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CHARLESTOWN NAVY YARD
Charlestown MA

Historic Pavement Study

100% Submission:

September 1, 1995

Prepared For:
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National Park Service
North Atlantic Region
Boston, MA

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The historic pavement study is being completed for the National Park Service, Northeast Field Area in response to the celebration of the 200th anniversary of the USS Constitution. It was also initiated due to the concerns for site safety of the park. The study is an investigation into the history and evolution of the pavement with recommendations for future re-paving of the Navy Yard.

The intent of the paper is to document the history of the pavement and the evolution of materials and make a series of recommendations for re-pavement. This was accomplished through archival research, light archaeological work and materials research. A number of site maps were drawn which depict the evolution of materials, the existing conditions and sub-surface conditions. The evolution of materials was depicted through 1907, 1928, 1954, 1973 and 1995 site maps. Although there were very little pre-1907 building records, maps or materials information, a series of historic photographs were used to tell the story of the evolution of materials from the mid-19th century to 1904. The existing conditions site maps depict the historic materials which can be found on the site and those which are just below the top layer of asphalt.

Through the investigative process it was found that during the early to mid-20th Century, a number of materials were used to pave the Navy Yard. These include: wood block, granite, vitrified brick, granolithic paving, belgian block, cobblestone, asphalt and bituminous concrete. During the 1900's these materials were slowly lifted or covered to be replaced by bituminous concrete and asphalt.

The archaeological work led to the discovery that there is still historic material left on the site. These materials were primarily found on 3rd and 4th Streets, Pier One and First Avenue. The discovery of the pavement assisted in the proposal of the three paving recommendations. Although the materials found are significant as they relate to the history of the Navy Yard, it was also important that the recommendations take into account the site safety and compliance issues, specifically *Section 106 Review*, the *Secretary of the Interior's Standards and Guidelines* and the *ADA* Handicap Accessibility Codes.

The Proposed Alternatives for Re-paving the Charlestown Navy Yard are as follows:

1. Pave over all the historic material and current asphalt with new asphalt to archaeologically preserve the pavement.

2. A. Keep the existing historic material exposed and pave up to those boundaries

   B. Further expose the historic material in strategic locations, by removing asphalt that was found to be covering the pavement. Pave up to these boundaries with new asphalt.

3. Use the existing historic material in conjunction with new, similar materials to create, in certain areas, new landscape design.

Upon consideration of these recommendations, members of the Park Service created a Preferred Alternative which is a hybrid of the three proposals. Although this proposal has addressed certain landscape issues, it is still considered to be a re-paving plan as opposed to a rehabilitation or restoration of the site.

Preferred Alternative

The Preferred Alternative calls for the repair or replacement of existing exposed materials as stated in the General Management Plan. All other areas are to be paved with asphalt except in those locations that will assist in the safety of visitors to the park, facilitate pedestrians through the park, or those areas which were felt to be important as key locations of the Navy Yard. The materials which have been proposed for these chosen sites are historical elements used in the Navy Yard. The chosen materials and placement have been reviewed to comply with the relevant codes and historic standards. A more detailed description of the Preferred Alternative is as follows:

1. Freedom Trail:

   The Freedom Trail should be a visual visitor flow path from the Main Gate, to the Visitor Center, USS Constitution, USS Cassin Young and The Constitution Museum. The path of the trail should be slightly altered to prevent any tripping over the train and crane tracks.

   To remain consistent with the full trail which is found throughout Boston, the red line through the Navy Yard will be two wythes of brick wide. Where the Freedom Trail runs through brick, the bricks will be framed by strips of granite on either side.

2. First Avenue:

   The Preferred Alternative proposes that brick be repaired, replaced and newly laid beginning at Gate One and continuing the entire length of First Avenue. The brick will not cover the locomotive scale which is in front of the Scale House.

3. Third Street:

   Yellow brick should remain and be repaired or replaced as needed. The Southern portion of the road is asphalt. A completion of the surface would be to lay brick from its existing border to the end of Third Street.

4. Fourth Street:

   It is proposed that the brick and wood block be fully exposed, repaired and replaced as needed.

5. Building 22, Constitution Museum:

   It is proposed that the covered brick on the Western edge of the museum be exposed, and the granite and brick be repaired and replaced as needed.

6. Pier I:

Railroad Tracks:

The tracks pose a threat to the safety of the visitors to the site. It is proposed that portions of the rail that are in the immediate walking path of the visitors or join with the Freedom Trail be removed. In particular, remove those sections which are in the path between the USS Constitution Dock and the USS Cassin Young.

The remaining tracks should be paved level to the tops of the rail to prevent tripping and to comply with ADA Accessibility Codes. The tops of the rails need to be exposed because of the historic significance of the tracks. To prevent tripping over the operable crane rail, full depth rubber crossing pads will be used to cover the tracks to allow the operation of the crane and to create a smoother surface for pedestrians.

Future Dock for the USS Constitution:

This area is needed for heavy industrial equipment that services the ship, the landscape will have to include materials that can withstand a 70 ton crane. It is proposed that smooth large granite blocks be placed around the upper Western portion of the pier and wrap around the North end, toward the finger pier. The granite will run down the Western edge of the pier and wrap around its Southern Tip.

Visitor Amenities:

The current parking lot to the North of the USS Constitution dock has been chosen as a visitors amenities site. It is proposed that a space be created that is comfortable to sit, relax, and watch the Constitution. The proposed pavement is red brick.

7. Crosswalks

The crosswalks are currently wide, green painted strips. They appear: at the intersection of Third Street and First Avenue, between Building Five and Third Avenue, and at the Scale House on First Avenue. It is proposed that these crosswalks be paved with red brick.

INTRODUCTION

I. INTRODUCTION

The Charlestown Navy Yard was founded in 1800 as one of the first United States Naval Yards designed to build and repair warships. The yard has had a long history of ship building and industrial experimentation. Reaching its peak during WWII, the Charlestown Navy Yard was an active and important element to the United States Navy and Charlestown MA. The Yard was closed in 1973 and in 1974, the National Park Service acquired the Western 30 acres of the site. Today it is a national and international tourist attraction.

