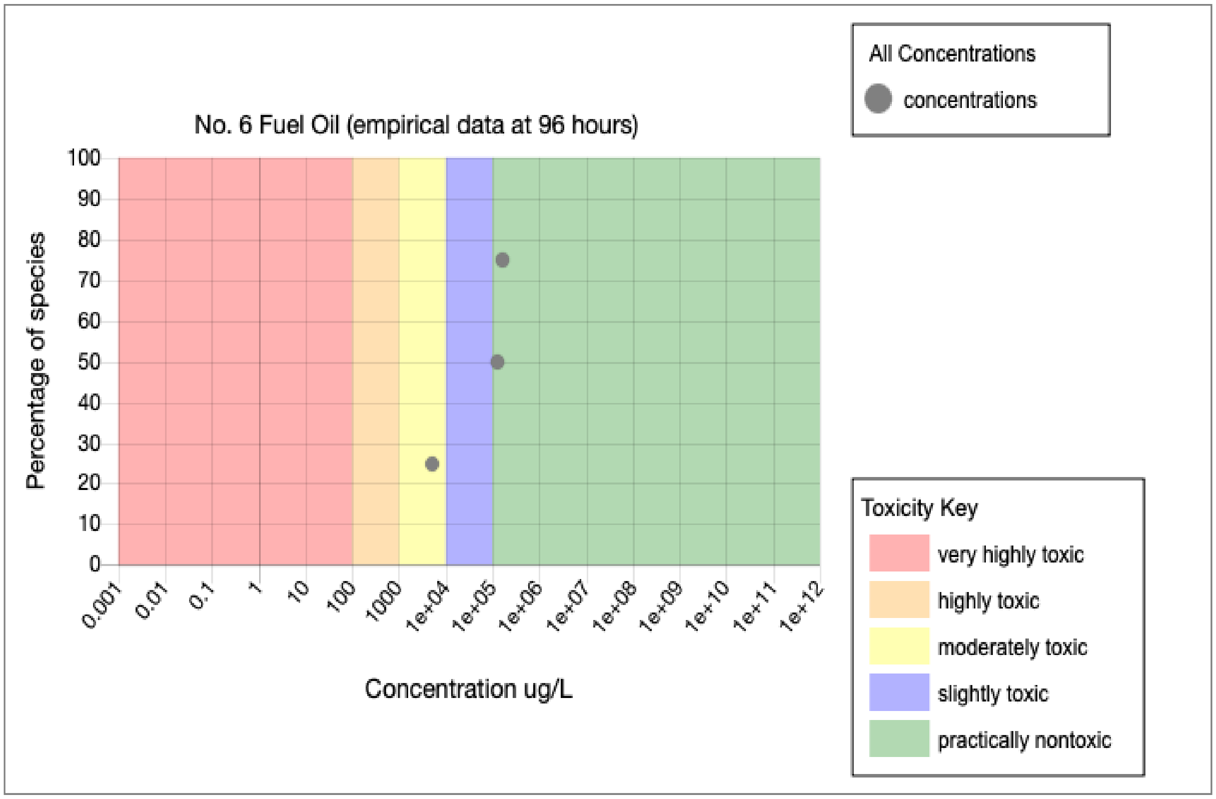


Figure 3-10. Concentration of diesel range organics in water on the USS *Yorktown*, for values up to 10,000 µg/L for decks 1-4 (top) and 5-9 (bottom), making lower values visible.



Exposure Conditions Constant static **Water Types** Salt Water **Species Names**

Atlantic Silverside, *Menidia menidia* Calanoid copepod, *Acartia tonsa* Diatom, *Skeletonema costatum*

Figure 3-11. Species sensitivity distribution plot for aquatic toxicity tests for No. 6 fuel oil, from the NOAA Chemical Aquatic Fate and Effects (CAFE) database

3.3.3 Oil Analysis and Assessment

About 100 tanks contain HFO. Half have less than 50 gallons, 75% less than 400 gallons, and the largest volume is a tank is about 6,400 gallons.

The fifteen oil samples, two from oil tanks and thirteen from tanks that contained both water and a thicker layer of oil, contained 21-71% DRO, which measures organics with carbon numbers from C_{10} to C_{28}. The pour point (the temperature above which the oil will flow) was measured in two bulk oil samples, at 3°C and 12°C. These data indicate that the oil in the tanks is typical heavy fuel oil.

When spilled on water, heavy fuel oil usually spreads into thick, dark-colored slicks, which can contain large amounts of oil. The most viscous oils will often breakup into discrete patches and tarballs, instead of forming slicks. Oil recovery by skimmers and vacuum pumps can be very effective, early in the spill. Very little of this viscous oil is likely to disperse into the water column.

Heavy fuel oil is a persistent oil; only 5-10% is expected to evaporate within the first hours of a spill (see oil weathering plots in Figure 3-12). Consequently, the oil can be carried long distances in the form of scattered tarballs by winds and currents. The tarballs will vary in diameter from several feet to less than 1 inch, and they may be very difficult to detect visually or with remote sensing techniques.

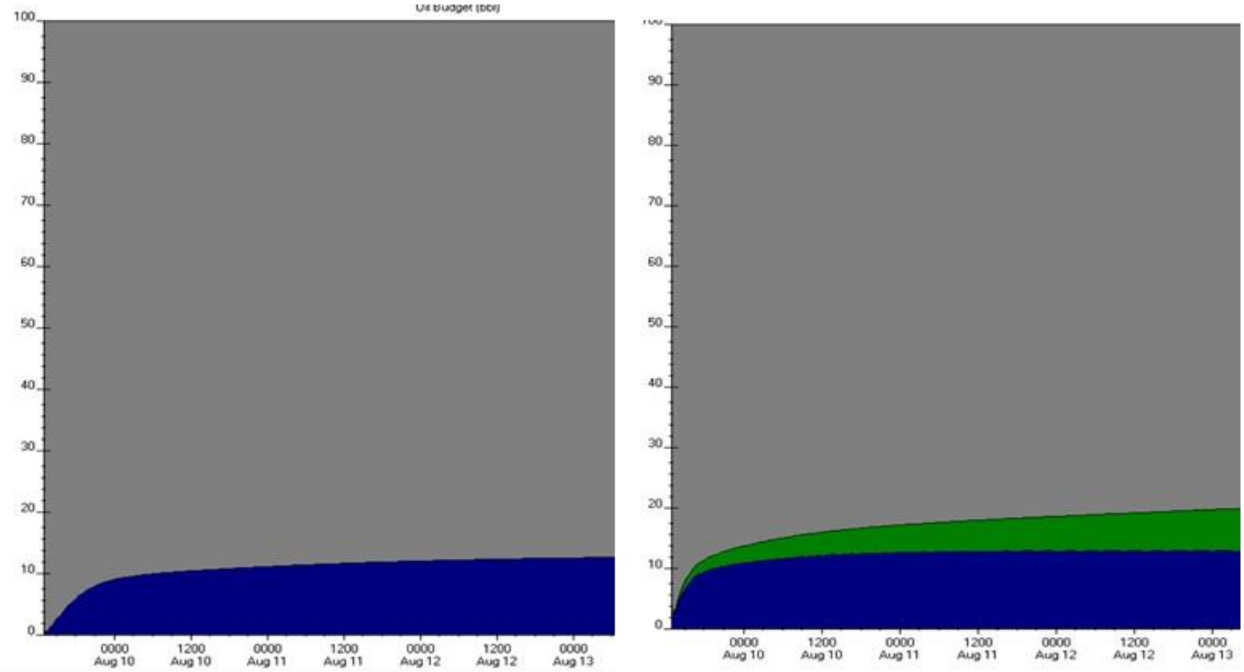


Figure 3-12. Plot of the oil weathering from the NOAA ADIOS2 model for a heavy fuel oil, with winds of 5 knots (left) and 20 knots (right). Blue = evaporated; green = dispersed; grey = remaining. Note that there is very little natural dispersion, even at wind speed of 20 knots.

The resources at risk from an oil release from the USS *Yorktown* would depend on the amount released, the spill trajectory, and the time of the year, which determines which species and life stages are present. The NOAA General Oil Modeling Environment (GNOME) is a publicly available oil spill trajectory and fate model that simulates oil movement and weathering due to winds and currents. WebGNOME was developed by the NOAA Office of Response and Restoration (OR&R) Emergency Response Division for use in oil spill response.

WebGNOME was used to generate an oil spill trajectory for a release of 50 barrels of No. 6 fuel oil from the USS *Yorktown*. The location file for Charleston Harbor, which contain pre-packaged information about tides, currents, and shorelines for the region, was used. Wind data were pulled from the National Weather Service forecast for 8 March 2023. Water temperature was set at 70°F, water salinity at 15 ppt, and sediment load was set at 50 mg/L The model was run for 2 days. Figure 3-13 shows the spread of the spilled oil. Models were run with different volumes with similar results.

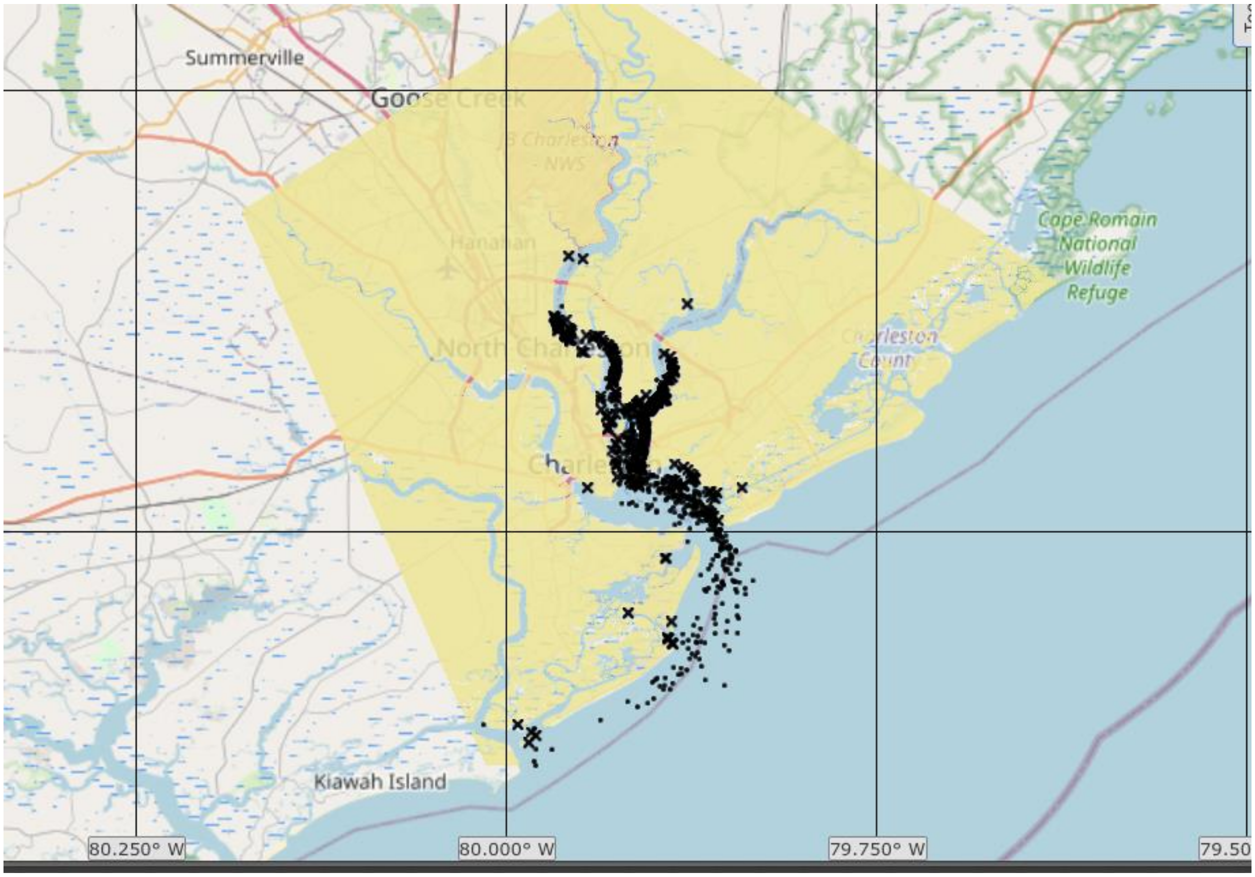


Figure 3-13. Trajectory for the release of 50 barrels of No. 6 fuel oil from the USS Yorktown on 8 March 2023, using forecast winds, by running the NOAA WebGNOME model for 2 days.

