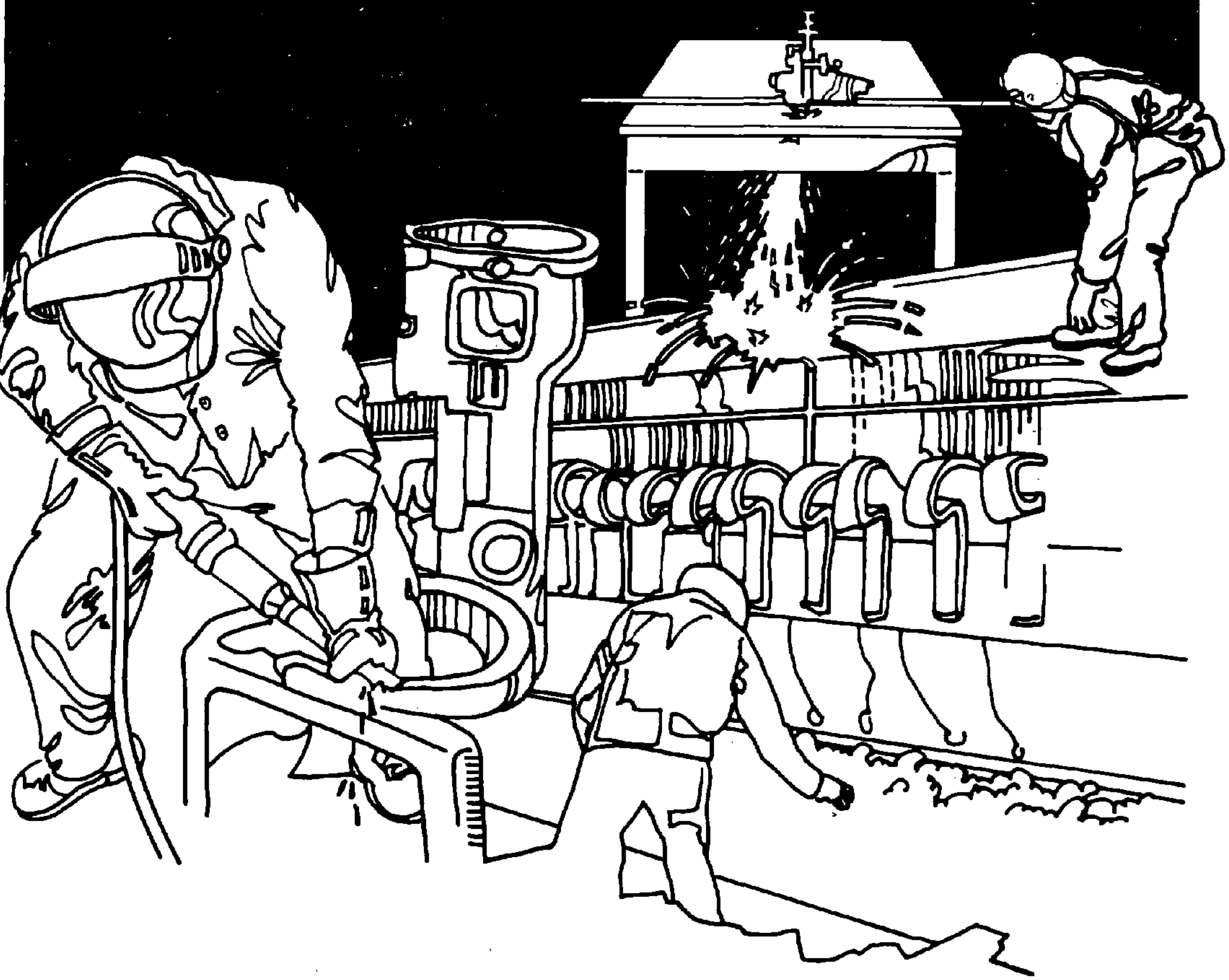
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

TA 80-099-859
TOBIN-MYSTIC RIVER BRIDGE
BOSTON, MASSACHUSETTS

REGION-1

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

TA 80-099-859
Massachusetts Dept. of Public Health
City of Boston Department of Health
and Hospitals
Tobin-Mystic River Bridge
Boston, Massachusetts

NIOSH INVESTIGATORS:
Philip J. Landrigan, M.D.
Wesley Straub, I.H.
Kevin McManus, I.H.
Gary F. Stein, M.D.
Edward L. Baker, M.D.
Jay S. Himmelstein, M.D.

I. SUMMARY

On July 16, 1980, the Centers for Disease Control (CDC) were asked to evaluate possible health hazards in Charlestown, Massachusetts resulting from removal of lead-based paint from the Tobin-Mystic River Bridge (MTB). Removal was intended to reduce exposure of children to paint chips flaking from MTB. Over populated areas, paint was removed by grit-blasting and replaced with zinc-based paint. On the center span (over water) paint was removed mechanically, and the bridge recoated with lead-based paint.

Investigators from the National Institute for Occupational Safety and Health (NIOSH) and the Bureau of Epidemiology conducted evaluations on July 20-25, August 13-14, and September 10, 1980. Occupational studies indicated that grit-blasters had personal (breathing-zone) air lead exposures of 10-1,090 ug/M^3 (mean 134 ug/M^3); the NIOSH recommended standard for occupational lead exposure is 50 ug/M^3. Grit-blasters wore positive-pressure, air-supplied respirators. Blood lead levels in 13 grit-blasters ranged from 25-47 ug/dl. Three (23%) had levels above 40 ug/dl; blood lead levels above 40 ug/dl in adults indicate increased lead absorption. Center span workers had air lead exposures of 6-1,017 ug/M^3 (mean, 139 ug/M^3). Blood lead levels in 19 center span workers ranged from 30-96 ug/dl; levels in 15 (79%) were above 40 ug/dl. Five center span workers had symptoms of lead poisoning. Adequate respiratory protection had not been provided to center span workers.