Owned by the National Park Service, the Navy Yard entertains over one million visitors a year. It holds a number of tourist attractions including the USS Constitution, USS Cassin Young, Constitution Museum, and a number of 19th and 20th Century historic buildings. The park is divided visually into two zones; residential and industrial. First Avenue divides the two. To The North of First Avenue, the historic residential area is home to the Commandant's Quarters and Marine Barracks. To the South of First Avenue are the Piers and Dry Docks where the USS Constitution and USS Cassin Young are docked. The Piers represent the industrial history and significance of the park. Currently the USS Constitution is in dry dock for repairs and is being prepared for its 200th Birthday.

Tourists visit the Navy Yard year round which leads to a number of site safety issues. The park staff is continually trying to maintain the park, its roads, landscapes and buildings. Because tourists visit the site year round, snow removal is an issue in the winter, and health problems related to the heat are concerns in the summer. Tripping over the historic train tracks is a weekly occurrence which has led to injuries and law suits against the park. Other concerns are handicap access and safety on board the two naval vessels.

There are a number of forms of transportation visitors can use to get to the Navy Yard. Tourist trolleys stop at Gate One as a regular part of their routes. Public transportation is accessible by 'T' or bus and their is a free parking lot for drivers. A water shuttle is also available which runs between Long Wharf and the park.

This paper is a study of the historic pavement of the Charlestown Navy Yard. Its historical significance as well as current tourist needs and concerns play a large role in the overall investigation of the site and the proposed alternatives for re-paving.

STATEMENT OF PURPOSE AND OVERALL GOALS

This historic pavement study of the Charlestown Navy Yard in Charlestown MA is being completed for the National Park Service, Northeast Field Area. The USS Constitution will be celebrating its 200th anniversary in 1997. In preparation, the National Park Service would like to have a better understanding of the road surface and its history in order to make decisions about the preservation, conservation and rehabilitation of the historic fabric.

Included in this document:
The pavement history of the Navy Yard beginning around the turn of the 20th Century,
Graphic documentation of:
existing conditions
evolution of pavement types;
Pre-1907
1902 - 1916
1928
1954
1973
1995
Recommendations for future re-surfacing and treatment
Preferred Alternative for re-surfacing and treatment

METHODOLOGY

A number of research methods were employed in order to complete this study. The following is a list of sources of information which have been used to complete the historic pavement study.

Archival research:
Building records of pavement changes,
Drawings which correspond to the above records, and
Photographs of the site through its history depicting different pavement materials.

Archaeological site work:
Archaeological pits of the site to determine the type and scope of existing pavement elements.
Inconspicuous sites were used where the pavement had already begun to decompose.
The material was dug up, documented and replaced by being tapped to secure its original position.

In some areas, a small jackhammer was needed to find the boundaries of the materials. Once these pits were dug, cold top was used to patch the holes.

Other sources of information include:
Research of historic technical books describing the materials involved in the study, and
Examination of other Historic Pavement Studies

Limitations:
Due to the limited archaeological nature of the study, it was unclear from the archaeological survey the exact dates or periods the existing historical material was laid, or the extent to which it exists under the asphalt. A more in-depth evaluation will be required in 1996 when the current asphalt will be completely removed, and at that time make further evaluation and recommendations.

STATEMENT OF SIGNIFICANCE: PAVEMENT AT THE CHARLESTOWN NAVY YARD

The Charlestown Navy Yard is owned by the National Park Service. It is listed on the National Register of Historic Places for its cultural and historic significance. The Navy Yard is especially significant for its involvement in the Industrial and Technological Revolutions and for the central role it played in The United States Naval history. The history of paving provides an interesting perspective of the Navy Yard and its relationship to the Industrial and Technological Revolutions.

Paving, in general, is significant in the facilitation of pedestrians, animals and vehicles throughout history. Different paving materials created patterns of movement and transportation. As technology became more sophisticated, road surfaces became more durable, lasted longer, were easier to install and repair, and were more comfortable to travel over and navigate. The growing knowledge of pavement surfaces also led to cleaner and more hygienic atmospheres in which to live.

The sophistication and diversification of materials:

As the Navy Yard began growing and diversifying in function, it required more sophisticated materials with which to build structures, boats, train tracks and pavement surfaces. The diversification in pavement types can most clearly be seen between 1902 and 1916 when the yard was paved with a number of different materials, serving a variety of purposes throughout the site. Not only does this indicate the knowledge of varying forms of road surfaces, it as well displays the interest in experimentation with materials during the period which mirrored the Industrial Revolution.

Experimentation with new materials and surfaces:

Experimenting with different types of material was one outlet for the enthusiasm of the Industrial and Technological Revolutions at the Navy Yard. For example, wood block was beginning to grow in popularity as a paving surface throughout the United States. With the exception of Tremont Street in Boston, the use of wood block was a rare occurrence in Boston. Overall, by 1904, there were 878.04 miles of road in Boston, only .87 miles was wood block. (Alvord, 26) In 1904, the Navy Yard paved all of 2nd Avenue in wood block, a residential, elegant road which housed the Marine Barracks and the Commandant's Quarters. It seemed that the previous paving on the road was too loud for the Commandant and his wife when the milkman, with a horse and carriage delivered milk in the mornings. The Commandant wanted a quieter surface. Wood block was a good, new surface to try in order to keep the residential area quiet. (Mr. Dave Rose, NPS)

The Navy was interested in using a new material to accommodate different functions of the Navy Yard. In fact, between the years 1902 and 1917, there were 8 different types of paving which may have been strategically placed to test the qualities of the materials for different types of traffic.

Periods of changes of material coincide with the flow of activity of the Navy Yard:

In the last decade of the 19th Century, the Navy Yard ceased working on ship repairs. To compensate, it became a center for product testing. Most of the testing was on fire fighting equipment. Other materials including yellow pine wood were tested and used on site for ship repair. (Black, 367-369) (Yellow pine was also a popular wood used for wood block paving.) Since the beginning of the 20th Century, the usage and changing of paving mirrored the events of the Navy Yard.