Based on this typical trajectory, the resources at risk from a spill from the USS *Yorktown* are summarized below:

Threatened and Endangered Species: *Threatened/endangered species are noted using the following abbreviations: FE – federally endangered, FT – federally threatened, SE – state endangered, ST – State threatened*

Atlantic sturgeon (FE) and shortnose sturgeon (FE, SE) may be present year round. Manatees (FE, SE) are present May-Oct. Sea turtles present include loggerhead (FT, ST, year round), leatherback (FE, SE, Apr-Jun), green (FT, ST, year round), and Kemp's ridley (FE, SE, year round). Piping plover (FT, SE) are present all months except June-July. Red knot (FT) have migrating populations in large numbers March-May and July-October; there is also a smaller wintering population present October-May. Wilson's plover (ST) may nest March-July.

Marine Mammals: Bottlenose dolphins are present year round. Chronic exposure to surface oil can cause reduced reproduction and increased disease and mortality, especially for dolphin populations that reside in enclosed waterways, such as Charleston Harbor. Little is known about the impacts of exposure to oil slicks and tarballs on manatees.

Birds: Shute's Island and Crab Bank are important bird nesting areas utilized by brown pelican, black skimmer, American oystercatcher, royal, sandwich, and gull-billed terns. These birds disperse to adjacent waterbodies after nesting season. Wading birds (herons, egrets) nest inland but feed in shallow intertidal areas. The area supports many wintering ducks, including scoters (can be present in 10,000s), scaup, bufflehead, mergansers, redhead, and mallard. Shorebirds are common on beaches and tidal flats in large numbers, particularly during migration periods in March-June and July-October. Diving birds (brown pelican, double-crested cormorant, loons, Northern gannet, shearwaters, storm-petrels, and phalaropes) can be found in coastal waters. Marsh birds such as clapper rail can be found in most intertidal marsh areas.

Fish: Atlantic and shortnose sturgeon are present in small numbers throughout the Cooper and Wando Rivers. Charleston Harbor supports spawning areas for many fish species, including spotted seatrout (May-August), black drum (March-April), and red drum (August-September). Migrating fish include blueback herring, hickory shad, American shad, and American eel.

Shellfish: Eastern oyster form reefs in shallow water throughout Charleston Harbor and adjoining creeks. Horseshoe crab are present year round and there are spawning and nursery areas behind Morris Island. Blue crab, brown and white shrimp, and Atlantic brief squid are present throughout.

Reptiles: Loggerhead sea turtles nest in moderate concentrations on the outer beaches, whereas green and leatherback may nest but in low numbers.

Shoreline Habitats: The dominant shoreline type in the area covered by the spill trajectory is composed of salt and brackish marshes, followed by tidal flats. Developed areas are fronted by seawalls, riprap, and other man-made structures.

The greatest hazard of heavy fuel oil spills to biological resources is smothering. Adverse effects of floating heavy fuel oil are related primarily to coating of wildlife dwelling on the water surface, smothering of intertidal organisms, and long-term sediment contamination. Direct mortality rates can be high for seabirds, ducks, and diving birds, especially where populations are concentrated in small areas, such as during bird migrations. Direct mortality rates are generally less for shorebirds and wading birds, because they rarely enter the water. Shorebirds, which feed in intertidal habitats where oil strands and persists, are at higher risk of sublethal effects from either contaminated or reduced populations of prey.

When released to water, dissolution of water-soluble constituents in heavy fuel oil will depend on environmental factors affecting water column mixing and oil weathering. Due to the low water solubility of their chemical constituents, the toxicity of heavy fuel oil to aquatic organisms is expected to be lower than that of other petroleum products such as diesel. Chronic toxicity from residual oil associated with sediments may be of greater concern.

Because of its high viscosity, beached heavy fuel oil tends to remain on the surface rather than penetrate sediments. Light accumulations usually form a "bathtub ring" at the high-tide line; heavy accumulations can pool on the surface. The most important factors determining the impacts of heavy fuel oil contamination on marshes are 1) the extent of oiling on the vegetation and 2) the degree of sediment contamination from the spill or disturbance from the cleanup. Many plants can survive partial oiling; fewer survive when all or most of the above-ground vegetation is coated with oil. However, unless the substrate is heavily oiled, the roots often survive and the plants can re-grow.

Because of the very high sensitivity of the animals and habitats in the Cooper and Wando Rivers, adjacent tidal creeks, and outer beaches that would be affected by a release of oil from the USS *Yorktown*, it is of highest priority that all the recoverable oil onboard the USS *Yorktown* be removed, particularly considering the deteriorating condition of the hull.

Chapter 4: Human Health Hazard Assessment of the USS *Yorktown*

4.1 Introduction

GEL developed and completed a field sampling strategy to evaluate and determine the human health risk of various population's exposure to asbestos-containing materials (ACMs), lead-based paint (LBP), and polychlorinated biphenyl (PCB) compounds throughout the various compartments in the USS *Yorktown*. The sub-groups of the total populations potentially exposed to these contaminants included the general public, the administrative employees and/or volunteers, and the maintenance employees occupying the USS *Yorktown*.

Ms. Sarah Browning, E.I.T., C.I.E.C., Ms. Bailey Erickson, and Ronald S. Sharpe, C.I.H., R.S., all from GEL and licensed asbestos building inspectors in the State of South Carolina Department of Health and Environmental Control (SCDHEC), performed the ACM, LBP, and PCB sampling with the assistance and escort of T&T staff. GEL also relied on T&T to identify the specific compartments, spaces, areas, and area-related sample numbering systems utilized throughout the USS *Yorktown*.

Ms. Erickson and Mr. Sharpe are also SCDHEC asbestos air samplers. Mr. Sharpe is a SCDHEC licensed asbestos management planner and asbestos project designer. Mr. Sharpe is a U.S. Environmental Protection Agency (USEPA)-trained lead inspector, risk assessor, supervisor, and project designer. The asbestos license and/or lead training certificates and licenses can be provided upon request.

4.2 Selection of Sampling Sites and Human Health Risk Strategies

The three types of contaminants assessed for health risk exposure for the populations present in the USS *Yorktown* included ACMs, LBP, and PCBs. The specific areas/sites selected for sample collection and the health risk strategies developed and implemented for each contaminant are described below.

4.2.1 Asbestos

Prior to GEL's field asbestos assessment, GEL reviewed various available documents and obtained information on previous asbestos assessments, inspections, abatement, hazard/personal protective equipment (PPE) hazard assessment, and/or other tasks associated with the identification, repair, and locations of the ACMs throughout the USS *Yorktown*. Information on historical asbestos tasks performed on the USS *Yorktown* included telephone and electronic mail correspondence, in addition to on-site meetings with USS *Yorktown* management, administrative, and maintenance personnel.

A preliminary walk-through inspection of the various compartments of the USS *Yorktown* was completed prior to follow-up field asbestos sampling. Park employees identified specific areas that were demarcated and secured due to potential exposure to asbestos fibers from damaged ACMs previously identified by other environmental consultants.

During the preliminary walk-through inspection, GEL noted and documented various thermal system insulation, surfacing materials, and/or miscellaneous materials (e.g., floor tile, wire insulation, wall/ceiling board insulation, etc.) that were labeled as ACMs. The visual assessment also identified suspect ACMs to be sampled and analyzed for the presence and content of asbestos. The current condition (i.e., good, damaged, or significantly damaged) of each ACM was also noted during the asbestos assessment. Conditions that may contribute or potentially contribute to disturbance of the ACMs were also noted during the asbestos assessment. These conditions that may disturb the ACMs include processes such as human contact, vibration, and air erosion.

Please note that GEL relied on previous asbestos inspection and assessment information in identifying and labelling suspect ACM throughout the USS *Yorktown*. The suspect ACM previously identified and labelled as an ACM include the thermal system pipe insulation in various areas throughout the ship. No confirmatory sampling and analysis of the thermal pipe insulation currently labeled as an ACM was performed. Therefore, all thermal pipe insulation must be deemed a Presumed asbestos-containing material (PACM) and handled and disposed of as an ACM.

The asbestos assessment was performed by observing and sampling suspect ACMs that were not previously labeled as ACMs throughout the USS *Yorktown*. Significant destructive testing was not utilized during the asbestos assessment.

Although reasonable effort was made to sample all suspect ACMs beyond the previously identified and labelled ACMs throughout the various compartments of the USS *Yorktown*, there is a potential that some areas of suspect ACMs introduced into the various compartments by undocumented renovations and/or repairs that may not have been detected. If additional suspect ACMs are identified during future renovation, repair, and/or demolition activities, GEL should be notified, and all work should cease until the suspect ACM(s) is/are sampled by a licensed asbestos inspector and laboratory analysis results have been reviewed.

The predominant route of entry for exposure to asbestos is inhalation of asbestos fibers. ACMs subjected to being disturbed may release asbestos fibers into the air, which may subsequently be inhaled by persons. Disturbance of ACMs may include but not be limited to physical damage to the ACMs; deterioration of ACMs due to age/wear; foot traffic and spread of pieces of asbestos material that may have fallen from the original substrates to which they were applied; vibration from operating mechanical systems on the vessel; exposure and subsequent deterioration of ACMs to rain, moisture, high relative humidity, and other inclement weather factors; and air erosion from ACMs in certain areas of the vessel, such as active air and fan shafts.

The strategy for sample collection focused on the ACMs likely to be encountered by the populations performing various tasks on the vessel. Routine tasks were identified (e.g., public touring, administrative duties, maintenance) on the vessel, and the specific locations and the task’s proximities to the ACMs present.

4.2.2 Lead-Based Paint

Paint coatings measured for lead content were selected based on the different types of colors, substrates, and components identified throughout the vessel. The predominant substrate in the vessel was metal, which is more resistant, durable, and functional to salt water in a corrosive environment. Other substrates that may be present on the vessel may include but not be limited to concrete, wood, canvas, and fiberboard insulation. The floor, walls, ceilings and fixtures in each area were measured for lead content.

Current condition of the paint was also noted during the LBP assessment as part of visual inspections of the paint coatings. The USEPA divides and defines the current condition of LBP in three separate categories: good, fair, and poor. Poor condition of paint coatings may include but not be limited to flaking, chalking, peeling, alligatoring, cracking, and delamination from the other layers of paint and/or the painted substrate.

The strategy for evaluating the health risk hazard for LBP for the populations exposed on the vessel are similar to the strategy for ACMs detailed above. The focus on the field visual assessment was to determine areas and likelihood of personal contact with deteriorated LBP. If deteriorated LBP has fallen on the walking floors from paint coated ceiling and/or wall substrates, the potential for contact and further disturbance of LBP is likely due to repeated foot traffic.

The routes of entry associated with LBP exposure include inhalation, contact, and ingestion. Disturbance of LBP may cause lead-containing particulates to become airborne. If personnel encounter LBP, routine hand-to-mouth activities (e.g., eating, drinking, smoking, use of cosmetics, etc.) may lead to ingestion of lead if poor personal hygiene practices occur. Hand-to-mouth activities leading to potential ingestion of lead is the most common route of entry for children, which is defined by the U.S. Department of Housing and Urban Development as humans under the age of six. The selection of the specific populations potentially exposed to ACMs, LBP, and PCBs are detailed below.

4.2.3 PCBs

The strategy for the collection of the PCB surface wipes focused on any area likely to be contacted by persons. These areas may include but not be limited to door handles; handrails; computer stations and keyboards; restroom doors, sink faucets, and toilet flush handles; and breakroom tables, chairs, and microwave handles.