Community air lead concentrations 27 meters from MTB in June, 1980 ranged from 2.7-12.9 ug/M^3. The EPA standard for lead in community air is 1.5 ug/M^3. Highest levels occurred when pollution controls were not properly used. In July, after controls had been improved, air lead concentrations at 12 meters ranged from 0.33-3.54 ug/M^3 and at 27 meters from 0.46-1.30 ug/M^3.

Surface soil lead concentrations in Charlestown averaged 3,272 parts per million (range, 953-5,147 ppm) within 100 feet of MTB; 457 ppm at 100-250 feet; and 197 ppm beyond 250 feet. Within 100 feet of MTB in Chelsea, where no grit-blasting had occurred, the mean surface soil lead concentration was 1,136 ppm (range 634-1638 ppm). Comparison soil samples taken at the Bunker Hill Monument in Charlestown contained 165 ppm lead.

Blood samples were obtained from 123 Charlestown children age 5 years or below living within 1/4 mile of MTB. Four (8.5%) of 47 children within 2 blocks had levels above 30 ug/dl; in children, blood lead levels above 30 ug/dl indicate increased lead absorption. None of 76 children beyond 2 blocks had levels above 30 ug/dl; that is a significant difference ($p = 0.0192$).

The long-term objective of reducing lead exposure through removing lead paint from MTB is reasonable. We found, however, that deleading workers' blood lead levels were elevated and that 5 workers had symptoms of lead poisoning. We found also that air, soil, dust, and blood lead levels in children were higher in proximity to the grit-blasting than at a distance. We conclude that lead-based paint removal has caused increased occupational and environmental lead exposure in Charlestown. Recommendations to reduce lead exposure in the deleading of MTB are presented on Page 11.

II. INTRODUCTION

The National Institute for Occupational Safety and Health of the Centers for Disease Control conducts evaluations of occupational exposures and diseases under the mandate of the Occupational Safety and Health Act of 1970.

On July 16, 1980, Mr. Harry Pierce, Esq., Greater Boston Legal Services requested that the Centers for Disease Control (CDC) evaluate possible occupational and community health hazards resulting from the removal of lead-based paint from the Tobin-Mystic River Bridge (MTB) in the Charlestown section of Boston, Massachusetts.

CDC discussed the request with Mr. Pierce, with the Massachusetts Departments of Public Health, Labor and Industry, and Environmental Quality Engineering, with the City of Boston Department of Health and Hospitals, and with the Massachusetts Port Authority (Massport), operator of the bridge. CDC chose to assist the evaluation through provision of NIOSH Technical Assistance to the Massachusetts Department of Public Health and to the City of Boston Department of Health and Hospitals.

On July 20-25, 1980, Philip J. Landrigan, M.D., M.Sc., Director, Division of Surveillance, Hazard Evaluations and Field Studies, NIOSH; Gary F. Stein, M.D., Epidemic Intelligence Service Officer, Chronic Diseases Division, Bureau of Epidemiology CDC; Wesley Straub, Regional Consultant, NIOSH; and Kevin P. McManus, Regional Industrial Hygienist, NIOSH met state and city officials and conducted occupational, environmental and medical evaluations at MTB. Additional evaluations of MTB workers were conducted on August 13-14 and September 10, 1980 by Edward L. Baker, Jr., M.D., M.P.H. and Jay S. Himmelstein, M.D., M.P.H., Occupational Health Program, Harvard School of Public Health under contract to NIOSH. Analyses of childhood blood lead levels were performed by the City of Boston Department of Health and Hospitals, and statistical evaluations were conducted by Dr. Stephen M. Meyer, Massachusetts Institute of Technology.

NIOSH issued a preliminary written summary of results on July 25, 1980 and a detailed interim report on July 31, 1980. Drs. Baker and Himmelstein issued a final report on their studies on February 5, 1981. Dr. Meyer issued reports of his analyses on July 25, 1980 and February 23, 1981.

III. BACKGROUND AND PREVIOUS STUDIES

The Tobin-Mystic River Bridge (MTB) is a high suspension bridge (190 feet above the water at its peak) which spans the mouth of the Mystic River between Charlestown and Chelsea, Massachusetts. It was built in 1949-50. Estimated average daily traffic volume is 70,000 vehicles.

The bridge is coated with a lead chromate paint. In 1977, studies conducted by Dr. William Burgess of the Harvard School of Public Health for Massport showed that air and soil lead levels under and immediately adjacent to the bridge were elevated over background.[1] Ambient airborne lead levels at adjacent homes ranged from 0.2-5.6 ug/M^3 in 9-hour daytime samples and from 1.2-3.5 ug/M^3 in 24-hour samples. The concentration of lead in air was found to be dependent on wind direction, on elevation of the bridge above the ground, and on distance from the bridge. In surface soil samples (top 1/4 - 1/2 inch) Burgess[1] found that lead concentrations under the bridge ranged from 1300 to 4800 parts per million (ppm), with an arithmetic mean of 2,700 ppm. Concentrations of lead in samples taken on side streets in Chelsea decreased directly with distance from the bridge; the lowest lead concentration observed in a street sample was 410 ppm. To evaluate the relative contributions to soil lead of automotive exhaust (tetraethyllead bromide) and of lead paint (lead chromate), Burgess[1] examined lead/bromide and lead/chromium ratios in soil samples. He found lead/bromide ratios to be highest under the bridge and to decrease with distance toward the ratio expected from the combustion of leaded gasoline; that finding suggested that a non-automotive source of lead, such as paint, was the major contributor to soil lead under the bridge. At the same time, the concentration of chromium relative to lead was highest under the bridge and decreased with distance. That analysis indicated that paint from the bridge had contributed to soil lead concentration under the bridge. Burgess[1] concluded that "the soil burden of lead noted directly under the bridge is due predominantly to lead from the bridge paint."