Between 1904 and 1914, there was a construction boom at the Navy Yard including the building of a physical plant, construction of a modern dry dock, major waterfront improvements and road surfacing. Work was scarce on the Yard, between 1922 and 1932. In fact, there was less work than any previous period in the 20th Century. (Black & Bears, 424) During this same time, very little to no work was issued on the roads, although inspection maps and plans of the paving were drawn. With WW II imminent, the ship yard became active. The roads were aggressively paved with bituminous concrete and asphalt which were sturdy, relatively cheap and durable materials. During the post Korean War era and in the midst of the cold war, until the mid to late 1950's, there was again a reduction in work on the yard, including road work. Experimentation with paving materials had greatly declined by this point.

The next major change in the pavement was in the early 1950's when a systematic wave of asphalt and bituminous concrete was laid. Coinciding with the wave was another boom period for the Yard. By the mid-1900's the experimentation with different materials was over. With the growing labor on war ships during WW2, the first major ship repair and building in almost 50 years, the experimentation in other technological areas subsided.

From the early 1960's to the Navy Yard's closing in 1973 there was little new paving. Instead, the records show only basic rehabilitation and repair of the existing asphalt.

PRESERVATION PHILOSOPHY: NATIONAL PARK SERVICE

The National Parks Service's enabling act (Public Law 93-431; 88 Stat. 1184) states that the National Park Service, "is to administer these sites to preserve for the benefit and inspiration of the people of the United States... certain historic structures and properties of outstanding national significance... associated with the American Revolution and the founding and growth of the United States." (General Management Plan, 1) The obligation of the Park Service to the Navy Yard specifically, is planning and management. The buildings on the yard are to be selectively preserved in the 20th Century motif. Those to be preserved are: the dry dock, marine railway and bulkheads. The minor buildings and features are to be preserved and maintained, and the grounds are to be preserved to the 20th Century naval-industrial character of the site. (General Management Plan, 2)

In April 1979, an 'Assessment of Alternatives' for the site was decided upon. This included treatment for the Navy Yard for "preferred alternative defined 'treatment' as preservation of 1973 detail..." (General Management Plan, 4) The alternative treatment decided upon included pavement detailing, therefore, the pavement was to be preserved to 1973 detail, mostly asphalt.

In regards to the preservation and development of the site, it was decided that:
"all pavement and planted areas will be at 1973 appearance,
repairs and replacement of pavement in kind,
asphalt maintained and patched as needed,
granite curbs be preserved,
concrete side walks preserved, and
continuum of landscaping will be preserved." (General Management Plan, 23)

The Management Plan also states that, ..."Earlier pavement types, where exposed, will be preserved to demonstrate the continuum of pavement in the yard. "(Management Plan, 23)

Development Subzones were created within the confines of the park. Some of these areas are located within the Preservation Subzones which restrictions are discussed above. The Development Zones includes,

> *"those park areas where major developments will be undertaken to accommodate the Water/Chelsea street connector system, the use of Gate 4 as a major auto/pedestrian access, and where other developments are necessary for access to the BRA redevelopment project."* (General Management Plan, 9)

Other areas which have been designated Development Subzones within the confines of this study are:

Lincoln Avenue,
Around Building 10, and
Gate 1, as a major pedestrian entrance.

See Appendix A for map of Development Subzone

DOCUMENTATION

II. DOCUMENTATION

BRIEF HISTORY OF CHARLESTOWN NAVY YARD

The Charlestown Navy Yard was founded in 1800. At that time, the Secretary of the Navy bought 43 acres of land and mud flats for $39, 214. (BRA, *Proposal*, 2) This was the first of six Navy yards in the United States created to build and repair warships for the US. Navy. The Charlestown Navy Yard reached its peak during WW II with its growing and diversified industrial capability. It served the United States for 174 years, and closed in 1974. Today, about 30 acres of the yard is owned by the National Park Service. The other portion of Yard is owned by the Boston Redevelopment Authority, BRA.

During the period 1883 - 1890, the Navy Yard was closed for ship building and repair. Due to inactivity with ship work, the Yard went through a period of industrial activity and product testing. (Black & Bears, 367) Products tested included fire fighting gear and a treatment facility for wood. "The Progressive Era displayed a deep concern with the saving of time in industrial activities..." (Black, Vol. I, 217) The Yard re-opened in 1897, and between the years 1900 and 1914, it went through major campus improvements. With this construction boom, a new, modern dry dock was built, buildings erected, and surfaces paved. There was later a great decline in work and activity on the yard in the 1920's as a reflection of the rejection of United States involvement in WW I. (Black, Vol. I, 424)

Slowly, starting around 1932, work at the Navy Yard picked up and by WWII reached its peak. During the post WW II years there was again a reduction in activity. The Yard was demobilized but was still working on ships in overhaul and repair capacities. By 1955 there was much work being done on the ships and the Yard was considered an, "active navy shore establishment." (Black, Vol. II, 729) There were still a number of workers at the yard in 1972, but little work to perform. In 1973, The Department of Defense closed the Charlestown Navy Yard.

The paving history of the Navy Yard is as essential to this study as the Park's general history. In 1828, a plan for the ship yard was created. (BRA, Proposal, 5) Alexander Paris designed the road plan after the "royal navy yards of Great Britain" (NPS, 4) This design was the coordination of a rectilinear grid imposed upon the original street layout of the site. The plan created a logical order of roads, grounds and buildings for the future development of the yard. Canals were laid between the structures to facilitate moving heavy equipment. They also assisted in drainage and landfill operations.