The primary routes of entry for exposure to PCBs include inhalation and skin contact/adsorption. PCBs are readily adsorbed through the skin and carry a skin notation, which means that the normal human skin is not an effective barrier of protection against skin contact and adsorption of PCBs into the body. The cutaneous skin consists of a lipid-protein-lipid layer, which usually provides a barrier of protection against various polar and non-polar chemical compounds. Based upon the cyclic (most organic and cyclic chemical compounds also carry a skin notation) nature of the PCB compounds, skin contact and subsequent adsorption may contribute to the overall exposure (in addition to inhalation hazard) of the populations to PCBs.

The specific surfaces to be wiped were identified, selected, and strategized based on the population groups and the surfaces likely for each population group to come into direct contact with during occupancy of the USS *Yorktown*. Further delineation and strategies for the selection of specific surfaces to be tested for each population groups are provided below.

4.2.4 Selection Exposure Populations

Selected populations included in the health risk assessment involving potential exposures to ACMs, LBP, and PCBs included the general public, administrative employees and/or volunteers, and maintenance employees. GEL coordinated with the USS *Yorktown* employees to identify the specific areas that the selected populations may be subjected to entry and to identify the specific task(s) performed by each population group.

4.2.4.1. General Public

The tour routes open to the general public are demarcated by signs on both the floor, walls, and doorways throughout the vessel. Additionally, some areas throughout the vessel were secured, roped off, chained, and/or demarcated with signs to identify areas not opened to the general public. In addition to the tour routes to which the general public may occupy, other areas open and likely to be occupied to/by the general public were also assessed. These areas may include but not be limited to restrooms, break/eating areas, vending areas, souvenir/information areas, and/or the general public walking aisleways.

A population sub-group of the general public population included children under the age of six. This population sub-group is at a higher health risk of exposure to ACMs, LBP, and/or PCBs due to the higher probability of direct contact with these contaminants due to in the inherent curious nature of children. If children directly contact any damaged ACMs, deteriorated LBP, and/or PCB-contaminated surfaces, hand-to-mouth pathways may lead to potential ingestion of these contaminants.

4.2.4.2. Administrative Employees and/or Volunteers Public

The focus on evaluating health risk hazard exposures to administrative employees and/or volunteers was typical surfaces that this population group is likely to come into contact within areas occupied during routine administrative duties on the USS *Yorktown*. These areas may include, but not be limited to, administrative office/desk areas, employee restrooms, employee breakrooms and lunch areas, information counter/desk area(s), conference rooms, and training rooms. Administrative employees and/or volunteers may also be subject to entering and performing task(s) in any of the general public tour route areas on the vessel.

4.2.4.3. Maintenance

Bulk samples of liquid oils were collected around hydraulic tanks, components, and/or other electrical systems. Unlike the population groups of public and administrative personnel, maintenance employees are subject to entering into areas that are closed to/restricted from the public and administrative employees and/or volunteers. These closed areas are usually located at the base/bottom of the vessel. Subsequently, these maintenance areas are in poorer condition due to age, lack of custodial cleaning, and/or maintenance neglect.

4.3 Sample Collection, Instrument Detection, and Laboratory Analytical Methods

The specific sample collection, instrument detection/sensitivity, and analytical methodologies developed and executed to evaluate the population's potential exposure to ACMs, LBP, and PCBs are described below.

4.3.1 Asbestos

Representative samples of various sizes (9 inch x 9 inch or 12 inch x 12 inch) and colors of floor tile and associated mastic, wall and ceiling board insulation, electrical wiring, and textured paint coatings were collected. These samples were recorded on a Chain-of-Custody record and submitted to Scientific Analytical Institute, Inc. (SAI) laboratory in Greensboro, North Carolina for analysis. SAI is accredited with the National Voluntary Laboratory Accreditation Program, which is administered by the National Institute of Standards and Technology (NIST).

The bulk samples of suspect material were analyzed utilizing Polarized Light Microscopy (PLM) coupled with dispersion staining and/or Transmission Electron Microscopy (TEM). The PLM analytical limit of detection is no asbestos fibers/structures detected, which means no asbestos fibers/structures were microscopically identified in the sample.

The USEPA and the SCDHEC asbestos regulations recognizes a material as ACM if an asbestos content of greater than one percent by weight (>1%) is detected in a representative sample. The U.S. Occupational Safety and Health Administration (OSHA) asbestos regulations state that any amount of asbestos above the laboratory analytical limit of quantification represents a potential airborne personal exposure to asbestos fibers if the material is likely disturbed.

4.3.2 LBP

Lead in paint coatings measurements were taken using an InnovX 600 Alpha Series X-ray Fluorescence (XRF) portable analyzer, which is a direct reading instrument. Lead measurements were taken on paint coatings on both the interior and exterior of the vessel. XRF readings were collected in the lead paint analytical mode.

The analyzer was factory calibrated annually and field calibrated using paint coating standards in accordance with the analyzer's manufacturer's instructions. Lead concentrations were given in milligrams per square centimeter (mg/cm^2) by the analyzer. The XFR instrument used during the LBP assessment has an instrument sensitivity range from 0.01 mg/cm^2 to 0.30 mg/cm^2, depending upon the thickness of the paint coatings and the instrument's electronic detection of the amount of lead in the paint coatings.

4.3.3 PCBs

Two types of PCB samples were collected during the health risk assessment: surface wipe and bulk liquid samples. Below are the sample collection and the laboratory analytical methodologies utilized during the PCB sampling.

4.3.3.1 Surface Wipes

The focus on surface wipe sampling to assess exposure to the general public was in the engine and propeller rooms (as two separate homogeneous areas) to represent the highest potential concentration of PCBs. A representative number of metal handrails were wipe sampled at the base right-hand side, which is used to exit the engine and propeller rooms. Most of the PCB wipes were collected on metal handrails throughout the USS *Yorktown*. While following the public routes during the exposure assessment to select the sampling sites, distances at approximate arm's length were measured from the public route walkways to engine, pipe, liquid reservoir, and/or transformers, which may be contaminated with PCBs. Any area/component within reach of the public that were oily or greasy (indicate of PCB contamination) were selected to obtain a wipe sample.

Various components and fixtures were also wipe sampled in public restrooms. Restrooms with the highest activity and use were wipe sampled to capture a worse-case exposure to PCB-contaminated fixtures. Fixtures wipe sampled in the public restrooms included, but not limited to, handle or metal plates on entrance/exit restroom doors, restroom sink faucet handles, and restroom toilet doors and flush handles. Primary focus was emphasized on male restroom fixtures, as males are more likely to touch items that are potentially contaminated with PCBs and other contaminants.

Breakrooms, rest areas/benches, snack/vending areas, and souvenir shops may also be occupied by the general public. A representative number of tables, chairs, countertops, and other surfaces were wipe sampled to evaluate potential health risk exposures to PCBs. Lastly, representative wipe samples from handrails, door handles, and table edges/countertops providing information in open rooms with talking movies and audio were collected to evaluate public exposures to PCBs.

The focus on evaluating the health risk hazard assessment of the administrative employee and/or volunteers included the collection of representative surface wipes on the following components in the office and administrative areas: tops of desk chairs and/or armrests, computer keyboards, phone handle, etc. where employees sit in office. Similar surface wipe samples were collected in the employee/volunteer breakroom and restrooms.

Representative surface wipes were sampled for the areas typically occupied by maintenance employees to evaluate the health risk of contact/adsorption and/or ingestion (the latter from poor personal hygiene habits) of PCBs. Surface samples may include, but not be limited to, metal handrails in the further depth compartments and spaces of the vessel, tops of tanks, door handles, piping, and/or other tops of handrails. Because maintenance employees are more likely to come into contact with these surfaces during repair and upkeep of various systems throughout the vessel, wipe samples were also collected around electrical transformers, motors, oil/hydraulic reservoirs, and/or other electrical components.

PCB wipe samples were collected using cotton gauze pads moistened with n-hexane. A set area (field measured in inches by inches, which were subsequently converted to centimeter by centimeter, square centimeter, cm^2) was demarcated on the surfaces to be wiped. Nitrile rubber gloves were worn and changed for each wipe sample collected to reduce the potential for cross contamination of wipe samples with PCBs. The virgin cotton gauze was moistened (not dripping wet) with n-hexane and the demarcated surface was wiped in three axes (side to side, up and down, and on the periphery of the demarcated area). The moistened cotton gauze was folded in half after each axis was wiped in the demarcated area. The spent cotton gauze was then placed into a glass jar following the similar protocol as the bulk samples of PCB liquid.

The surface wipe samples were analyzed using the USEPA Solid Waste (SW)-846 Test Methods 8082A (PCB by Gas Chromatography) and 3541 (Automated Soxhlet Extraction). The laboratory reported the results of the PCB analyses in micrograms (μg) per wipe. The final PCB surface wipe results are reported as µg/cm^2. The analytical limit of detection for the PCB wipe samples was calculated for each individual sample based on the total weight of the wiped sample (i.e., weight of the cotton gauze, n-hexane used to moisten the gauze, and the PCBs).

4.3.3.2 Bulk Samples

T&T collected bulk samples of liquid from various tanks throughout the USS *Yorktown*. The purpose of this sampling was to determine the presence and concentration of PCBs.

The bulk samples of liquid suspect PCB-containing materials were collected by T&T by opening a valve or fitting on the tank/reservoir of various mechanical and electrical components throughout the USS *Yorktown*. Bulk samples were collected in suitable glass jars with Teflon-coated lids labeled with a unique sample number, packed on ice (chilled to four degrees Celsius or less), and physically transported to GEL Laboratories, LLC with a chain-of-custody form for log in and subsequent analysis.

Because bulk samples of liquid suspected of containing PCBs are unlikely to come into direct contact with personnel unless leaking (which would be promptly repaired by maintenance employees when discovered) and/or if tanks/vessels, and/or reservoirs are breeched by maintenance employees, the scope of this risk hazard assessment does not include PCB bulk liquids.

The bulk samples were analyzed using the USEPA Solid Waste (SW)-846 Test Methods 8082A (PCB by Gas Chromatography) and 3541 (Automated Soxhlet Extraction). The laboratory reported the PCB bulk sample results in micrograms per kilogram, µg/kg or parts per billion, ppb. The analytical limit of detection for the PCB bulk liquid samples were calculated for each individual sample based on the total weight of the bulk sample.

The surface wipe and bulk liquid samples were analyzed for the following seven different PCB compound mixtures: Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260. These seven PCB compound mixtures are chemically comprised of a biphenyl cyclic ring with anywhere from one to ten chlorine groups attached to the base biphenyl compound.

4.4 Regulatory and Consensus Standards

OSHA and USEPA, SCDHEC, and various consensus standards for each of the three contaminants tested and evaluated during the health risk assessment are further detailed below. OSHA, USEPA, and SCDHEC regulatory standards are enforceable by law.

Some applicable agency consensus standards may include, but not be limited to, the American Conference of Governmental Industrial Hygienists (ACGIH), American Industrial Hygiene Association (AIHA), and the National Institute for Occupational Safety and Health (NIOSH). Consensus standards are not enforceable by law, are generally updated more often than OSHA and USEPA standards, are typically more stringent than the published OSHA and USEPA regulatory standards and are generally accepted in the industrial hygiene profession.

Please note that these standards solely apply to personal exposures and health risk hazard assessment pertaining to ACMs, LBP, and PCBs. These regulatory and/or consensus standards do not apply to any environmental aspects/issues related to ACMs, LBP, and PCBs, which may include but not be limited to characterization, profiling, and/or ultimate fate of disposal of these contaminants.

4.4.1 Asbestos

4.4.4.1 OSHA

OSHA's published occupational exposure limits for exposure to airborne asbestos fibers are defined in OSHA's Asbestos regulation 29 CFR 1910.1001. The primary hazard and route of entry of asbestos fibers is via inhalation, the major route of entry and exposure.