A blood lead survey of 1 to 6 year-old children living near the bridge was conducted in the summer months of 1977 by Community Action Program Inner City (CAPIC), a local anti-poverty group, and the City of Chelsea. In 78 children living near the bridge, the mean blood lead was 39 ug/dl, with 53 (68%) having lead levels ≥30 ug/dl, the level considered by the Centers for Disease Control[2] to represent increased lead absorption in children. In 82 children living farther away from the bridge, the mean blood lead level was 29 ug/dl, and 30 (37%) values were ≥30 ug/dl. The difference in blood lead levels between the two groups of children was attributed, in part, to greater deterioration of homes near the bridge (and thus to increased deterioration of surfaces painted with lead) and in part to exposure of children to paint chips and to automotive emissions from the bridge.[3]

IV. THE PROCESSES

In 1977, as a result of the above studies, Massport decided to remove lead-based paint from the two ends of the MTB, where the bridge passes over neighborhoods; the center span was still to be covered by lead-based paint.[3] The procedure chosen for deleading was abrasive grit-blasting of rusted areas (approximately 1/3 of the total painted surface) followed by coating with an organic zinc primer and a non-leaded top coat. The grit used for the blasting was Black Beauty, an abrasive derived from copper smelter slag.

Grit-blasting began in Charlestown in the spring of 1979 and continued through the summer of 1980, except for a shutdown during the winter months. The work was conducted under contract to Massport by the George Campbell Painting Co., Flushing, New York. Except for a small amount of preliminary experimental grit-blasting in 1977, no grit-blasting has yet been undertaken in Chelsea.

The procedure for grit-blasting is as follows: Black Beauty is carried in high-pressure hoses from a reservoir at ground level to a jet-gun held by a worker, who directs the stream of abrasive at rusted areas. The worker is protected by a positive-pressure air-supplied respirator. Each worker is completely enclosed by a 6-sided box which is connected to the side of the bridge and which is intended to reduce atmospheric emissions. Canvas shrouds seal the box to the bridge. The boxes are mounted on wheels and are moved along the bridge rail as the work proceeds. The boxes are maintained under slight negative air pressure, and spent Black Beauty and paint chips are drawn from the bottom of the box through a large-diameter hose to a cyclone and scrubber situated in series on the ground beneath the bridge. The chips and Black Beauty are intended to be trapped in the cyclone and scrubber, from whence they are transported to a landfill.

The procedures for environmental protection appear to work most efficiently during the grit-blasting of horizontal bridge members, but much less well because of adverse geometry during work on vertical and diagonal members. Several breaks in technique were described by observers of the process, although no index of their frequency is available: canvas shrouds have not always been tightly sealed and have occasionally fallen to the ground; the large diameter suction hoses have developed leaks; hoses have become disconnected from the cyclone; and spent Black Beauty with paint chips has been allowed to accumulate on the ground under the bridge.

Grit-blasting is conducted during one shift per day (6:00 AM - 2:30 PM), six days each week. It is estimated by Massport officials that actual blasting occurs for approximately 60% (28.8 hours) of the 48-hour work week. At the time of the NIOSH evaluation, two blast booths were in use, and two were inactive. Personnel consist of two operators in each booth, two helpers outside each booth, one to two workers on the ground beneath the bridge who are responsible for loading Black Beauty and for tending to pollution control equipment and air compressors, and a foreman. Grit-blasters wore positive-pressure, air-supplied respirators. It is estimated by Massport that the entire work force turned over three times between April and July 1980, because of unpleasant working conditions.

In addition to the workers involved in grit-blasting, a second separate group of workers were simultaneously engaged in scraping lead-based paint off the center span of the bridge with pneumatic and hand tools and in applying a new coat of lead-based paint with spray guns.

V. METHODS OF STUDY

A. Environmental

High volume air samples were collected in June and July 1980 at seven sites near the bridge in Charlestown by the Massachusetts DEQE and were analyzed for lead content. Two sites were located at ground level 12 meters from the western edge of the bridge, four were located at ground level 27 meters from the western edge of the bridge, and one was situated on a three-story rooftop approximately 50 meters from the bridge. Both short-term (6-8 hour) and 24-hour samples were collected.

Surface soil samples were collected in July 1980 by CDC/NIOSH. Samples of the top 1 cm of soil were taken from areas that appeared undisturbed. At each sampling location, 15-20 scoops of soil were taken from within an area of 1 m^2 with a stainless steel spatula and placed in a plastic bag. Samples were also obtained of bridge paint and of used grit. Analyses for lead content in all these samples were performed by Environmental Sciences Associates, Bedford, Massachusetts.

In Charlestown, soil samples were taken from within 100 feet of the bridge, at 100-250 feet, and at 300 feet. Also, in Chelsea, samples were obtained from within 100 feet of the bridge. Comparison samples were collected within 100 feet of the elevated I-93 roadway at Sullivan Square, Charlestown; at the Bunker Hill Monument in Charlestown; and at a rural area in Bedford, Massachusetts. Comparison of the Charlestown and Chelsea MTB samples was intended to evaluate the incremental addition of lead to soil near the MTB that resulted from grit-blasting. Comparison of Chelsea with I-93 (Sullivan Square) and rural samples was intended to evaluate the relative contributions to soil lead of auto emissions and of paint flaking.

B. Occupational

Personal (breathing zone) air samples were obtained by the Massachusetts Division of Occupational Hygiene for evaluation of lead exposure of bridge workers. Samples were obtained on workers in the grit-blasting operation and also on workers engaged in the scraping and repainting (with lead-based paint) on the center span. Analyses of samples were performed by the Massachusetts Division of Occupational Hygiene.

Medical evaluations of workers included questionnaires, blood analyses, neuropsychological tests and neurologic examinations. The questionnaires sought information on symptoms known to be associated with lead toxicity. Questions on work practices and on factors such as age, education, and pre-existing medical conditions were included in addition to complete occupational and non-occupational exposure histories. Blood samples were obtained by venipuncture and were collected in lead-free tubes. Samples were analyzed for blood lead and zinc protoporphyrin (ZPP) content.