In 1863, a railroad track system was installed. (Historic Structures Report, 6) This track was originally created for horse drawn cars. In 1891, the track was torn up and rebuilt from the head of the dry dock to the gate. (Historic Structures Report, 9) This track utilized rail road cars and was drastically changed and improved upon in 1902 and 1937. It played a significant role in the daily functioning of the yard until the 1950's when trucks facilitated the shipping, loading and moving of materials. (Historic Structures Report, 6)

Coinciding with the growth and sophistication of the rail road track around the turn of the century, 1902-1916, the Navy began experimenting with road surfaces. Some of the materials used included: brick, wood block, bituminous concrete, granite and granolithic paving. (Building Records)

Between 1917 and 1952 new pavement was beginning to be laid throughout site. Experiments in concrete and granite followed the extensive variety of the decades before. This new paving endeavor received assistance between 1920 and 1936 when the WPA, Works Projects Administration, initiated work at the yard. Much of the work performed was done on the road surface. The WPA lasted until the start of WWII. (NPS, 7)

In 1953 , asphalt became the accepted material for pavement in the Navy Yard. It was a good surface for heavy traffic areas, was easy to install and maintain, and was quite durable. Very quickly, the yard turned into a sea of asphalt as did much of the United States. Much of the work performed on the roads during the 1950's to the 1970's was re-paving and/or repairing with bituminous concrete and concrete, and new paving with the same materials.

Today, much of the shipyard is land-fill construction which is paved in asphalt. (NPS, 7) There are still many areas though where the historic pavement from the early 1900's is exposed. Further archaeological research will reveal some existing layers of historic fabric which lay beneath the asphalt.

STUDY AREA

Location of Navy Yard:

"The yard is located at the confluence of the mystic and Charles Rivers in Charlestown, just across Boston Harbor from downtown Boston. (*Memorandum*, 1)

The scope of the study area includes only the property, (about 30 acres on the Western portion of the Navy Yard), owned by the National Park Service. It consists of: Pier One, many of the historic industrial, naval, and residential buildings, parts of First and Second Avenues, Lincoln Avenue, 3rd, 4th and 6th Streets, and Dry Dock 1.

The following study zones were created for the organization and better understanding of the site for this study. They are used here for convenience and consistency. These zones are:

Zone A: USS Constitution visitor congregation and access. Part of Freedom Trail. Receives very high use. Detailed recommendations for landscape improvement needed.

Zone B: Major pedestrian access area to the shipyard. Part of Freedom Trail. NPS prefers to keep this area asphalt-paved for reasons of accessibility and snow removal.

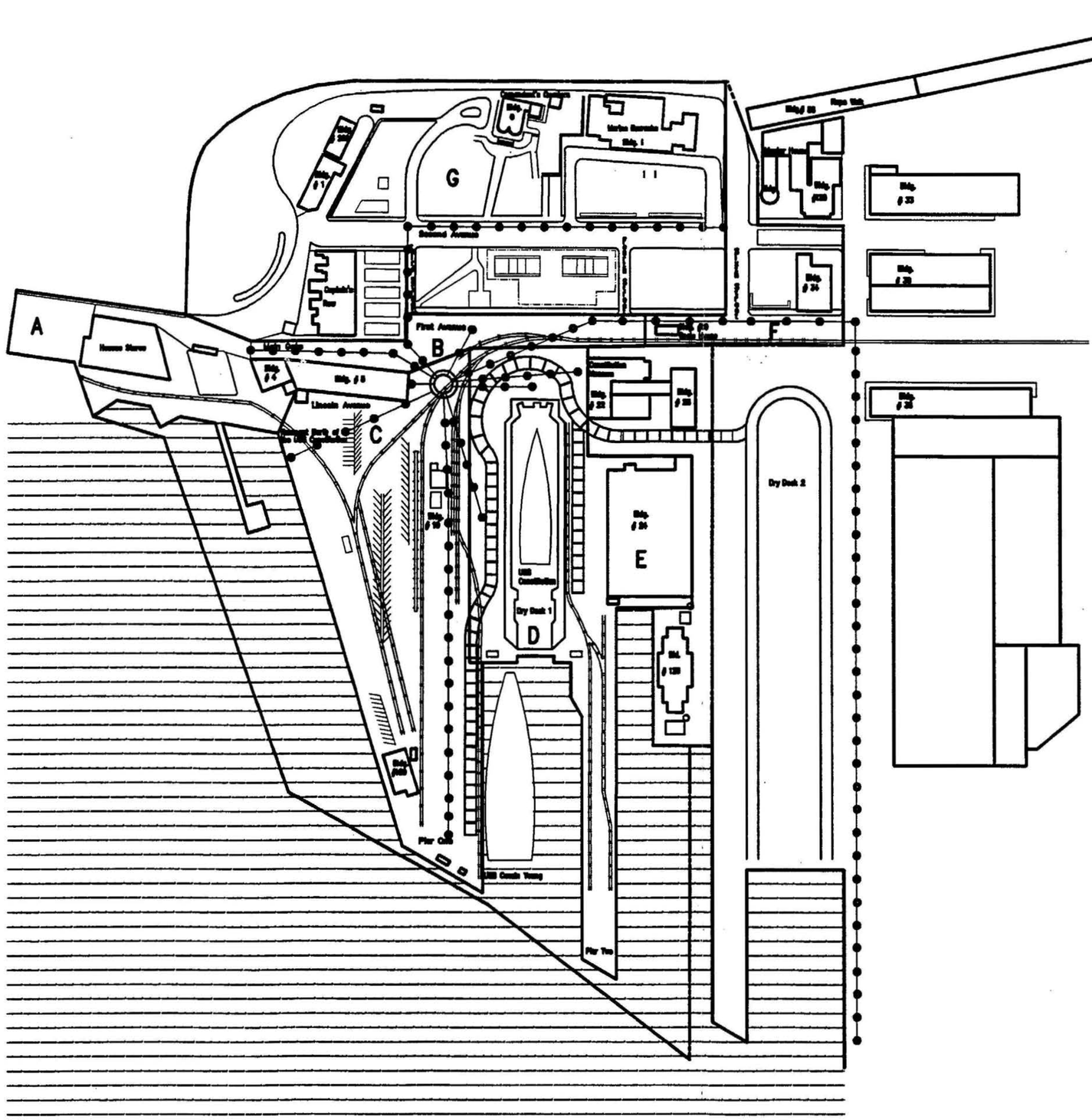
Zone C: Pier 1, Used for strolling, parking, small concession and seating area, occasional large public events. NPS would like to maintain industrial character of this area, and is concerned that varied paving can cause accessibility and snow removal problems. Standard gauge railroad tracks can be paved right up to the tracks. Crane tracks must remain operable, and require unpaved buffer- - some system of removable blocking must be devised.