1. Permissible Exposure Limit (PEL) = 0.1 fibers per cubic centimeter (f/cc) as the 8-hour Time-Weighted Average (TWA) airborne concentration to which normal, healthy workers may be exposed to for up to 8-hours a day, 40-hours a week, for a working lifetime up to thirty years without any adverse health effects.

2. Excursion Limit (EL) = 1.0 f/cc as the 30-minute (short-term) TWA airborne concentration for normal workers as described above. The 30-minute airborne exposure should be measured during the task(s) where the highest perceived airborne exposure to asbestos fibers is anticipated.

The above regulatory limits apply only to normal, healthy adult employees. These regulatory standards do not apply to the general public, children, sensitive populations, volunteers, and non-occupational-related personnel.

4.4.4.2 USEPA and SCDHEC

The USEPA and the SCDHEC have a published airborne exposure standard of 0.01 f/cc. This exposure standard represents the clearance standard acceptable for re-entry of unprotected personnel after completion of asbestos abatement activities. Asbestos abatement activities include the removal, repair, encapsulation, routine operations and maintenance, and/or enclosure of asbestos. This clearance standard applies to all three of the populations subject to entering, touring, and working on the USS *Yorktown.* Asbestos abatement activities are strictly controlled by the applicable USEPA and the SCDHEC asbestos regulatory standards.

As previously mentioned, the USEPA and the SCDHEC recognizes a material as ACM if an asbestos content of greater than one percent by weight (>1%) is detected in a representative sample. The OSHA asbestos regulations state that any amount of asbestos above the laboratory analytical limit of quantification represents a potential airborne personal exposure to asbestos fibers if the material is likely disturbed.

4.4.4.3 Consensus Standards

ACCIH has a published threshold limit value (TLV) of 0.1 f/cc, which is the 8-hour TWA airborne concentration that normal, healthy working persons may be exposed to for up to 8 hours a day, 40 hours per week, for a working lifetime up to 30 years without any adverse health effects. The ACGIH TLV basically mirrors the OSHA PEL and the applicable populations.

4.4.2 LBP

Regulatory and consensus standards for lead address airborne concentrations and the presence and content of lead defining LBP criteria. The major routes of entry for exposure to lead is through inhalation for adults and ingestion (hand-to-mouth activities) for children.

4.4.2.1 OSHA

OSHA has the following published occupational exposure limits for exposure to airborne lead, as inorganic compounds as lead. These exposure limits are defined in OSHA's Lead regulation 29 CFR 1910.1025. As previously stated, the primary hazard and the major routes of entry for lead is via inhalation in adults and ingestion (via hand-to-mouth activities) in children defined as less than 6 years of age).

1. PEL = 50 micrograms per cubic meter ($\mu g/m^3$) of lead as the 8-hour TWA airborne concentration to which normal, healthy workers may be exposed to for up to 8 hours a day, 40-hours a week, for a working lifetime up to thirty years without any adverse health effects. The airborne concentration of lead for any employee should not exceed the PEL. Engineering, process, and/or administrative controls must be utilized in the workplace to ensure airborne exposures to lead are below the PEL.

2. Action Level (AL) = 30 $\mu g/m^3$ of lead applicable to employees without regard to use of respirators.

The above regulatory limits apply only to normal, healthy adult employees. These regulatory standards do not apply to the general public, children, sensitive populations, volunteers, and non-occupational-related personnel.

If employees work more than 8-hours per shift, the OSHA PEL for lead must be reduced in accordance with the following mathematical formula:

Maximum permissible limit (in $\mu g/m^3$) = 400 / hours worked in the day

4.4.2.2 USEPA

No regulatory standards are currently published pertaining to personal airborne exposures to LBP. The USEPA defined LBP as paint containing lead greater than 1.0 mg/cm^2.

4.4.2.3 SCDHEC

No state regulatory standards are currently published pertaining to personal airborne exposures to LBP. SCDHEC defined LBP-coated waste as paint containing lead greater than 0.7 mg/cm^2. The OSHA lead regulations state that any amount of lead above the laboratory analytical limit of quantification and/or the direct reading instrument sensitivity represents a potential airborne personal exposure to lead if the LBP is likely disturbed.

4.4.2.4 Consensus Standards

ACGIH and NIOSH have published TLV and Recommended Exposure Limit (REL), respectively, of 50 µg/m^3 as the 8-hour TWA airborne concentration of lead. The above regulatory limits apply only to normal, healthy adult employees. These regulatory standards do not apply to the general public, children, sensitive populations, volunteers, and non-occupational-related personnel.

4.4.3 PCBs

Regulatory and consensus standards for PCBs will address airborne concentration and the surface concentration criteria. The major routes of entry for exposure to PCBs is skin contact and adsorption for adults and children, and ingestion (hand-to-mouth activities) for children. PCBs have a skin notation, which refers to the potential contribution to the overall exposure by cutaneous route including mucous membranes and eyes by either airborne or direct skin contact with PCBs.

4.4.3.1 OSHA

OSHA has published two PELs for exposure to airborne PCBs based on the percentage of chlorinated compounds in the PCB mixture. The PELs represent the TWA airborne concentration to which normal, healthy workers may be exposed to for up to 8 hours a day, 40 hours a week, for a working lifetime up to thirty years without any adverse health effects:

1. PEL = 1,000 µg/m^3 for PCB mixture 42% chlorinated
2. PEL = 500 µg/m^3 for PCB mixture 54% chlorinated

The above regulatory limits apply only to normal, healthy adult employees. These regulatory standards do not apply to the general public, children, sensitive populations, volunteers, and non-occupational-related personnel.

No OSHA standards currently exist for surfaces contaminated with PCBs.

4.4.3.2 USEPA

40 CFR 761.125 includes regulatory requirements for PCB cleanup, specifically the cleanup requirements for decontamination of spills of PCBs in high-contact solid (non-porous) surfaces. High-contact solid surfaces must be cleaned to the following two criteria based upon density of occupancy as measured by a standard wipe test:

1. 10 µg/100 cm^2 in high-occupancy areas (areas occupied by the general public and administrative employees and/or volunteers)
2. 100 µg/100 cm^2 in low-occupancy areas (areas occupied by maintenance employees)

For sensitive areas where the potential for hand-to-mouth activities may occur with the general public population such as break areas, concession areas, vendor areas, and other areas where people may eat and drink, the potential for exposure to PCBs is greater. Therefore, GEL established a criteria of less than the laboratory limit of detection for PCBs for high-risk areas where hand-to-mouth activities may occur.

4.4.3.3 SCDHEC

No airborne or surface wipe test standards for PCBs are currently published by SCDHEC.

4.4.3.4 Consensus Standards

ACGIH has the following published occupational exposure limits for exposure to airborne PCBs. Like the OSHA PELs for PCBs, ACGIH has two published 8-hour TWA TLVs based on the percentage of chlorinated compounds in the PCB mixture. Like the OSHA EL, ACGIH has a short-term exposure limit (STEL) for PCBs:

1. TLV = 1,000 μg/m^3 for PCB mixture 42% chlorinated
2. TLV = 500 μg/m^3 for PCB mixture 54% chlorinated
3. STEL = 2,000 μg/m^3 as the 15-minute (short term) TWA airborne concentration for normal workers as described above. The 15-minute airborne exposure interval should be measured during the task(s) where the highest perceived airborne exposure to PCBs is anticipated.

NIOSH has a published REL of 1 μg/m^3 as a 10-hour TWA airborne concentration.

4.5 Findings, Locations, and Laboratory & Instrumentation Results

The findings from laboratory analytical and direct reading instrument results of the ACMs, LBP, and PCBs and locations where these contaminants were present are detailed below.

4.5.1 ACMs

USS *Yorktown* staff informed GEL of the following previous activities performed in reference to the ACMs on the vessel.

1. Numerous asbestos inspections were performed on the vessel by several environmental consultants. Although certain, limited portions/areas of thermal system pipe insulation did not contain asbestos, the vast majority of thermal system pipe insulation contained asbestos as confirmed by laboratory analysis. Due to the difficulty of mapping and labelling the non-asbestos containing pipe insulation from the asbestos-containing pipe insulation, and in light of very limited portions of the pipe insulation not containing asbestos, it is assumed that all pipe insulation on the vessel be categorized as a PACM. Thus, any renovations, repairs, and demolition activities of the pipe insulation must be handled and disposed of as ACM.
2. Approximately two years ago, an environmental consultant performed an asbestos inspection of the damaged and significantly damaged suspect ACMs throughout the vessel. Bulk samples of the damaged suspect ACMs were collected and sent to a laboratory for analysis for the presence and content of asbestos. The damaged and laboratory-confirmed and identified ACMs were quantified and located. An asbestos abatement contractor as utilized to repair the damaged ACMs using wet wrap and other approved materials.
3. The air exhaust vent shafts on the vessel are the only areas where respiratory protection (full facepiece supplied air respirators), full disposable body coveralls, and safety shoes are required. These air exhaust vent shafts are locked and demarcated with signs

prohibiting entrance on the doors leading to this space. Only maintenance employees enter this space. Asbestos-containing insulation within this space included thermal system pipe insulation.

Other than the thermal system pipe insulation in the exhaust air vent shafts, thermal pipe insulation, which is wrapped in a thick canvas covering that has been painted several times, is in good condition. Very few areas (approximately ten to twelve areas), mainly in the propeller and engine rooms in the tour routes traversed by the general public, are minimally disturbed (open exposed insulation behind delaminated canvas wrap on some ends of piping). Such minimally damaged pipe insulation is typically out of reach to the general public.

No asbestos was detected in the samples of the flowing materials throughout the vessel:

1. Twelve inch by twelve inch floor tile and the associated mastic;
2. Wall and ceiling board cover and underlying insulation; and
3. Textured paint material on walls and ceilings.

Asbestos was detected in the nine inch by nine inch floor tile and associated mastic and the electrical wiring insulation throughout the vessel. The majority of the nine inch by nine inch floor tile was in good condition except for a few, limited areas of damaged (i.e., cracked, broken, and/or loose) and/or missing floor tile in some walkway routes used by the general public and in some areas. Limited areas of damaged floor tile pose more of a potential tripping hazard than a potential airborne exposure, as asbestos fibers are relatively low in weight (typically 3-5% by weight of asbestos) and are embedded in a non-friable matrix/medium. Unless asbestos-containing floor tile is mechanically sanded, ground, cut, and/or physically disturbed using powered tools, exposure to airborne concentrations of asbestos fibers in excess of the OSHA regulatory limits is unlikely. Electrical wire insulation throughout the vessel is currently in good condition with minimal potential for disturbance and contact.

Several areas of floor tile were damaged in areas that are only occupied by maintenance employees and restricted from access by the general public and administrative employees and/or volunteers. Limited periods of time other than a general walk-through of these areas is periodically performed by the maintenance employees.

Table 4-1 provides a list of asbestos results from the health risk hazard assessment.

Table 4-1. Results of asbestos testing on the USS *Yorktown*.

Material Description	Asbestos Containing Material (> 1%) (Yes/No)
9" x 9" Floor Tiles and Associated Mastic	**YES**
Pipe Insulation	**PACM (1)**
Electrical Wire Insulation	**PACM (1)**
12" x 12" Floor Tiles and Associated Mastic	NO - Non-Detected
Wall and Ceiling Board Cover and Insulation	NO - Non-Detected
Textured Paint Material	NO - Non-Detected

[1]PACM = Presumed Asbestos Containing Material

4.5.2 LBP

As previously stated, the major substrate to which paint coatings were applied is metal. More tightly adhering paint such as polyurethanes, epoxy primers, and oil-based (exterior) paint coatings are usually applied to metal surfaces. This is typical especially for substrates that are subject to inclement weather, corrosive (salt) atmospheres, and other forces. These types of resilient paint coatings may peel and crack, but seldom show any signs of chalking and reduction of coatings to a powdery state. No visible signs of chalking were observed where the LBP was in poor condition throughout the vessel. Based upon historical air monitoring for lead, increased airborne concentrations of lead occurs when chalking and powdering (deterioration) of LBP, which is typically applied to non-metallic, interior substrates (e.g., plaster, drywall, and concrete), is present. Based on GEL's visual assessment of the LBP in poor condition, no anticipated airborne exposures to LBP exceeding the regulatory and consensus air standards are anticipated.