A complete blood count (CBC) was obtained on each worker to evaluate possible lead effects on the hematopoietic system, particularly anemia. Blood urea nitrogen (BUN) and serum creatinine levels were analyzed to assess kidney function.

Neuropsychological testing was performed to detect possible subclinical effects of lead on the central and peripheral nervous system. The following tests were used:

1. The Santa Ana Dexterity Test - tests hand-eye coordination and peripheral motor function.

2. The Digit Span Subtest of the Wechsler Adult Intelligence Scale (WAIS) - a short-term memory test, frequently affected by neurotoxins.

3. The Digit Symbol Subtest of the WAIS - combines short and long-term memory information processing and accuracy of information recall.

4. Vocabulary Subtest of the WAIS - a stable indicator of overall intelligence and education.

A neurologic examination was performed by a physician to identify any clinical evidence of lead poisoning and to detect any abnormalities or diseases that would affect performance on the neuropsychological tests.

Lead toxicity (poisoning) was diagnosed in any worker with:

blood lead level above 60 ug/dl		3 central nervous systems symptoms
<u>or</u>	<u>and</u>	<u>or</u>
zinc protoprophyrin (ZPP) above 100 ug/dl		anemia (hemoglobin below 14 g/100 ml).

C. <u>Community</u>

Fingertip blood samples were obtained from children 5 years of age and below living within one-fourth mile of MTB in Charlestown. They were analyzed for blood lead and erythrocyte protoporphyrin (EP) levels. Samples were collected by the Lead Poisoning Prevention Center, Department of Health and Hospitals, City of Boston with assistance from CDC/NIOSH. Analyses were performed at the Massachusetts State Laboratory and at Environmental Sciences Associates, Bedford, Massachusetts. Samples were collected at the Bunker Hill Health Center in Charlestown, and, additionally door-to-door visits were undertaken in the blocks near the bridge to obtain samples from children who had not visited the health center. Samples of house dust (from window sills or vacuum cleaner bags) were collected during the home visits and were analyzed for lead content. Houses of children found to have blood lead levels $\geq$30 ug/dl were evaluated for lead-based paint sources using X-ray fluorescence detectors.

VI. EVALUATION CRITERIA

Lead

Prolonged absorption of lead from inhalation or from oral ingestion, can result in gastrointestinal disturbances, anemia (low blood count), neuromuscular dysfunction, slowed reaction times, central nervous system complaints, mental deficiency, and in the most extreme cases, encephalopathy with coma, convulsions, and death. Symptoms of lead poisoning may include abdominal discomfort, loss of appetite, insomnia, tiredness, and weakness. Physical findings usually occur late and include abdominal tenderness, malnutrition, extensor muscle weakness and pallor secondary to a hypochromic, microcytic anemia. Obvious extensor muscle paralysis (wrist drop) and encephalopathy may accompany the most severe and prolonged poisonings. Chronic kidney disease in the exposed adult, and damage to the unborn fetus are among the additional adverse effects of lead.

Due to these health effects, NIOSH[4] currently recommends that for adult male workers blood levels of 0-40 ug/100mg be considered in the "safe" range; 40-60 ug/100 ml represent increased absorption with potential adverse effects; levels above 60 ug/100 ml are undesirable. Fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/dl. Also, the Centers for Disease Control recognize that children are more vulnerable to the harmful effects of lead than are adults. CDC therefore considers any blood lead level in a child of 30 ug/dl or above to indicate increased lead absorption.[2]

VII. RESULTS AND DISCUSSION

A. Environmental

Air Samples

In June 1980, high-volume air samples obtained 27m from the bridge had a mean lead concentration of 5.32 ug/m^3; the EPA air lead standard is 1.5 ug/m^3 (expressed as a 3-month average)[5] (Table 1) (Figure 1). One sample obtained at approximately 50m contained 2.8 ug lead/m^3 air. The highest value in June (site #2, 27m from MTB, June 26; 12.9 ug/m^3) was obtained on a day when the canvas shroud was not in place for two hours of the 6.1-hour sampling period. The lowest value (site #2, 27m from MTB, June 30; 2.7 ug/m^3) was obtained during a 4.8-hour daytime period on a rainy Monday when no grit-blasting was in process. An attempt was made in the June sampling to distinguish coarse (less than 2.5-15 ug diameter) from fine airborne particulates (2.5 um diameter) by a dichotomous sampling technique. Although problems with that method preclude presentation of data by particle size, those problems do not appear to have influenced the high-volume sampling results, as presented in Table 1 and Figure 1.

In July 1980, highest air lead concentrations (mean 1.43 ug/m^3) were seen at sites closest to the bridge and decreased with distance (Table I) (Figure 1). Higher values were observed in 6- to 8-hour samples spanning rush hour than in

21- to 24-hour samples. Also, lead concentrations were higher on a Friday (July 11) with an average traffic volume of 80,000 vehicles than on a Sunday (July 13) with 60,000 vehicles. There was a general trend toward lower air lead concentrations in July as compared to June. This decline paralleled the application of tighter air pollution and work practice controls to the grit-blasting operation.

Paint, Grit, and Soil Samples

The mean lead content of 5 paint samples scraped from the MTB was 273,800 ppm (range, 185,000-450,000) (Table 2). The paint sample also had a mean chromium content of 13,020 ppm. Three samples of used Black Beauty had a mean lead content of 8,127 ppm (range 4,080-12,900 ppm); unused copper smelter slag grit has previously been reported to contain 12 ppm lead.[6]

The mean lead content of 10 surface soil samples obtained within 100 feet of MTB in Charlestown was 3,272 parts per million (ppm). The lead concentration in soil decreased sharply with distance from the MTB to 457 ppm at 100-250 feet, and 197 ppm at 300 feet (Table II) (Figure 2). Soil samples taken within 100 feet of MTB at its opposite end in Chelsea, where no grit-blasting had occurred, had a mean lead concentration of 1,003 ppm - a concentration approximately one-third that observed in Charlestown.