Zone D: Dry Dock 1: Must remain operable, but will probably be used infrequently after completion of Constitution restoration. Open "lay down" space must be preserved for possible future ship repair work.

Zone E: Utility/ Vehicle Storage Area: Buildings currently under renovation. Tourists are not prohibited from this area (outside the buildings), but tourist traffic is usually very low. Note that Pier 2 is outside the project area.

Zone F: In the North part of this zone, 5th Street is the major public vehicular access to the site. Tour buses enter from here. To facilitate bus access, NPS proposes increasing turning radius of curb at northeast corner of 5th Street and 1st Avenue. To the east, this zone abuts areas owned by the BRA. Where NPS/ BRA boundary runs down the middle of the street, NPS has a permit from BRA to use full width of street. NPS plans landscape design improvements to blend this zone with adjoining BRA area, (including brick sidewalks, etc.).

Zone G: Contains the most architecturally significant buildings on the site, but receives relatively little pedestrian traffic, compared to the southern parts of the site. Second Avenue is a major thoroughfare through the site which NPS would like to keep asphalt- covered. This zone contains exposed historic pavements of various types. In some areas, NPS is open to suggestions for repair or replacement of these materials.



Circulation Flow

100 0 50 100
SCALE OF FEET

TRUE NORTH

DESIGNED: EG	SUB SHEET NO.	SITE PLAN, ZONES	DRAWING NO. 457 62,590
DRAWN: EG	A 1	And Visitation Circulation Diagram	PROJ. NO. 9009
TECH. REVIEW: JB		Charlestown Navy Yard	SHEET 2
DATE: 09/01/95		Charlestown MA	OF 23

ON MICROFILM

DATA ANALYSIS
Description of Materials Used

Asphalt



Asphalt is a mineral pitch which contains bitumen and organic matter mixed with mineral earth. Because of its many ingredients, it varies greatly in character. (Spaulding, 214) It was first used as paving in Paris in 1838 and slowly grew in popularity. By 1869, London began using the material. After that period, asphalt became widely used throughout Europe and the United States. It was found to be noiseless, self draining, impermeable and had a smooth surface. The problems were its softness in the heat and its slippery character. With further experimentation, it was found that refining the asphalt based oil and using it as a binder with the asphalt created a better and cheaper surface which was more practical for cars. Although asphalt was less durable than block materials, it was quick and easy to fix and at a lesser cost than other materials. (National Register Nomination, 8 -9) Asphalt was easily laid and cleaned and suited all types of traffic. There was little inconvenience involved in the installation or maintenance and it was durable and easily repaired. (Byrne, 195-198)

Asphalt was laid on a foundation of hydraulic cement concrete or bituminous concrete that needed to be 'solid and unyielding'. It was also possible to lay asphalt on top of old brick pavement, after cleaning and other preparations. Stone was also a possible foundation layer. (Byrne, 212)

In the second quarter of the 20th Century, the Charlestown Navy Yard began to pave their roads with asphalt. In a matter of years, almost the entire yard was a sea of asphalt.

Bituminous Concrete

Bituminous materials are stone chips, gravel and sand. (Blanchard and Drowne, 337) Bituminous concrete was first used in Nottingham England in 1840 and in the United States in 1866 in Knoxville Tennessee. By the early 20th Century, the use of this paving material was urged by engineers. Bituminous concrete is a mixture of stone, gravel, sand, shell, slag mixed with bituminous materials which include asphalts, heavy asphaltic oils, refined water gas tars and other varieties of asphalt's. (Blanchard and Drowne, 414 - 416)

The construction of a bituminous concrete surface consists of a sub-grade , stone foundation of 4 - 8 inches. With an ordinary foundation, it was appropriate to pour 2 layers or coats of the concrete for a finish thickness of 6 - 8 inches. (Blanchard and Drowne, 424)

Bituminous concrete was thought to be stable and more durable than other roads. Although the first cost of construction was high, the relative ease and cheapness of maintenance combined with its durability on high traffic roads made this material desirable. (Blanchard and Drowne, 462 - 464)

In 1958, bituminous concrete was used on 2nd Avenue to cover the wood block that had been used as a paving material on that road since 1916.

Belgian Block

Belgian Block was the next improvement from cobblestone in the history of stone paving. This stone was made with clean, coarse quartzes mixed with 1/4 its weight in dry hydraulic lime. It was then molded, heated and pressured. Once dry, Belgian Block was able to withstand 6000 pounds per square inch of weight. (Greenwell, 72)



The paving stone was a cubicle block; 5 - 7 inches long, 5 - 6 inches wide and 6 - 7 inches deep. The regular shape made the material more comfortable for passengers than did the cobble stone, but it was thought to have a poor horse foot hold. The stones wore in a rounded manner which created an irregular road surface. Belgian Block was also a noisy material. (Byrne, 131)

Belgian Block could be used in high traffic areas. It was cheaper and could be made smoother than previous stone surfaces. The material was relatively easy to maintain and replaced cobblestones in heavy traffic areas in American cities and industrial locations. The material is hard and durable, it held heavy loads and was a good material for industrial sites. The paving surface had a foundation of poured concrete with a cushion layer of sand. Once placed, the blocks were grouted with a mixture of sand and Portland cement. (Philadelphia Register of Historic Places, 7)

Evidence of Belgian block can be found in the records of the Navy Yard. It was primarily used in very heavy industrial locations, primarily the areas surrounding the large crane rails.