In areas occupied by the general public, certain areas have LBP currently in poor condition. These areas are limited to ceilings and certain walls in the tour routes. Where LBP chips and debris fall from the ceiling and walls, most residual LBP chips and debris in walkways have migrated to the peripheral wall to floor junctions out of the way of normal foot traffic by the general public.

An area of greater concern pertaining to potential exposure of the general public to LBP is the forecastle of the vessel used for certain non-adult groups (e.g., boy scouts, girl scouts, and other similar children's groups) subject to spending the night in a specific area designated for these activities, and it is also along a general public tour route. LBP in poor condition was observed on the floor, walls, and ceiling of this space.

The paint coatings on the high bay ceilings (at least thirty feet above the operating floor, making it physically inaccessible to the general public) in the hangar bay on the main floor of the vessel contains LBP that is currently on poor condition. This LBP is open to the elements with continuous sea breezes blowing through this area. Small amounts of LBP may periodically fall from this ceiling onto the metal floor. Maintenance employees routinely clean the metal floors with a drivable wet spray detergent clean followed by vacuum extraction. Very small amounts of visible paint chips or debris were observed on this operating floor during the LBP assessment.

Maintenance employees are subject to entering into other areas of the vessel that are not open to the general public and the administrative employees and/or volunteers. These areas have significantly more LBP in poor condition due to neglect and non-conditioned spaces. Most of these areas are subject to condensation and moisture, which maintains the LBP chips and debris in a wet state. LBP in a wet state is less likely to become airborne from disturbance activities. Additionally, the limited amount of time that the maintenance employees occupy these spaces categorizes it as a low occupancy, therefore, reducing the health risk hazard to exposure to LBP.

The instrument results for the LBP measurements taken are summarized in Table 4-2 (general public areas of high occupancy), Table 4-3 (administrative areas of high occupancy), and Table 4-4 (maintenance areas of low occupancy). Please note that only results that measured above the instrument limit of sensitivity are included in these tables. All other painted surfaces that were measured were below the instrument limit of sensitivity, and therefore are not classified as lead-based paint.

In the areas occupied by the general public, 14 of 81 measurements (17%) were LBP currently in poor condition. Sixty-seven of 81 measurements (83%) were LBP currently in good condition. Nineteen of 81 measurements (23%) were below the USEPA and SCDHEC limits defining LBP. Sixty-two of 81 measurements (77%) exceeded the USEPA and SCHDEC limits defining LBP.

In the areas occupied by the administrative employees and/or volunteers, 100% of the six LBP measurements were in good condition and exceeded the USEPA and SCDHEC limit defining LBP.

In the areas occupied by the maintenance employees, 34 of 60 measurements (57%) were LBP currently in poor condition. Twenty-two of 60 measurements (43%) were LBP currently in good condition. One of 60 measurements (less than 1%) were below the USEPA and SCDHEC limits defining LBP. Fifty-nine of 60 measurements (98%) exceeded the USEPA and SCHDEC limits defining LBP. All 60 LBP measurements exceeded the instrument sensitivity.

Table 4-2. Lead-based paint instrument measurements in general public areas of high occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCDHEC standards.

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Black Paint - Steel Anchor Chains	**Forecastle**	**Poor (i.e., peeling, flaking, etc.)**	**7.74**	**1.0**	**0.7**
White Paint - Steel Anchor Chains	**Forecastle**	**Poor (i.e., peeling, flaking, etc.)**	**2.98**	**1.0**	**0.7**
Red Paint - Metal Anchors	**Forecastle**	**Poor (i.e., peeling, flaking, etc.)**	**2.07**	**1.0**	**0.7**
Gray Paint - Metal Ceilings/Structural Steel/Walls	**Forecastle**	**Poor (i.e., peeling, flaking, etc.)**	**1.98**	**1.0**	**0.7**
White Paint - Metal Overhead	**Hangar Bay**	**Poor (i.e., peeling, flaking, etc.)**	**5.64**	**1.0**	**0.7**
Gray Paint - On Electronic Boxes	**B-0201ACL CIC**	**Poor (i.e., peeling, flaking, etc.)**	**2.76**	**1.0**	**0.7**
Red Paint - Metal Deck	**B-0201ACL CIC**	**Poor (i.e., peeling, flaking, etc.)**	**6.7**	**1.0**	**0.7**
Red Paint - Metal Deck	**B-0409L**	**Poor (i.e., peeling, flaking, etc.)**	**5.03**	**1.0**	**0.7**
Red Paint - Metal Deck	**B-0513L**	**Poor (i.e., peeling, flaking, etc.)**	**5.01**	**1.0**	**0.7**
Red Paint - Metal Deck	**A-204E**	**Poor (i.e., peeling, flaking, etc.)**	**4.04**	**1.0**	**0.7**
Red Paint - Metal Deck	**B-0601-1L Pilot House**	**Poor (i.e., peeling, flaking, etc.)**	**3.4**	**1.0**	**0.7**
Gray Paint - Door Coaming	**B-0201CEL**	**Poor (i.e., peeling, flaking, etc.)**	**2.28**	**1.0**	**0.7**
Cream Paint - On Metal Slot Into Adjoining Space	**B-201-4L**	**Poor (i.e., peeling, flaking, etc.)**	**2.76**	**1.0**	**0.7**
Green Paint - Metal Overhead	B-215-1L	Poor (i.e., peeling, flaking, etc.)	0.3	1.0	0.7
White Paint - Stanchions For Racks	C-0206.5L	Good	3.28	1.0	0.7
Yellow Paint on Bullseye's on Walls	Throughout Ship	Good	1.43	1.0	0.7
Red Paint - Metal Deck	C-201L	Good	1.71	1.0	0.7
Gray Paint - Metal Deck	B-318-L	Good	5.75	1.0	0.7
Red Paint - Metal Deck	B-321-L	Good	5.14	1.0	0.7
Gray Paint - Metal Hatch	B-207-L	Good	4.04	1.0	0.7

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Green Paint - Metal Deck	B-316-L	Good	0.16	1.0	0.7
Green Paint - Metal Deck	B-316-L Butcher Shop	Good	0.14	1.0	0.7
Red Paint - Metal Firestations	C-201-L	Good	0.16	1.0	0.7
Yellow Paint - Overhead Metal Rail	C-301-L	Good	0.43	1.0	0.7
Gray Paint - Equipment	C-301-L	Good	0.52	1.0	0.7
Red Paint - Metal Firestations	B-318-L	Good	2.2	1.0	0.7
Brown Paint - Leather Woven Ladder Handrails	B-320-L	Good	0.29	1.0	0.7
Gray Paint - Metal Ladder	B-320-L	Good	0.61	1.0	0.7
Yellow Paint - Overhead Metal Rail	B-312-EL	Good	0.58	1.0	0.7
Yellow Paint - Metal Overhead Beam	B-309-EL	Good	0.53	1.0	0.7
Metalic Silver High Temperature Paint - Engineering Area	B-3-1	Good	0.46	1.0	0.7
Yellow Paint - Overhead Metal Rail	C-204E	Good	3.44	1.0	0.7
White Paint - Metal Joiner Wall	B-316L	Good	3.86	1.0	0.7
White Paint - Metal Bulkhead	B-312EL	Good	1.86	1.0	0.7
Red Paint - Metal Deck	C-203-L	Good	1.76	1.0	0.7
Red Paint - Metal Deck	B-217-EL	Good	1.76	1.0	0.7
Red Paint - Metal Deck	B-215-1L Sick Bay	Good	2.41	1.0	0.7
Red Paint - Metal Deck	B-215-1L Clerical Office	Good	2.7	1.0	0.7
Red Paint - Metal Deck	B-214-L	Good	3	1.0	0.7
Gray Paint - Metal Hatch	A-210-2L	Good	0.14	1.0	0.7
Gray Paint - Metal Hatch	A-214-EL Passage	Good	1.83	1.0	0.7

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Yellow Paint - Metal Placard Frame	A-212-L	Good	0.27	1.0	0.7
Gray Paint - Metal Hatch	A-308-LA	Good	1.76	1.0	0.7
Dark Green Paint in Space	A-306-E	Good	2.18	1.0	0.7
Gray Paint - Metal Hatch	A-314-1L	Good	0.5	1.0	0.7
Yellow Paint - Emergency Light Box	A-427-1AT	Good	0.64	1.0	0.7
White Paint - Metal Support Column	A-321-1L	Good	1.63	1.0	0.7
Gray Paint - Metal Elevator Ram Frame	B-217EL	Good	3.84	1.0	0.7
Yellow Paint - Metal Battle Lantern	A-214-EL	Good	2.41	1.0	0.7
Red Paint - Metal Fittings, Sprinkler, Etc.	A-208-L	Good	1.34	1.0	0.7
Red Paint - Metal Deck	A-306E	Good	0.9	1.0	0.7
Yellow Paint - Metal Bomb Elevator Hatch and Overhead Rail	A-314-1L	Good	1.56	1.0	0.7
Black Paint - Metal Deck	Brig 4-61-3	Good	3.21	1.0	0.7
Yellow Paint - Overhead Metal Rail	B-309-E	Good	0.53	1.0	0.7
Gray Paint - Metal Cable Rack	A-210-2L	Good	0.15	1.0	0.7
Gray Paint - Metal Hatch	A-210-1l Ready Room	Good	3.19	1.0	0.7
Red Paint - Metal Fittings, Sprinkler, Etc.	A-214-Eal	Good	1.76	1.0	0.7
Gray Paint - Metal Hatch	A-212-L	Good	1.3	1.0	0.7
White Paint - Metal Cable Rack	A-208-L	Good	0.25	1.0	0.7
Red Paint - Metal Firestations	A-308-LA	Good	0.26	1.0	0.7
Red Paint - All Red Paint in Area	A-306-E	Good	0.72	1.0	0.7
Red Paint - All Red Paint in Area	A-314-1L	Good	0.18	1.0	0.7
Red Paint - All Red Paint in Area	Brig	Good	0.53	1.0	0.7

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Yellow Paint -Metal Emergency Lights	A-0101L	Good	5.08	1.0	0.7
Red Paint - Metal Deck	Forecastle	Good	4.61	1.0	0.7
Black Paint - Metal Door Coamings and Metal Bunkbed Stanchions	C-0202L	Good	1.92	1.0	0.7
Red Paint - Metal Door Coaming	C-0207L	Good	2.82	1.0	0.7
White Paint - Metal Bunkbed Stanchions	A-0201-L	Good	2.71	1.0	0.7
White Paint - Metal Old HVAC Ductwork	C-0202-L	Good	2.72	1.0	0.7
White Paint -Metal Bulkhead	C-0207-L	Good	4.46	1.0	0.7
Gray Paint - Metal Bulkhead	B-0601-1L Fly Bridge	Good	1.08	1.0	0.7
Gray Paint - Metal Bulkhead	Flag Open Bridge 05-79-1	Good	2.67	1.0	0.7
Gray Paint - Metal Door	B-201-1L	Good	2.69	1.0	0.7
White Paint - Metal Bulkhead	B-211L	Good	9.16	1.0	0.7
White Paint - Metal Bunkbed Stanchions	JR Officer’s Bunkroom	Good	3.21	1.0	0.7
White Paint - Metal Bunkbed Stanchions	B-304L	Good	1.84	1.0	0.7
White Paint - Metal Bulkhead	Hanger bay 1	Good	2.67	1.0	0.7
White Paint - Metal Bulkhead	Hanger bay 2	Good	5.57	1.0	0.7
White Paint - Metal Bulkhead	Hanger bay 3	Good	6.96	1.0	0.7
White Paint - Metal Door	Hanger bay 1	Good	2.38	1.0	0.7
Gray Paint - Roll-Up Door	Hanger bay 3	Good	4.96	1.0	0.7

Table 4-3. Lead-based paint instrument measurements in administrative areas of high occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCHEC standards.