The average lead concentration of soil samples taken beneath the elevated I-93 roadway in Sullivan Square was 593 ppm, approximately 50% of the average value in Chelsea. This finding suggests that approximately one-half of the soil lead contamination in Chelsea is accounted for by automobile exhaust and the rest by flaking of lead paint from the bridge; that estimate should, however, be considered only approximate as the traffic volume on I-93 is less than that on MTB.

Soil lead concentrations in comparison samples obtained from the Bunker Hill National Monument averaged 165 ppm, and in a rural area (Bedford) 83 ppm. Those values are typical of average background urban and rural soil lead concentrations in the United States.

B. Occupational

Personal (breathing zone) air lead exposures of workers varied from 10-1,090 ug/m^3 in the grit-blasting operation, and from 6 to 1,017 ug/m^3 among center span workers engaged in the paint-scraping/lead-painting operations (Table 3). In the grit-blasting operation, highest exposures occurred in helpers. In the lead-painting operation, highest exposures were found in "scrape and prime" workers. Actual worker exposures may have been lower than those indicated, especially in grit-blasting, as a result of respirator use.

Grit-blasting workers were slightly older and had worked slightly longer than center span workers but were otherwise similar (Table 4). Blood lead levels and zinc protoporphyrin levels were markedly elevated among center span workers. Three (23%) of 13 grit-blasting workers had lead concentrations of 40-60 ug/dl; none were above 60 ug/dl. By contrast, 4 (21%) of 19 center span workers had blood lead levels of 40-60 ug/dl, and another 11 (58%) had levels above 60 ug/dl. The highest level in a center span worker was 96 ug/dl.

Symptoms - A higher frequency of central nervous system (CNS) symptoms was found among center span workers than grit-blasters (Table 5). Gastrointestinal complaints were also slightly more common among center span workers, but this difference was not statistically significant.

Hematologic Effects - Four individuals with anemia (hemoglobin less than 14 grams) were identified. The two most severe (Hgb = 12.4 and 12.6) were center span workers, both of whom also had elevated blood lead and ZPP levels (greater than 60 ug/100ml Pb; greater than 300 ug/100ml ZPP). BUN levels were not different between the two groups of workers, but creatinine levels were slightly higher among grit-blasting workers, possibly due to their greater average age.

Physical Evaluation - None of the workers examined demonstrated wrist or ankle drop, lead lines, or abdominal tenderness. No workers demonstrated abnormalities that would interfere with neuropsychological testing.

Neuropsychological Testing - No significant differences were noted between workers on performance of neuropsychological tests when stratified by contract, blood lead level, or zinc protoporphyrin level.

Diagnosis of Lead Toxicity - Five workers, all of whom were principally employed in the "scrape and prime" operation on the center span of MTB, were diagnosed as having lead toxicity (Table 6). Three had blood lead levels in excess of 70 ug/dl and complained of two or more central nervous system symptoms; none of those three had physical signs of lead poisoning. Two additional workers had elevated blood lead and ZPP levels and multiple CNS symptoms. One also had anemia.

C. Community

Fingertip blood samples for lead and EP analyses were obtained from 123 children 5 years old or below living within one-fourth mile of MTB in Charlestown. That number represents approximately 50-60% of children of that age group in the target area. However, survey participation rates in the 2-3 blocks closest to the MTB, where the most intense door-to-door visiting occurred, are estimated to have been 80-90%.

Four (3.3%) of the 123 samples contained more than 30 ug/dl lead, the level considered by CDC to indicate increased lead absorption in children. The highest value was 35 ug/dl. All four of the children with blood lead levels above 30 ug/dl lived within two blocks of the MTB. Two of those children (sibs) were found to have lead-based paint in their home. However, the paint was not deteriorated or chipped, and no teeth marks were evident. The other two children lived in public housing projects, and no lead paint was found in their homes. Within two blocks of the MTB the prevalence in children of blood lead levels above 30 ug/dl was four of 47 (8.5%). Beyond that distance none of 76 children had elevated blood lead levels. That difference is statistically significant ($p = 0.0192$ by Fisher's exact test). A significant difference was noted also between the mean blood lead level in children living within two blocks of MTB (20.9 ug/dl) as compared to that in children living farther away (18.4 ug/dl) (p <0.01). No increases in childrens' blood lead levels were noted from 1979 to 1980;[7] however, data collection procedures had changed from 1979 to 1980, and the two sets of data are not comparable.

Interior dust samples were obtained during the blood lead survey in eight apartments, all in public housing projects near the MTB. The mean lead content of four samples from apartments within one block of the MTB was 7,580 ppm (range 4,930 - 10,000 ppm). The mean of five samples from four apartments located 1-3 blocks from the bridge was 628 ppm (range 193 - 1,500 ppm). That difference is statistically significant (p 0.0002).

VIII. CONCLUSIONS

The air, soil, and dust samples and samples of used blasting abrasive collected in this investigation indicate that environmental contamination with lead is high near the MTB and decreases with distance. The high concentrations of lead found in surface soil near the bridge in Charlestown appear to reflect contributions from (a) grit-blasting, (b) "normal" paint flaking from the bridge, and (c) automotive exhaust. Although the precise contribution of grit-blasting is not known, it is our conclusion that blasting accounts for a significant portion of the 2,000 ppm difference in soil lead concentration found between the Charlestown and Chelsea samples; increased automotive exhaust resulting from daily traffic jams on the Charlestown side of the bridge may also account for a smaller portion of the difference.

Air-sampling data indicate that air lead concentrations have been highest when the grit-blasting has proceeded without adequate attention paid to environmental control measures. Improvements in environmental containment appear to have been made between the June and July sampling periods, and reductions in community air lead levels resulted.