Brick, Vitrified (Yellow, Red)



Vitrified brick is harder and more durable than brick used for buildings. It goes through a firing process that approaches fusion, (the manipulation of the material into glass.) (Blanchard, 1102) In the beginning of the 20th Century, vitrified brick was popular for its durable and inexpensive qualities, and because the material was easy to repair. Its resistance to traffic was light, and it was not as slippery a surface as were others at the time. It could also be laid in connection to street car tracks. The material was considered to be sanitary because it was easy to clean due to its impervious character.. A disadvantage of using brick was the noise it produced by horses and vehicles. (Blanchard, 1102-1104)

The fo ndation for a brick surface was to be "solid and unyielding". (Byrne, 262) A good material to use for the foundation was cement concrete with a cushion of sand, 1/2 to 3 inches deep. Once the sand was wet and smoothed, the brick could be laid. Brick was to be laid on edge, perpendicular to the edge of the street. Long and transverse expansion joints were placed to prevent buckling due to temperature and weather changes. The bricks were then rammed and the joints filled with pitch or asphaltic paving cement. (Byrne, 262 - 263)

Brick was easily laid. The decision to use or not use artificial foundations was the decision of the engineer. An artificial foundation of gravel or sand could be put in at sub-grade level. In general though, brick was laid without artificial foundations to save costs. (Blanchard, 1106)

In the Navy Yard, brick was used in the smaller and larger streets, (2nd , 3rd and 4th Streets, and First Avenue). There are still some large exposed areas of yellow brick. (Building Records)

Special Rail Brick was used at the Navy Yard. It was the same vitrified material, but with all the edges rounded to 1/4" unless otherwise figured. (Building Records) This brick was placed between and outside the rails.

Cobblestone

Cobblestones are round "undressed" stones or rocks that have been used as paving material for centuries. Its disadvantages are attached to the qualities of cobblestone since its paved surface is not smooth or finished. It was difficult to maneuver horses and was quite bumpy for automobiles. (Philadelphia Historic Street Paving, 3) The cobblestone as well, was found to be less durable than other surfacing materials. (Alvord, 20)

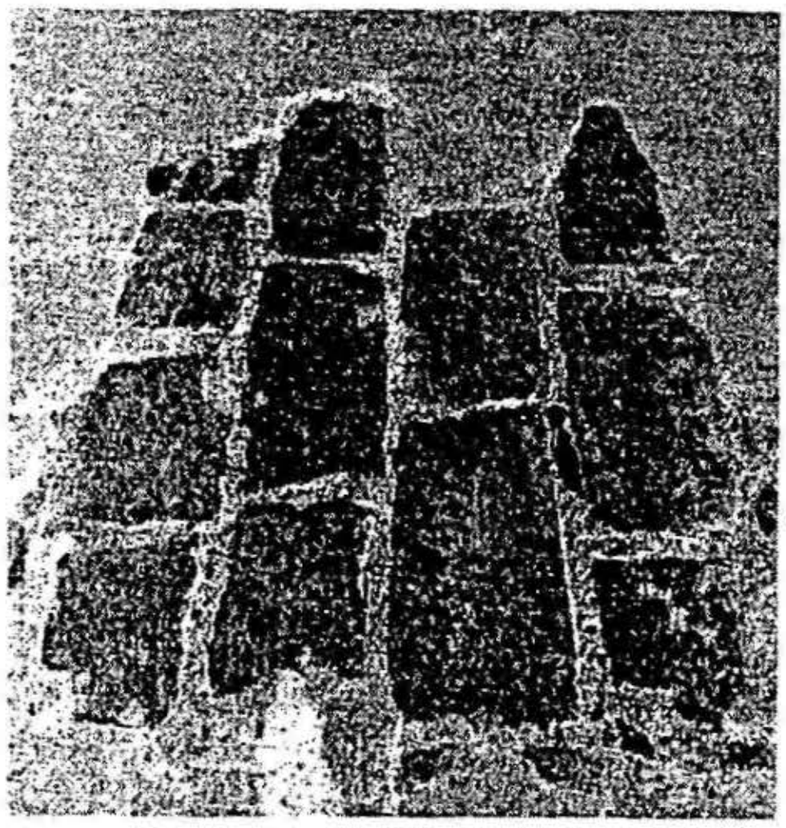
Cobblestone was rarely laid but for unimportant streets or allies. The hard durable stones were 5 - 10 inches deep and 4 - 8 inches wide. They were set compactly together to try and break the joints, which were considered a problem.. Once laid, the stones were "tamped with a rammer", and when the road settled, covered with a layer of sand, which was swept in the joints. (Blanchard, 603 - 604) Although cobblestones were cheap, they were irregular sizes and created erratic joints. It was difficult, once the stones were set, to hold them in place. They had a tendency to loosen in traffic. Cobblestones were hard to keep clean as well. (Byrne, 129)

Cobblestones were used for gutters on the Navy Yard.

Granite

Granite is a naturally occurring igneous rock used for paving and curbing. It has been used for centuries, in the United States since the mid 19th Century. This material was found to be quite durable, but was slippery in the rain and noisy. Granite was desirable on streets with heavy freight traffic or with car tracks. It provided maximum resistance to wear, with a satisfactory horse foothold. (Philadelphia Historic Street Paving, 3) Properly placed, granite blocks were laid on a concrete foundation poured to grade. (Alvord 20)

Granite was used on Pier 1 and the sidewalks on the yard up to around 1917. It was used as a curbing material throughout the Navy Yard, which still exists today. (Building Records)



Charlestown Navy Yard
Charlestown MA

Granolithic Paving

Granolithic paving is one of a number of artificial stones that was used as a surface material. Contained within the variety of these stones were: clean chippings of granite or syenite, good hard gravel, free stone chips, and good cement, preferably Portland. These were all tested and used in the early 20th Century. Granolithic paving was a composition of different stones, including granite dust and particles. The slabs of material were soaked in soluble silicate solution, and poured into molds. The molds were "jumped" to release the air bubbles. They were then treated with a silicate solution for protection from exterior elements, and to create a better surface for vehicles, pedestrians and horses. Granolithic paving was thought to be a good hard and durable material. It was more homogeneous in color and texture, contained less defects than natural stone, and had less negative effects from temperature changes. (Greenwell, 67 - 72)

Granolithic paving was used on Dry Dock 1 in the Navy Yard in 1913, and on many sidewalks throughout the years. (Building Records)

Tarvia

Tarvia is a bituminous material that was used as a patching element on bituminous macadam in the early 20th century. It could also be used to patch holes in wood block, brick and stone block. Tarvia-KP was a good material because it could be used at any time of the year, was worked and manipulated cold, and a mixture could be prepared and not sit for a number of weeks before being used. (Harger, 558)