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Gray Paint on Metal Deck	**B-0208 AEL Passage**	**Good**	**5.18**	**1.0**	**0.7**
Gray Paint on Metal Deck	**Passage Aft of Parachute Drying Room Forecastle Deck**	**Good**	**4.36**	**1.0**	**0.7**
Gray Paint on Metal Deck	**Archive Storage 02 Deck**	**Good**	**4.24**	**1.0**	**0.7**
Red Paint on Metal Deck	**B-0206-AEL**	**Good**	**2.91**	**1.0**	**0.7**
White Paint on Door Coaming	**Passage**	**Good**	**2.55**	**1.0**	**0.7**
Gray Paint on Metal Bulkhead	**Passage B-208 AEL**	**Good**	**1.28**	**1.0**	**0.7**

Table 4-4. Lead-based paint instrument measurements in maintenance areas of low occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCDHEC standards.

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Red Paint on Metal Bulkhead	**B-405-A**	**Poor (i.e., peeling, flaking, etc.)**	**6.44**	**1.0**	**0.7**
White Paint on Metal Bulkhead	**B-439**	**Poor (i.e., peeling, flaking, etc.)**	**6.01**	**1.0**	**0.7**
Green Paint - Metal Bulkhead	B-1-1	Poor (i.e., peeling, flaking, etc.)	0.67	1.0	0.7
Green Paint on Metal Bulkhead	**A-307-T**	**Poor (i.e., peeling, flaking, etc.)**	**5.92**	**1.0**	**0.7**
Red Paint on Metal Bulkhead	**B-404**	**Poor (i.e., peeling, flaking, etc.)**	**5.68**	**1.0**	**0.7**
Yellow Paint - On web of Beam Supporting HPA Receiver	**B-8-1**	**Poor (i.e., peeling, flaking, etc.)**	**5.4**	**1.0**	**0.7**
Red Paint on Metal Bulkhead	**B-409-A**	**Poor (i.e., peeling, flaking, etc.)**	**4.73**	**1.0**	**0.7**
Green Paint on Metal Bulkhead	**C-0104-A**	**Poor (i.e., peeling, flaking, etc.)**	**4.39**	**1.0**	**0.7**
Green Paint on Metal Cabinets and Fixtures	**B-5-1**	**Poor (i.e., peeling, flaking, etc.)**	**4.06**	**1.0**	**0.7**
Red Paint - Metal Overhead	**B-409A**	**Poor (i.e., peeling, flaking, etc.)**	**3.9**	**1.0**	**0.7**

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Red Paint - Metal Bulkhead	B-419-L	Poor (i.e., peeling, flaking, etc.)	3.52	1.0	0.7
Red Paint - Metal Bulkhead	B-510-T	Poor (i.e., peeling, flaking, etc.)	3.39	1.0	0.7
Red Paint - Metal Bulkhead	A-423-A	Poor (i.e., peeling, flaking, etc.)	3.32	1.0	0.7
Green Paint - Metal Bulkhead	C-317-L	Poor (i.e., peeling, flaking, etc.)	2.93	1.0	0.7
Yellow Paint - Dehumidifier system/ bullseye	B-6-1	Poor (i.e., peeling, flaking, etc.)	2.89	1.0	0.7
Red Paint - Metal Bulkhead	C-415-T	Poor (i.e., peeling, flaking, etc.)	2.83	1.0	0.7
Red Paint - Metal Bulkhead	B-511-M	Poor (i.e., peeling, flaking, etc.)	2.54	1.0	0.7
Red Paint - Metal Bulkhead	B-401-A	Poor (i.e., peeling, flaking, etc.)	2.48	1.0	0.7
Red and Green Paint - Metal Overhead	A-423-A	Poor (i.e., peeling, flaking, etc.)	2.46	1.0	0.7
Red and Green Paint - Metal Deck	B-425-L	Poor (i.e., peeling, flaking, etc.)	2.44	1.0	0.7
Red Paint - Metal Bulkhead	A-305.5-2A	Poor (i.e., peeling, flaking, etc.)	2.41	1.0	0.7
Red Paint - Metal Deck	B-1-1	Poor (i.e., peeling, flaking, etc.)	2.4	1.0	0.7
Red Paint - Metal Bulkhead	C-316-2L	Poor (i.e., peeling, flaking, etc.)	2.39	1.0	0.7
Red Paint - Metal Bulkhead	C-315-L	Poor (i.e., peeling, flaking, etc.)	2.38	1.0	0.7
Red Paint - Metal Overhead	B-405-A	Poor (i.e., peeling, flaking, etc.)	2.24	1.0	0.7
Red Paint - Metal Bulkhead	B-5-1	Poor (i.e., peeling, flaking, etc.)	2.23	1.0	0.7
Red Paint - Metal Bulkhead	C-406-A	Poor (i.e., peeling, flaking, etc.)	1.96	1.0	0.7
Red Paint - Metal Overhead	C-0104A	Poor (i.e., peeling, flaking, etc.)	1.79	1.0	0.7
Red Paint - Metal Overhead	B-413-L	Poor (i.e., peeling, flaking, etc.)	1.69	1.0	0.7
Red Paint - Metal Bulkhead	B-401A	Poor (i.e., peeling, flaking, etc.)	1.69	1.0	0.7
Red Paint - Metal Bulkhead	B-413-L	Poor (i.e., peeling, flaking, etc.)	1.66	1.0	0.7
Red Paint - Metal Overhead	A-305.5	Poor (i.e., peeling, flaking, etc.)	1.63	1.0	0.7

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Red Paint - Metal Deck	**B-2-1**	**Poor (i.e., peeling, flaking, etc.)**	**1.55**	**1.0**	**0.7**
Dark Green - Fixtures, Etc.	**A-304-E**	**Poor (i.e., peeling, flaking, etc.)**	**1.52**	**1.0**	**0.7**
Red Paint - Metal Deck	B-8-1	Good	2.54	1.0	0.7
Gray Paint -Electrical Boxes/Motor Controller	B-8-1	Good	2.5	1.0	0.7
Green Paint - Metal Deck	B-419L	Good	1.53	1.0	0.7
Red Paint - Metal Deck	B-505-M	Good	2.17	1.0	0.7
Red Paint - Metal Overhead	A-425-L	Good	2.13	1.0	0.7
Red Paint - Metal Overhead	B-419-L	Good	2.05	1.0	0.7
Red Paint - Metal Bulkhead	A-429-A	Good	2.26	1.0	0.7
Red Paint - Metal Deck	B-445-A	Good	2.78	1.0	0.7
Red Paint - Metal Bulkhead	B-439-A	Good	2.72	1.0	0.7
Yellow Paint - Dehumidifier Fittings on Boiler Front	B-2-1	Good	2.6	1.0	0.7
White Paint - Metal Bulkhead	Hanger bay 2	Good	3.06	1.0	0.7
Red Paint - Fire Station/GA Contact Maker	B-2-1	Good	3	1.0	0.7
Gray Paint - Metal Deck	B-121 AE	Good	3.45	1.0	0.7
Black Paint - Metal Shelf	C-0104 A	Good	3.83	1.0	0.7
Red Paint - Vertical Pipe	B-441AL Main GSK	Good	3.73	1.0	0.7
Red Paint - Metal Deck	B-409A	Good	3.6	1.0	0.7
Red Paint - Metal Deck	B-441-AL barber shop	Good	4	1.0	0.7
Red Paint on Metal Bulkhead	B-7-1	Good	4.28	1.0	0.7
Red Paint - Metal Deck	C-302–L	Good	4.13	1.0	0.7
Yellow Paint - Metal Bulkhead	A-313-L	Good	5.3	1.0	0.7

Sample Color, Component, Substrate	Location	Condition	Measured Lead Concentration mg/cm^2	USEPA Standard mg/cm^2	SCDHEC Standard mg/cm^2
Gray Paint - Metal Deck	C-501-M	Good	5.28	1.0	0.7
Red Paint - AFFF Station	A-205-1L	Good	1.52	1.0	0.7
Red Paint - Metal Overhead	B-315 L aft crews galley	Good	1.29	1.0	0.7
Red Paint on Metal Deck	B-6-1	Good	19.77	1.0	0.7
Red Paint on Metal Deck	B-218-L	Good	11.57	1.0	0.7
Red Paint on Metal Deck	A-423A	Good	5.93	1.0	0.7

4.5.3 PCBs

The laboratory analytical results for the PCB wipe samples collected throughout the vessel are summarized in Table 4-5 (general public areas of high occupancy), Table 4-6 (administrative areas of high occupancy), and Table 4-7 (maintenance areas of low occupancy).

In the areas occupied by the general public, four of 33 wipe samples (12%) had concentrations of PCBs below the laboratory limit of detection (less than 0.0333 µg/103 cm^2). Eighteen of 33 wipe samples (54%) had concentrations of PCBs less than the USEPA limit but greater than the laboratory limit of detection. Eleven of 33 wipe samples (33%) had concentrations of PCBs greater than the USEPA limit for high occupancy.

In the areas occupied by the administrative employees and/or volunteers, no wipe samples (0%) had concentrations of PCBs below the laboratory limit of detection. Two of three wipe samples (67%) had concentrations of PCBs less than the USEPA limit but greater than the laboratory limit of detection. One of three wipe samples (33%) had concentrations of PCBs greater than the USEPA limit for high occupancy.

In the areas occupied by maintenance employees, no wipe samples (0%) had concentrations of PCBs below the laboratory limit of detection. Seventeen of fifty-seven wipe samples (30%) had concentrations of PCBs less than the USEPA limit but greater than the laboratory limit of limit for low occupancy, with 40 wipe samples (70%) exceeding the USEPA limit.

Airborne exposures to PCBs are unlikely on the vessel unless the PCB compounds are burned from overheating or aerosolized from overheating and/or cleaning with a high pressure cleaning solution. The predominant routes of entry for exposure to PCBs is via skin contact and adsorption and ingestion, the latter from mouth-to-hand activities.

Table 4-5. PCB wipe measurements in general public areas of high occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCDHEC standards.