Workers employed on the grit-blasting operation showed only minimal evidence of excessive blood lead levels or of lead toxicity despite their intense exposure to airborne lead. In contrast, workers of similar age, work background, and level of previous health working on the center span showed significant evidence of elevated blood lead levels and symptoms of lead toxicity. Differences in personal protective technique between the two jobs appear to account for significant differences in lead inhalation. In the grit-blasting operation, workers wore air-supplied respirators or other appropriate respiratory protective equipment. Workers employed on the center span wore protective equipment which was less effective.

Evidence of lead toxicity in workers was related primarily to symptoms of central nervous system dysfunction and to red blood cell enzyme impairment resulting in increased levels of zinc protoporphyrin. Overt anemia also occurred. There was no evidence of disruption of performance on standardized neuropsychological tests and no evidence of kidney dysfunction.

Children's blood lead data indicate that highest lead levels in 1980 occurred in children living closest to the MTB. While it is not possible to quantify precisely the relative contributions to children's lead absorption of lead released by grit-blasting and of automotive emissions, it is prudent public health practice to assume that both grit-blasting and automotive emissions have contributed to those childrens' lead absorption. An effort was made to compare blood lead levels obtained in Charlestown children in 1979 (before the start of grit-blasting) with those obtained in 1980.[7] No difference in blood lead levels between the two years was noted. However, differences existed between the two years in procedures for recruiting children into the lead screening programs, and therefore the two sets of data are not comparable.

IX. RECOMMENDATIONS

1. The deleading of MTB should continue, since this process will remove an important source of lead exposure from the Charlestown and Chelsea communities.

2. Prior to the start of any future cycles of grit-blasting (either in Charlestown or in Chelsea) samples of air, dirt, and surface soil ought to be collected in areas adjacent to the bridge for baseline determination of lead content. It will then be possible to assess more accurately the extent and severity of any environmental lead contamination which is the result of the grit-blasting operation.

3. The deleading/grit-blasting process must be conducted with utmost attention paid to environmental controls. Controls have been lax at times in the past, and environmental contamination has resulted from that laxness. Laxness in environmental controls defeats the primary goal of the deleading operation. Ambient air monitoring must be conducted in close proximity to the deleading operation throughout the period of deleading. Any elevations in measured air lead levels above background levels near MTB will indicate that pollution controls are ineffective; in such circumstances, controls must be tightened. Elevations in ambient air lead levels above the EPA standard of 1.5 ug/M^3 (calculated as a 3-month average) constitute a definite health hazard. Deleading must be conducted in such a way that the EPA air lead standard is not exceeded.

4. Paved areas under and near the bridge must be wet-swept at the end of each working day.

5. At the end of the grit-blasting operation, the contaminated soil under the bridge must be carried away to a safe landfill and/or paved over. As a part of that procedure, the depth of soil lead contamination under the bridge must be determined.

6. Careful consideration must be given toward improving work practices among workers employed in the center span of the bridge. Symptomatic lead poisoning has been documented in those workers. Improved techniques of respiratory protection and careful job rotation schedules must be employed to reduce the likelihood of further episodes of lead toxicity in workers.

7. Pre-employment medical evaluation must be performed on all workers prior to their entering lead-exposed areas. Pre-employment evaluation should include a careful work history with particular attention paid to previous lead exposure or work with other neurotoxic chemicals. A medical history and physical examination should be performed. Blood tests should be taken to determine blood lead level, zinc protoporphyrin, hemoglobin, hematocrit, BUN, and serum creatinine levels. Workers with significant abnormalities in these tests should not be placed in lead exposure areas.

8. Periodic testing (every one to two months) of workers for blood lead and ZPP levels must be performed to detect early evidence of increased lead absorption prior to the development of overt symptoms. Workers with blood lead levels over 60 ug/100ml must be rotated immediately to areas of work with less exposure to lead.

9. Despite the lack of evidence for lead-related disease among workers in the grit-blasting operation, pre-employment and periodic examinations must also be performed on those workers to ensure that disease does not occur in this group in the future.

10. Children under the age of 6 years and pregnant women living within one-eighth mile (2 blocks) of the bridge should have blood lead testing performed prior to the start of the next cycle of deleading and every one to two months thereafter for as long as the grit-blasting continues. Any children or pregnant women found to have blood lead levels of 30 ug/dl or higher must be considered to have absorbed excessive amounts of lead and must be placed under close medical supervision.

11. Careful consideration should be given to the possibility of removing young children and pregnant women from areas within two blocks of MTB grit-blasting operations during those weeks when grit-blasting is underway.

X. Report Prepared By:

Philip J. Landrigan, M.D.
Director
Division of Surveillance, Hazard Evaluations and Field Studies

Wesley Straub
Regional Consultant, NIOSH
Kevin McManus
Industrial Hygienist, NIOSH
Region, I

Gary F. Stein, M.D.
EIS Medical Epidemiologist
Chronic Disease Division
Bureau of Epidemiology
Centers for Disease Control

Edward L. Baker, Jr., M.D., MPH
Jay S. Himmelstein, M.D., MPH
Occupational Health Program
Harvard School of Public Health

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
Cincinnati, Ohio

Chronic Diseases Division
Bureau of Epidemiology
Centers for Disease Control

Report Typed By:

Marlene Hoffmann
Secretary
Office of the Director, DSHEFS

XI. REFERENCES

1. Burgess W: A study of lead concentrations in air and soil in the Walnut-Chestnut Streets neighborhood in Chelsea. A study conducted for the Massachusetts Port Authority, 1977.

2. Center for Disease Control: Prevention of Lead Poisoning in Young Children: A Statement by the Center for Disease Control. Atlanta: April 1978.

3. Faramelli N: Memorandum, Progress Report on Lead Studies Related to Mystic River Bridge.

4. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard...Occupational Exposure to Inorganic Lead, Revised Criteria - 1978. U.S. Department of Health, Education and Welfare, 1978.