This patching material was a mixture of one part sand, 3 parts 3/4" stone and 16 - 18 gallons of tarvia. It could be used to fill holes and re-pave entire surface areas. To fill a hole; the sides of the hole needed to be cut vertically and cleaned of old debris. Stone was used as a foundation for the patch. After the stone was rammed, a light layer of tarvia was painted on the foundation. Then, a larger quantity of the tarvia mixture was poured and tamped or rolled until level with the surface. A final layer of tarvia was painted on to create a seal, and the patch was covered with screenings. (Harger, 559)

To resurface an old madam road, the old material was scarified and reshaped with stone. Any ruts or depressions were swept with a layer of tarvia, crushed stone and sand. A layer of liquid was poured over the surface to be paved, and a 2 1/2" layer of tarvia would be poured and rolled. A final seal coat was placed and the area left to set-up for several days.

Tarvia was found on the Navy Yard in Pier 1. It was first used on 1907, and a larger patch was placed adjacent to the original in 1928.

Wood Block

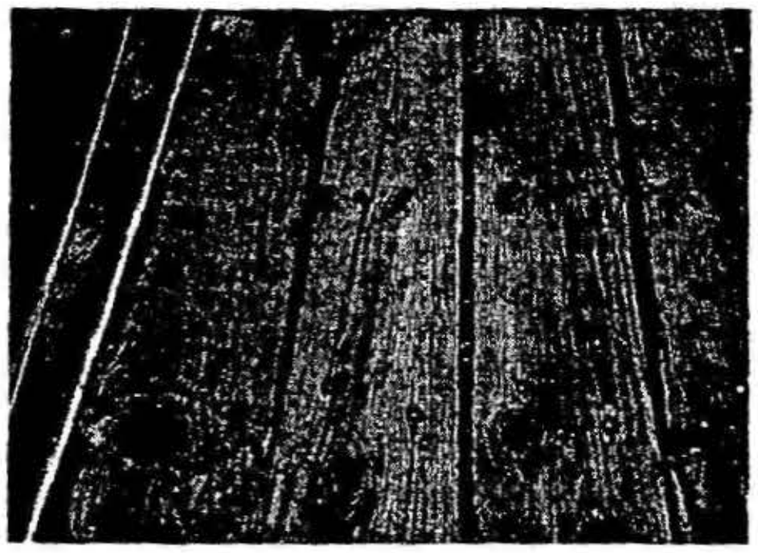


Wood block was a popular material used in the end of the 19th and beginning to mid 20th Centuries. After much testing and failing of the block in different parts of Europe and the United States, certain specifications for wood block became used regularly. Wood block specifications were adopted in 1916 by the American Society for Municipal Improvement. (Blanchard, 1042) Typical woods used for this paving material were: Southern Pine, Norway Pine, Hemlock and Blue Gum. (Bateman, 301) A typical block size was, 6 - 9" x 3 - 4" x 2 1/2 - 4". (Bateman, 302) In order to have a solid road way, it was important that the wood be of the same species and with few to no imperfections. The fewer annual rings the better as well. (Bateman, 302) After pressure treatment with creosote, a chemical additive, the wood block was less likely to have animal infestations or expand, contract and buckle due to wet weather or from temperatures changes. Similar to stone, wood block contained positive qualities; it was relatively inexpensive, could last from 5 - 25 and even up to 40 years. (Blanchard, 1034) If treated properly, the material was not slippery and could be prevented from bleeding, as it would due to hot weather. Wood block was also preferable in high traffic streets.

The foundation of a wood block surface was cement, generally Portland. In America, engineers practiced laying cushions of sand or mortar on the concrete before they would lay the wood so as to create a better setting for the road surface. Wood block was then laid, and tapped into placed. Expansion joints were placed to prevent buckling due to expansion. Joint were filled, and sand was periodically poured over the roadway to prevent slipperiness and to cure any bleeding that might have occurred in the hotter months due to the creosote. (Blanchard, 1045 - 1048)

A large amount of wood block paving was installed on Second Avenue in 1916. It lasted until 1958 when bituminous concrete was laid on top of the wood. (Building Records) This block lasted 42 years, longer than what was expected of the material.

Wood Plank



When new, plank roads were comfortable for heavy and light traffic. As the material began to wear though, the surface was not comfortable for passengers or appropriate for heavy traffic. The boards were generally 9 - 12 inches by 3 inches, and flooring was laid in 8 foot tracks. Planks would rest upon two parallel rows of stringers or sills 4 feet apart or 2 feet from the axis of the road. The sills were laid flat and embedded to create a firm bedding for the boards. Their function was also to spread the live loads of the moving traffic. The boards were laid perpendicular to the axis of the road, and the stability of the planks depended upon the well packed earth between and around the sills. (Byrne, 358)

In the Charlestown Navy Yard, Wood planks were used and replaced extensively in connection with the rail road tracks. (Building records) After the second decade of the 20th Century, the use of wood plank slowly ended as the new, more durable materials such as asphalt and bituminous concrete, became more widely used.

Charlestown Navy Yard
Charlestown MA

Evolution of Materials: Chronological List of Changes

Pre-1907 Material Evolution

This information has been extrapolated from a series of photographs obtained from the archives at the Charlestown Navy Yard. Although this information is not specific in regards to exact location or boundaries of pavement, it begins to tell the story of the evolution of materials.