Sample Number	Location	PCB Concentration (µg/area of wipe)
B-3-1-ZZ-54	B-3-1 Handrail	1.405 µg/ 103 cm^2
B-3-1-ZZ-55	B-3-1 Trash Can	0.246 µg/ 103 cm^2
B-3-1-ZZ-56	B-3-1 Handrail	1.001 µg/ 103 cm^2
B-4-1-ZZ-57	B-4-1 Throttle wheels	2.119 µg/ 103 cm^2
B-4-1-ZZ-58	B-4-1 Upper Flat Handrail	6.154 µg/ 103 cm^2
B-309-EL-ZZ-59	B-309-EL Hand Sanitizer Station	0.1549 µg/ 103 cm^2
B-318-L-ZZ-60	B-318-L Lighting Panel 2-F-118-E	0.414 µg/ 103 cm^2
B-321-L-ZZ-61	B-321-L Ladder Handrail	0.2128 µg/ 103 cm^2
C-203-L-ZZ-62	C-203-L Valve Station Handles	5.54 µg/ 103 cm^2
FR194RR-ZZ-66	Rest room hanger 3 stbd side frame 194 Men Door	0.0871 µg/ 103 cm^2
FR194RR-ZZ-67	Rest room hanger 3 stbd side frame 194 Men urinal handle	< 0.0333 µg/ 103 cm^2
FR194RR-ZZ-68	Rest room hanger 3 stbd side frame 194 Men faucet	< 0.0333 µg/ 103 cm^2
FR194RR-ZZ-63	Rest room hanger 3 stbd side frame 194 Women door	0.1048 µg/ 103 cm^2
FR194RR-ZZ-64	Rest room hanger 3 stbd side frame 194 Women stall	< 0.0333 µg/ 103 cm^2
FR194RR-ZZ-65	Rest room hanger 3 stbd side frame 194 Women sink	< 0.0333 µg/ 103 cm^2
Heeding-ZZ-69	Geedunk cafe area chair backs	0.4859 µg/ 103 cm^2
Theater-ZZ-70	Theater fwd in hanger bay 1 armrests	1.647 µg/ 103 cm^2
WRSR119-ZZ-71	WRSR 119 Phone & Mouse	1.541 µg/ 103 cm^2
B-0105-L-ZZ-72	B-0105-L Keyboard	0.746 µg/ 103 cm^2
Freight elevator-ZZ-76	Freight elevator Door Handle & Keypad	0.797 µg/ 103 cm^2
B-217-EL-HYD-SYS-FR132-86	**Gearbox for reach rod**	**100.42 µg/ 103 cm^2**
B-214-L-HYD-SYS-FR133-87	Valve actuator station	0.944 µg/ 103 cm^2
5INGUN-HYD-SYS-FR32-93	**Port side 5" Gun Fr 32**	**16.69 µg/ 103 cm^2**
A-306–E-HYD-DK-FR49-14	**Deck inside containment outbd of control panel**	**718.5 µg/ 103 cm^2**
A-306-E-HYD-SYS-FR49-15	**Bottom fwd end of ram**	**50.479 µg/ 103 cm^2**
A-306-E-GR-SFC-FR49–16	**Wire on fwd sheave**	**24.716 µg/ 103 cm^2**
B-217-EL-HYD-DK-FR136-19	**Inbd of containment fr136**	**65.2 µg/ 103 cm^2**
B-3-1-HYD-SFC-FR93-25	**Valve actuator fwd of port boiler**	**26.62 µg/ 103 cm^2**
B-3-1-LO-SYS- FR99-28	Port Inbd FD fan	1.761 µg/ 103 cm^2
B-3-1-HYD-SYS-FR99-27	**Main Steam stop aft end of port boiler**	**11.55 µg/ 103 cm^2**
B-3-1-HYD-DK-FR99-26	**Deck below port mn steam stop vlv**	**61.27 µg/ 103 cm^2**
C-203-L-HYD-SYS-FR153-33	**C-203-L**	**29.05 µg/ 103 cm^2**
A-321.25-1L-HYD-SYS-FR72-43	**A-321.25-1L Valve Actuator Station**	**123 µg/ 103 cm^2**

Table 4-6. PCB wipe measurements in administrative areas of high occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCDHEC standards.

Sample Number	Location	PCB Concentration (µg/area of wipe)
OPSOFFLADDER-ZZ-73	Ladder 02 level fwd of fr121 outside ops office	0.2105 µg/ 103 cm^2
C-0212-AL-ZZ-74	C-0212-AL Keyboard & Phone	1.367 µg/ 103 cm^2
02AVLOSTRTK-LO-DK-FR113-95	**Aviation lube oil storage Tk Residue**	**29.716 µg/ 103 cm^2**

Table 4-7. PCB wipe measurements in administrative areas of high occupancy on the USS *Yorktown*. **Bold** indicates concentrations about USEPA or SCDHEC standards.

Sample Number	Location	PCB Concentration (µg/area of wipe)
A-203-E-hyd-DK-FR12-1	A-203-E	25.48 µg/ 103 cm^2
A-203-E-HYD-SYS-FR12-2	A-203-E	81.3 µg/ 103 cm^2
A-304-E-HYD-DK-FR25-3	Fwd end of catapult	70.58 µg/ 103 cm^2
A-304-E-HYD-SYS-FR25-4	A-304-E	4.26 µg/ 103 cm^2
A-304-E-GR-SFC-FR25-5	Wire sheave	80.8 µg/ 103 cm^2
A-404-AE-DK-FR27-6	**Inbd aft hyd pump containment**	**258.9 µg/ 103 cm^2**
A-404-AE-SYS-FR27-7	**Bottom of ram**	**431 µg/ 103 cm^2**
A-213-L-HYD-SYS-FR62-8	Control station #1 Stbd	17.1 µg/ 103 cm^2
A-211-EL-HYD-SYS-FR53-9	Hyd control station gear pump casing fwd	80.8 µg/ 103 cm^2
C-303.25-E-HYD-DK-FR152-10	**C-303.25-E deck**	**205.2 µg/ 103 cm^2**
C-303.25-E-HYD-SYS-FR152-11	Input shaft	68.24 µg/ 103 cm^2
C-405-A-HYD-SFC-FR158-12	Fire main valve actuator in ovhd	6.31 µg/ 103 cm^2
A-318-J-HYD-SYS-FR60-13	Aft valve on outbd bulkhead	16.55 µg/ 103 cm^2
A-406-E-HYD-DK-FR45-17	**Deck fwd of outbd hyd pump**	**163.38 µg/ 103 cm^2**
A-406-E-HYD-SYS-FR45-18	**Drive end of fwd inbd hyd pump**	**335.01 µg/ 103 cm^2**
B-204-E-HYD-DK-FR95-20	Deck Inbd of ram on frame 95	19.89 µg/ 103 cm^2
B-204-E-HYD-SYS-FR95-21	Underside of hyd actuator for ram	31.58 µg/ 103 cm^2
B-204-E-GR-SFC-FR95-22	On wire	14.525 µg/ 103 cm^2
B-410-E-HYD-SYS-FR88-23	Pump 2b flange leak	85.4 µg/ 103 cm^2

Sample Number	Location	PCB Concentration (µg/area of wipe)
B-410-E-HYD-DK-FR88-24	Inbd on deck of fwd hyd accumulator	75.71 µg/ 103 cm^2
B-4-1-HYD-SYS-FR101-29	**Er#1 lower level fwd port circ pump**	**219.76 µg/ 103 cm^2**
B-4-1-HYD-SFC-FR101-30	ER#1 bulkhead vlv centerline	43.37 µg/ 103 cm^2
2-60-4-HYD-DK-FR59-31	**Capstan machinery room**	**166.7 µg/ 103 cm^2**
2-60-4-HYD-SYS-59-32	**Capstan machinery room**	**180.8 µg/ 103 cm^2**
AG#1-HYD-DK-FR185-34	Arresting gear #1	35.68 µg/ 103 cm^2
AG#1-HYD-SYS-FR185-35	**Arresting gear #1**	**135.3 µg/ 103 cm^2**
AG#2-HYD-DK-FR183-36	Arresting gear #2	14.24 µg/ 103 cm^2
AG#2-HYD-SYS-FR183-37	**Arresting gear #2**	**110.26 µg/ 103 cm^2**
AG#3-HYD-DK-FR172-38	**Arresting gear #3&4**	**183 µg/ 103 cm^2**
AG#3-HYD-SYS-FR172-39	**Arresting gear #3&4**	**645.1 µg/ 103 cm^2**
AG#4-HYD-SYS-FR170-40	**Arresting gear #3&4**	**626.2 µg/ 103 cm^2**
C-407.5-M-HYD-DK-FR160-41	C-407.5-M Deck	43.71 µg/ 103 cm^2
C-407.5-M-HYD-SYS-FR160-42	C-407.5-M Valve Actuator	53.6 µg/ 103 cm
A-543-1ME-HYD-SYS-FR67-44	**A-543-1ME Valve Actuator**	**113.8 µg/ 103 cm^2**
A-204-3T-HYD-DK-FR23-45	A-204-3T Stair Tread	41.15 µg/ 103 cm^2
A-204-3T-HYD-SYS-FR23-46	A-204-3T Valve Actuator	12.039 µg/ 103 cm
A-504-M-HYD-DK-FR41-47	A-509-M Deck	37.25 µg/ 103 cm^2
A-504-M-HYD-SYS-FR41-48	A-509-M 5" Hoist	8.42 µg/ 103 cm^2
C-410-AT-HYD-DK-FR170-49	C-410-AT Deck	60.8 µg/ 103 cm
C-410-AT-HYD-SYS-FR170-50	**C-410-AT Valve Actuator**	**157.63 µg/ 103 cm^2**
C-607-A-HYD-DK-FR164-52	C-607-A Deck	48 µg/ 103 cm^2
C-607-A-HYD-SYS-FR164-53	C-607-A Valve Actuator	1.914 µg/ 103 cm
C-104-E-ZZ-75	C-104-E Office Door	3.301 µg/ 103 cm^2
A-543-1ME-ZZ-77	A-543-1ME Ladder Handrail	3.831 µg/ 103 cm^2
C-208-L-ZZ-78	C-208-L Top of Mini-split AC	1.153 µg/ 103 cm
C-214-L-ZZ-79	C-214-L Power Panel 2-187-1	16 µg/ 103 cm^2
C-214-L-ZZ-81	C-214-L Door	0.865 µg/ 103 cm^2
C-214-L-ZZ-80	C-214-L Dolley Handle	4.551 µg/ 103 cm
A-509-14-HYD-SYS-FR42-83	A-509-M Fire main valve actuator	45.814 µg/ 103 cm^2

Sample Number	Location	PCB Concentration (µg/area of wipe)
A-531-T-HYD-SYS-FR62-84	**Drip tray for valve actuator pump**	**131 µg/ 103 cm**
A-310-L-LO-DK-FR56-85	**Oil on deck**	**488 µg/ 103 cm^2**
B-506-M-HYD-SYS-FR149-88	Fire main valve actuator	15.53 µg/ 103 cm^2
B-8-HYD-SYS-FR150-89	Fire main valve actuator	6.2 µg/ 103 cm
C-502-T-LO-DK-FR151-90	Oil on deck in bomb elevator	93.8 µg/ 103 cm^2
A-428-L-HYD-SYS-FR70-91	Valve actuator	71.17 µg/ 103 cm
A-0207-E-HYD-SYS-FR44-92	Nose Launch Equipment	3.678 µg/ 103 cm^2
02PSELE-HYD-SYS-FR86-94	Deck edge elevator equipment	74.5 µg/ 103 cm

Electrical components in some areas (touring routes) are slowing leaking oil and/or are greasy to the touch. Most of these components are not readily accessible to the general public due to installation of handrails around equipment and distances greater than four feet from the general public tour route walkways and equipment. However, certain leaking equipment and reservoirs in approximately two areas may be subject to contact by the general public.

Maintenance employees are subject to the highest risk of exposure to PCBs due to the greater areas of PCB-contaminated equipment and surfaces in areas not opened to the general public and administrative employees and/or volunteers. However, the cumulative time that maintenance employees occupy these areas is very low (hence, low occupancy), as entry into these areas occurs infrequently and only in the event that inspections or repairs are needed.

4.6 Rank Order of Potential Exposures to Contaminants by Population

Based on the above findings and laboratory and instrument results, the rank order of potential exposures to ACMs, LBP, and PCBs was determined for each of the three populations subject to entering the USS *Yorktown.*

4.6.1 Inhalation

As stated above, the probability of airborne exposure to ACMs, LBP, and PCBs for the three populations is low. The rank order of the three populations from highest to lowest health risk hazard for airborne exposures (the major route of entry) to ACMs are the maintenance employees, administrative employees and/or volunteers, then the general public. The ACMs in the areas occupied by the administrative employees and/or volunteers and the general public are currently in good condition. Based upon the personal protective equipment worn by maintenance employees when entering the exhaust vent shaft, these employees are well protected against exposure to airborne asbestos fibers.

The rank order of the three populations from highest to lowest health risk hazard for exposures to LBP are the maintenance employees, the general public, then administrative employees and/or volunteers. Maintenance employee are likely to enter into areas of the vessel restricted to the other two populations. The major reason the general public is ranked higher in health risk hazard to LBP as compared to the administrative employees and/or volunteers is the higher potential for disturbance and re-entrainment of lead-containing dusts and particulates into the air due to curiosity and the higher potential for touching/contacting equipment and surfaces throughout the touring routes. Regardless of the aforementioned findings, the risk of exposure to airborne lead in excess of regulatory limits is highly unlikely.

The rank order of the three populations to potential exposures to airborne PCBs is the same as for the exposure to LBP mentioned above and for the similar reasons.