5. U.S. Environmental Protection Agency, Office of Air and Waste Management: National Ambient Air Quality Standard for Lead: Notice of Proposed Rulemaking /40 CFR part 50/ /FRL 821-4/. Research Triangle Park, NC: 14 Dec., 1977.

6. Mackay GR, Stettler LE, Kommineni C, Donaldson HM: Fibrogenic potential of slags used as substitutes for sand in abrasive blasting operations. Amer Industrial Health Assoc J 41:836-842, 1980.

7. Meyer, S.M.: An analysis of the effect of deleading the Mystic-Tobin Bridge on local lead exposure. Prepared at the request of the Office of Health and Environmental Affairs, City of Boston, Department of Health and Hospitals, 23 February 1981.

XII. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

For the purpose of informing the "affected employees", Massport and its contractor(s) must post this report for at least 30 days in a prominent place(s) near where employees work.

Copies of this Determination Report are currently available, upon request, from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

Greater Boston Legal Services, Inc.
108 Maverick Street
East Boston, Massachusetts 02128

Massachusetts Port Authority
90 High Street
Boston, Massachusetts 02110
Attn: Norman J. Faramelli
Richard Heidlane
Marilyn Tobey

Massachusetts Department of Public Health
600 Washington Street
Boston, Massachusetts 02111
Attn: Gerald S. Parker
Assistant Commissioner for Environmental Health

Massachusetts Department of Environmental Quality Engineering
600 Washington Street
Boston, Massachusetts 02111
Attn: Thomas McLaughlin
Bruce Maillet

Massachusetts Department of Labor and Industries
Division of Occupational Hygiene
600 Washington Street
Boston, Massachusetts 02111
Attn: Joel P. Weddig

City of Boston
Department of Health and Hospitals
Office of Environmental Affairs
Lead Poisoning Project
818 Harrison Avenue
Boston, Massachusetts 02118
Attn: Ronald R. Jones, Director

Boston Air Pollution Control Coimmission
182 Tremont Street
Boston, Massachusetts 02111
Attn: Eugenie Beal
Executive Director

U.S. Environmental Protection Agency
Boston Regional Office
JFK Federal Building
Boston, Massachusetts 02203
Attn: T.M. Spruitt
Thomas Whooley

U.S. PHS - Region I
JFK Federal Building
Boston, Massachusetts 02203
Attn: Arthur S. Harper

NIOSH, Region I

U.S. Department of Labor, OSHA, Region I

Dr. Stephen M. Meyer
Department of Political Science
Massachusetts Institute of Technology
Cambridge, Massachusetts 02115

Douglas W. Cooper
Harvard School of Public Health
55 Shattuck
Boston, Massachusetts 02115

Herbert Needleman, M.D.
Childrens Hospital Medical Center
300 Longwood Avenue
Boston, Massachusetts 02115

Vernon Houk, M.D.
Director, Division of State Services
Center for Environmental Health
Centers for Disease Control
Atlanta, Georgia 30333

Clark W. Heath, Jr., M.D.
Director, Chronic Diseases Division
Center for Environmental Health
Centers for Disease Control
Atlanta, Georgia 30333

Bunker Hill Health Center
73 High Street
Charlestown, Massachusetts 02129

Dr. William Burgess
Occupational Health Program
Harvard School of Public Health
55 Shattuck
Boston, Massachusetts 02115

Hon. Rosemary Sansone
Chair, Committee on Human Services
Boston City Council
Boston, Massachusetts 02201

Chelsea Fair Share
240 Broadway
Revere, Massachusetts 02151

Boston Fair Share
304 Boyslton Street
Boston, Massachusetts 02167

CAPIC
48 Washington Avenue
Chelsea, Massachusetts 02150
Attn: Robert Repucci

TABLE I

LEAD CONCENTRATIONS IN HIGH-VOLUME AIR SAMPLES ADJACENT TO TOBIN-MYSTIC RIVER BRIDGE, CHARLESTOWN, MASS., JUNE-JULY, 1980*

Distance From Bridge (Meters)	June 24-30			July 10-13		
	No. Samples	Mean	Range	No. Samples	Mean	Range
12	-	-	-	6	1.43	0.33-3.54
27	4	5.32	2.7-12.9	10	0.84	0.46-1.30
50	1	2.8	-	3	0.36	0.30-0.40

*Data from Massachusetts DEQE

TABLE 3

AIRBORNE LEAD EXPOSURES OF WORKERS - MYSTIC-TOBIN BRIDGE, 1980*

	NO. OF SAMPLES	AIRBORNE LEAD (ug/m^3) MEAN	RANGE
GRIT-BLASTING			
Abrasive Blaster	4	305	10 - 1,090
Blaster Helper	3	302	256 - 386
Vacuum Truck Maint.	1	46	-
PAINT-SCRAPING/LEAD-PAINTING			
Scrape and Prime	3	391	24 - 1,017
Midcoat	2	35	30 - 39
Finish Coat	3	7	6 - 9
Needlegun Only	1	87	-
Foreman	1	38	-

*Data from the Massachusetts Division of Occupational Hygiene

TABLE 4

CHARACTERISTICS OF CONTRACT WORKERS TOBIN-MYSTIC RIVER BRIDGE, 1980

	GRIT-BLASTING (n=13)	CENTER SPAN (n=19)	T-TEST SIGNIFICANCE LEVEL
Age (years)	27.2	24.6	NS
Weeks worked	20.7	15.1	NS
Education (years)	11.9	11.7	NS
Blood lead level [mean (range)] (ug/dl)	33.2 (25-47)	61.2 (30-96)	<.001
Zinc protoporphyrin level [mean (range)] (ug/dl)	51.5 (25-113)	214.1 (22-592)	<.001
Hematocrit (vol. percent)	40.0	42.3	NS
Hemoglobin (gm/dl)	14.95	14.81	NS
Blood urea nitrogen (mg/dl)	15.5	15.0	NS
Creatinine (mg/dl)	1.23	1.0	NS

TABLE 5

SYMPTOM PREVALENCE IN CONTRACT WORKERS
TOBIN-MYSTIC RIVER BRIDGE, 1980

SYMPTOM	GRIT-BLASTING (n=13) NUMBER (%) WITH SYMPTOM	CENTER SPAN (n=19) NUMBER (%) WITH SYMPTOM
Sleeping problems	1 (8)	4 (21)
Tiredness	1 (8)	7 (37)
Irritability	4 (31)	6 (32)
Memory problems	2 (15)	5 (26)
Headache	0 (0)	2 (10)
Any 1 CNS symptom	5 (38)	13 (68)
More than 2 CNS symptoms	0 (0)	4 (21)

TABLE 6

CHARACTERISTICS OF WORKERS WITH OVERT LEAD TOXICITY*
TOBIN-MYSTIC RIVER BRDIGE, 1980

CASE NO.	WEEKS WORKED	LEAD LEVEL	ZPP	HCT	HGB	CNS SYMPTOMS
1	24	71	493	46.0	16.0	Tired, irritable, headache
2	12	96	508	37.0	12.4	Tired and irritable
3	13	76	370	41.7	14.3	Irritable, poor memory, sleepy
4	16	62	182	43.6	15.2	Tired and irritable
5	14	58	343	37.2	12.6	Sleepy, tired, headache

*Defined as an individual with a blood lead level >60 ug/dl or ZPP level >100 ug/dl, plus either anemia or two or more central nervous system symptoms.

FIGURE 1 LEAD CONCENTRATIONS IN HIGH-VOLUME AIR SAMPLES, MYSTIC RIVER BRIDGE, JUNE-JULY, 1980

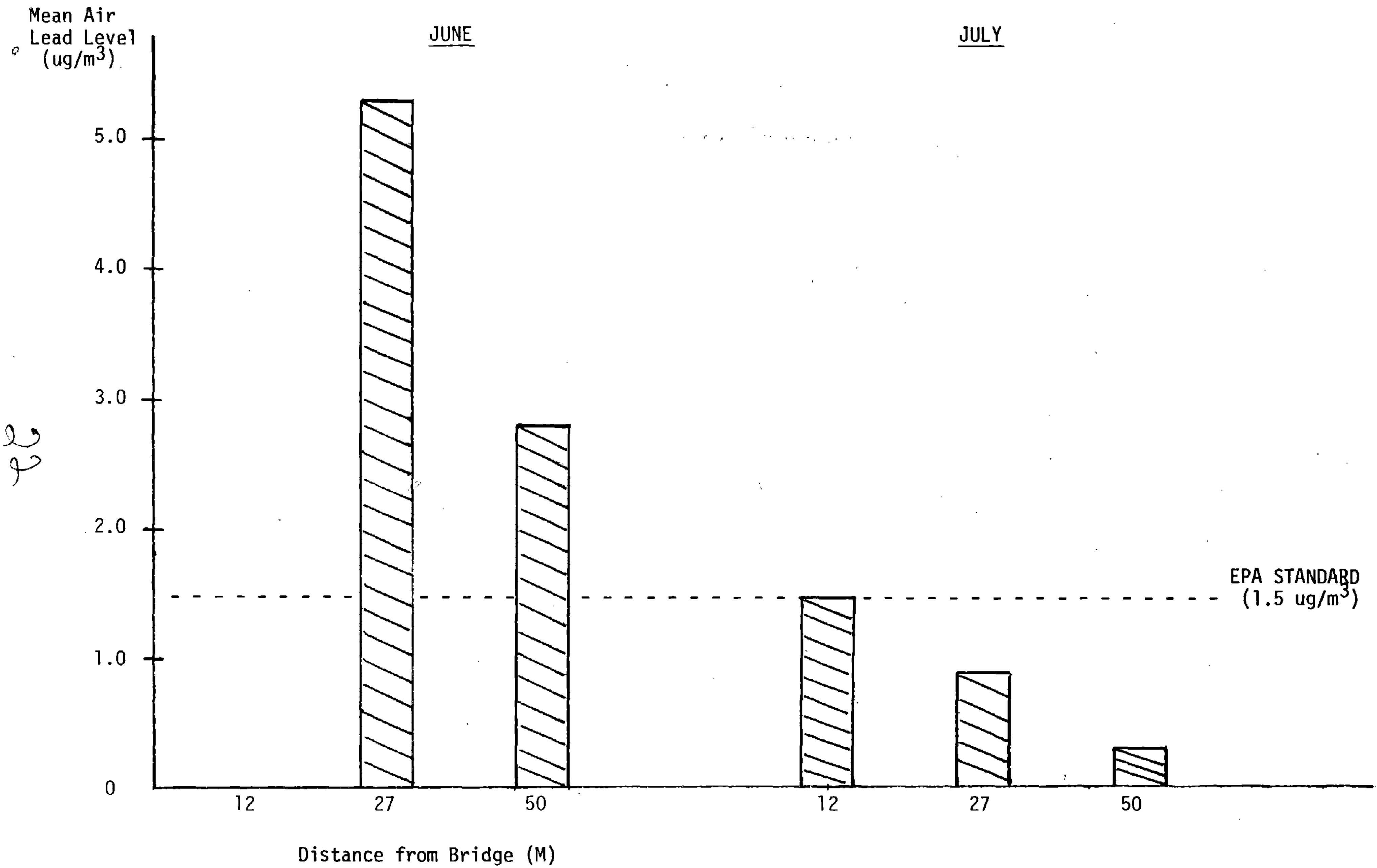


FIGURE 2 LEAD CONTENT OF SURFACE SOIL, CHARLESTOWN, CHELSEA, AND RURAL MASSACHUSETTS, 1980