4.6.2 Skin Contact and/or Adsorption

Skin contact and adsorption is the major route of entry for exposure solely to PCBs. As mentioned above, PCB compounds carry a skin notation and can be readily absorbed through the skin when contacted with unprotected bare hands.

The rank order of the three populations from highest to lowest health risk hazard for exposures to PCBs are the maintenance employees, the general public, then administrative employees and/or volunteers. Maintenance employee are likely to enter into areas of the vessel, which have the highest amounts of PCB-contaminated surfaces, that are restricted to the other two populations. The major reason the general public is ranked higher in health risk hazard to PCBs as compared to the administrative employees and/or volunteers is the higher potential for contact and adsorption of oily PCB compounds due to curiosity and the higher potential for touching/ contacting equipment and surfaces throughout the touring routes.

4.6.3 Ingestion

The major route of entry for LBP and PCBs for children under the age of six (in the general public population) is ingestion due to contact/adsorption and subsequent hand-to-mouth activities. Even adults exercising poor personal hygiene habits may be a high health risk hazard for ingestion of LBP and PCBs. Examples of poor personal hygiene habits include not washing hands after contact with LBP and/or PCBs and before eating, drinking, using tobacco products, and/or applying cosmetics. Since the majority of the ACMs on the vessel are currently in good condition, the potential for contact/disturbance of ACMs is very low from a health risk hazard standpoint.

4.7 Conclusions and Recommended Controls

Based upon the above findings and rank order of health risk hazard for the three populations assessed, GEL offers the following conclusions and recommendations for further controls for ACM, LBP, and PCB exposures.

Overall, the existing controls and current condition of the ACMs and LBP are adequate in reducing the health risk hazards to the general public, administrative employees and/or volunteers, and the maintenance employee populations subject to occupying the USS *Yorktown*. Existing controls include but are not limited to physical barriers (e.g., handrails; plexiglass partitions, chains, etc.); locked and demarcated areas restricted to the general public and the administrative employees and/or volunteers; and routine cleaning of areas open to the general public.

GEL identified certain areas and existing conditions on the vessel that may increase the potential for exposure of the populations to ACMs, LBP, and PCBs. These additional control recommendations and reasonable efforts are detailed and addressed below in efforts to further reduce the potential for personal exposures to ACMs, LBP, and PCBs on the vessel.

4.7.1 Physical Barriers and Demarcation of Area(s)

Physical barriers should be installed between the tour route walkways and equipment that is contaminated and/or leaking PCBs to prevent contact and adsorption for the general public. As a rule of thumb, if distances between the general public on the tour route walkway and the contaminated equipment is less than four linear feet, an appropriate physical barrier should be installed at this point. These areas include but are not limited to the hydraulic remote control panels along the public tour routes, and certain tanks/vessels in the engine rooms.

4.7.2 Exclusion of Selected Population(s) from Area(s)

The forecastle (fo'c's'le) of the vessel currently on a public tour route and used for boy and girl scout activities should be closed and excluded from future use due to LBP on the floor, ceiling and walls that is in poor condition in this area. If available, an alternate area should be considered for use for the boy and girl scout activities where a LBP hazard does not exist. If such an area is not available, remediation measures may be completed on the existing area as further detailed below.

4.7.3 Abatement and/or Remediation

The USS *Yorktown* staff should continue to use SCDHEC licensed asbestos contractors to repair any damaged ACMs in areas subject to occupancy by the general public and administrative employees and/or volunteers.

If not already in place, the USS *Yorktown* staff should develop and implement written asbestos, LBP, and PCB Operations and Management (O&M) plan(s) to address periodic maintenance, repairs, and visual assessments, handling and disposal of ACMs on the vessel. This O&M plan should also include periodic air (asbestos and lead) and surface wipe testing (PCBs) to confirm existing controls are adequate in maintaining a low health risk hazard to the exposed populations on the vessel.

Maintenance employee should continue to use respiratory, body, and foot protection when entering areas restricted to the general public and administrative employees and/or volunteers for repairs and/or other tasks. The goal is to reduce potential track-out of contaminants.

Clean-up protocols for LBP should include procurement and use of HEPA-filtered vacuums (either backpack-type or portable) to remove LBP chips and debris on the floor and at peripheral floor areas in certain tour route walkways. Use of the existing wet cleaner/scrubber utilizes regulatory wet methods to reduce the potential for re-entrainment of lead dust into the air, but vacuum extraction is not filtered and may likely re-entrain lead aerosols back into the air. This wet cleaner/scrubber may be used to clean floors after residual lead dust and debris are removed from the floor using an approved HEPA vacuum cleaner.

Due to the high costs to abate LBP (using paint stabilization methods followed by encapsulation using an approved exterior lead encapsulant) in the high bay ceiling of the hangar bay on the main floor of the vessel, periodic clean-up of LBP chips and debris from the floor is recommended as mentioned above.

Periodic cleanup of PCB-contaminate surfaces should be performed using an aqueous detergent that contains chemicals that solubilize grease (e.g., citrus or terpene-based cleaners, alkyl-easter salts, surfactants, and/or alcohol). Emphasis should be placed on areas where the general public and other populations may eat, drink, use tobacco products, and/or apply cosmetics where the potential for normal hand-to-mouth activities is greatest.

Encapsulation, enclosure (defined by the asbestos and LBP regulations as an air-tight physical barrier), and removal are currently not recommended as abatement/remediation controls for ACM, LBP, and PCBs on the vessel. The exception is the continued maintenance of the encapsulation of the flight deck wood, which contained elevated PCBs.

Chapter 5: Summary of the Remediation Plan for the USS *Yorktown*

The following remediation recommendation are based on the analysis of the results of the 2023 survey to identify and prioritize contaminants on the USS *Yorktown*.

Fluids in Tanks and Compartments

Because of the very high sensitivity of the animals and habitats in the Cooper and Wando Rivers, adjacent tidal creeks, and outer beaches that would be affected by a release of oil from the USS *Yorktown*, it is of highest priority that all the recoverable oil onboard the USS *Yorktown* be removed, particularly considering the deteriorating condition of the hull.

A. De-water the flooded compartments and survey the condition and contents.
B. Remove recoverable bulk heavy fuel oil and hydraulic oil from all tanks not in use, both structural and non-structural.
C. Remove fluids from tanks integral to the portion of the hull in vicinity of the tidal zone extremes +/- 4 feet (note fluid removal plans must consider maintaining a safe hydrostatic condition). Maintaining fresh water in double bottom tanks may be an alternative.
D. After the removal of heavy fuel oil, clean, restore, repair, or modify the tanks integral to the hull in the vicinity of the tidal zone to achieve and promote watertight integrity, isolated from systems, with means to monitor and maintain the space.
E. Remove fluids from either the double bottom or third bottom to maintain at least one dry, accessible, compartment between machinery spaces and the hull plating. This should include restoring the watertight boundary of the dry space in way of the access hatch and sounding tube. Due to conditions throughout the machinery space bilges, a substantial level of effort is needed to achieve conditions to facilitate these repairs.
F. Remove recoverable oil from accessible oily water tanks by using absorbents or other means.

Machinery Fluids and Spills

G. Clean and remove hydrocarbons from machinery spaces that have previously flooded, are prone to, or at risk of, flooding in the future (for example: A-9E, elevator machinery room). Clean or isolate accessible machinery sumps in public or frequented areas, removing, isolating, or encapsulating hydrocarbons.
H. Install drip pans where isolation, encapsulation, or removal is not viable.
I. Clean hydrocarbon spills in accessible areas that are susceptible to track-out.

Asbestos Remediation

J. No areas were identified requiring asbestos remediation in the public areas based on the risk assessment.
K. Staff should continue to use personal protection equipment in maintenance areas with identified asbestos hazards.
L. Periodic air monitoring for asbestos should be conducted, as part of the Operations and Management Plan described below.

Lead-based Paint Remediation

M. Due to the high costs to abate lead-based paint (using paint stabilization methods followed by encapsulation using an approved exterior lead encapsulant) in the high bay ceiling of the hangar bay on the main floor of the vessel, it is reasonable to conduct routine clean-up of LBP chips and debris from the floor.
N. Use HEPA-filtered vacuums to remove lead-based paint chips and debris on the floor and at peripheral floor areas in certain tour route walkways. The wet cleaner/scrubber currently in place may be used to clean floors after residual lead dust and debris are removed from the floor using an approved HEPA vacuum cleaner.
O. The lead-based paint in poor condition in the forecastle should be abated, which includes paint stabilization (wet scrap, HEPA vacuum, paint feathering) followed by application of an approved, exterior lead encapsulant. Until this abatement occurs, this area should be closed to the general public including the boy and girl scouts.

Polychlorinated Biphenyl (PCB) Contamination Remediation

P. Clean all identified surfaces in public and administrative areas with PCB contamination above standards using an aqueous detergent that contains chemicals that solubilize grease.
Q. Conduct periodic cleaning of areas where the general public and other populations may eat, drink, use tobacco products, and/or apply cosmetics where the potential for normal hand-to-mouth activities is greatest, as needed based on monitoring data.
R. Maintain the integrity of the encapsulation of the flight deck wood, which contains elevated levels of PCBs.

Control Measures to Exclude the Public from Contaminated Areas Not Amenable to Remediation

S. Close off, isolate, and install access control measures in areas where contaminants exist but are not amenable to removal.
T. Isolate machinery and systems in public areas that are prone to minor leaks that may be hazardous (examples: hydraulic control stations, catapult, elevator machinery, etc.).
U. The forecastle was identified as an area where the lead-based paint on the floor, ceiling, and walls is in poor condition and should be closed and excluded from future use. If exclusion is not an option, then this area will require lead-based paint abatement (using paint stabilization methods followed by encapsulation using an approved exterior lead encapsulant), which will be very difficult and expensive to implement.

Operations and Management Plan Focused on Contaminant Monitoring and Control

V. Maintenance staff should implement and follow very strict personal protection measures to reduce the potential for track-out of PCB contamination when exiting maintenance areas.
W. Staff should conduct periodic air (asbestos and lead) and surface wipe testing (PCBs) to confirm existing controls are adequate in maintaining a low health risk hazard to the exposed populations on the vessel.

Other

X. Repair the external hull and restore watertight integrity.

Attachments

The following attachments provide all the site survey data and photographs collected by the survey teams using the Esri® application Survey123, the raw spreadsheets for these data, the AutoCAD drawings for each deck and the Liquid Loads that were generated by the survey team, consolidated spreadsheets of all the laboratory results provided by GEL, the HELSALV Condition report and definitions used therein, and a spreadsheet with the non-structural tank data collected by the survey team. In addition, the certifications for the GEL Certified Industrial Hygienist, asbestos license, and lead training certifications are also provided. These attachments contain all of the data, photographs, and work products of the study.

Attachment 1. RPI_Yorktown Survey Data_Photos by Deck March 2023 (folder)
Attachment 2. RPI_Yorktown AutoCAD Drawing by Deck and Liquid Load 2023 (folder)
Attachment 3. RPI_Yorktown HECSALV Condition Report March 2023.pdf
Attachment 4. RPI_Yorktown HECSALV Definitions. March 2023.pdf
Attachment 5. RPI_Yorktown Non-Structural Tank Data. March 2023.xlsx
Attachment 6. RPI_Yorktown Consolidated Sample GEL Lab Results. March 2023.xlsx
Attachment 7. RPI_Yorktown Survey123 _Raw Data Excel Files March 2023 (folder)
Attachment 8. RPI_Yorktown_PCB Wipe Data Sheets_Photograph. March 2023.pdf
Attachment 9. RPI_Yorktown PCB Wipe Log Results by Compartment Use. March 2023.xlsx
Attachment 10. RPI_Yorktown_Original Survey Samples Report.March 2023.pdf
Attachment 11.RPI_Yorktown_Original Survey Access Report.March 2023.pdf
Attachment 12. RPI_Yorktown_GEL Certificates June 2023 (folder)