1851	View of 3rd St., wood block carving	Dirt
1860-65[1]	Unknown location, photograph	Granolithic walk and dirt roads
1860-65	First Avenue, photograph	Brick or stone block
1860-65	Unknown location, photograph	Dirt
1860-65	West side of Dry Dock I, photograph	Dirt
1860-65	First Avenue, photograph	Brick or stone block
1860-65	Pier, photograph	Wood plank
1860-65	Building 107, photograph	Dirt
1860-65	Unknown location, photograph	Dirt
1860-67	Unknown Gate, photograph	Cobble stone
1876	View from the top of lower ship house, photograph	Hard packed dirt, granite curbs
1899	East Shallow Bassin, photograph	Dirt, stone block wall
1901	*Lincoln Avenue*	Brick
1902	6th Street, photograph	Dirt, rail with wood plank
1902	First Avenue, photograph	Large granite block
1902	First Avenue, photograph	Mud, rail with wood plank, granite curb
1903	West Fourth street looking NE, photograph	Brick road
1903	Pier One, photograph	Wood plank
1903	First Avenue, photograph	Granolithic sidewalk? rail with wood plank
1904	Second Avenue, photograph	Dirt with piles of cobble (Aug. 11, 1904, wood block, Building Records)

[1] The 1860-1865 photographs are courtesy of the Massachusetts Commandery Military Order of the Loyal Legion and the US Army Military History Institute

Post-1902 Materials Evolution

May 14, 1902	First Avenue	Plan of property Paving & RR Tracks
Jan. 7, 1903	RR Track	Vitrified brick for use on track, sections
May 5, 1903	Third Street	Yellow Brick Paving, granolithic sidewalk
	Second Avenue cross-walk	Large granite paving blocks with brick sidewalk
Oct. 27, 1903	1st Avenue	Granite Curbing
Feb. 4, 1904	RR Track	Special rail brick
July 20, 1904	Pier 1	Granite, wood and rails
Aug. 11, 1904	Second Avenue	Wood paving
	Fourth Street	Stone block on 1/2 of street
April 17, 1905	Pier 1	Brick paving
Nov. 1, 1907	Yard plan	Road and walk paving
	RR and walks	Plank
Sept. 1, 1909	Second Ave, North side	Granolithic sidewalk
July 1, 1910	Crane rail	Concrete within rail
May 3, 1913	Dry Dock 1	Paving, brick paving, Granolithic within crane rails
Oct. 8 1913	Dry Dock 1	Granite paving
Sept. 22, 1914	Rail Road	Concrete foundation
Aug. 10, 1915	Between Bld 24 & Crane Rail	Belgian Block
Sept. 28, 1915	Barracks	Granite
April 7, 1916	2nd Avenue, & between 2 & 3 Sts	Wood block replaced with cinder road, Cobble gutter, granolithic walk
Aug. 22, 1917	Walks	Concrete replacement
Dec. 10, 1917	Main Gate	Granite paving?
Aug. 1928	Annual inspection map, conditions on July 31, 1928	
Aug. 1930	Drive to Marine Barracks	Concrete drive and walk
April, 1932		Plan of paving
March, 1939		Plan of paving
May 7, 1946	Marine Barracks	Rebuild curbs
April 19, 1949	Between Bldg 24 and Crane rail	Paving blocks and bituminous concrete paving
May 1, 1951	Bldg 114 & vicinity	Paving plan, now bituminous concrete
Mar. 17, 1953	Dry Dock 1	Bituminous concrete
May 7, 1953	Pier 1, middle of pier	Pave with bituminous concrete
May 13, 1953	South of Building 194, (Pier 1)	Proposed paving
May 27 1952	Patching and resurfacing road	Good base map
Aug. 12, 1953	Pier 1 & Lincoln Avenue	Asphalt begins
Aug. 2, 1954	Pavement repairs	Site plan
Aug. 2, 1954	Site map	Bituminous sealed coating, almost all paved
April 13, 1955	USS Constitution Area	Paving, drainage, fencing, bituminous concrete
July 28, 1955	2nd Avenue to Gate 4	Concrete replace by air-entrained concrete
July 28, 1955	Road at Marine Barracks quarters	Concrete drive to be replaced w/ sheet asphalt
July 11, 1956	Pier 1, E. & S. of Bldg. 10	Pave with bituminous concrete
July 19, 1956	Inspect and test concrete and bituminous concrete	
Feb. 2, 1957	First Avenue	Bituminous concrete, foundation 18"
Feb. 4, 1957	First Avenue	Pave with bituminous concrete
June 1, 1958	Inspection of concrete and bituminous concrete	
July 15, 1958	Gate 2 and Second Avenue	Rehab and widen street, concrete sidewalk

Aug. 1958	Roads 2nd Ave, Gate 2 to 3rd St	Bituminous concrete over wood block and sheet asphalt
Aug. 1958	First Ave., Gate 1	Revision of concrete
Aug. 22, 1958	Gate 1 and First Avenue	Bituminous concrete, re-surface
Aug. 22, 1958	Gate 1, sidewalk	Revision with new concrete
Mar. 20, 1959	2nd Avenue, 3rd St. to 4th St	Rehab of road, concrete over wood block
April 14, 1959	Building 5	Concrete walk and granite curbs
Sept, 18, 1959	Second Avenue	Repair street & walks, bituminous concrete
Sept. 24, 1959	Pier 1	Red brick and paving block, Where renovated, bituminous concrete
1959	2nd Avenue, 4th -6th Sts.	Rehab, bituminous concrete over wood block
May 25, 1960	2nd Avenue	Revision of sidewalk
June 23, 1960	Pier 1 W & Lincoln Ave.	Pave
July 1960	Storage Hopper	Repair with bituminous concrete
July 8, 1960	Pier 1 W, Bld 9	Rehab of roads, bituminous concrete over Granite paving blocks
July 11, 1960	Firth Avenue, by Building 104	Re-paving & drainage, bituminous concrete
July 12, 1960	Lincoln Avenue	Rehab- paving and track work, bituminous concrete
July 15, 1960	Gate 4	Rehab- paving and drainage, concrete paving
Aug. 4, 1960	Sand Hopper, Pier 1 W.	Pave with bituminous concrete
Aug. 5, 1960	West of Sand Hopper #259,	RR Tracks & paving
March 31, 1961	Crane Rail, Dry Dock #2	Replacement, rehab of pavement
April 27, 1961	Pier 1	Re-surface with bituminous concrete
Oct. 20, 1961	North of Bldg. 28	Bituminous concrete
April 4, 1962	Adjacent to Crane Rail, DD #2	Pavement restoration
May 1964	Marine Quarters I	Rehab of drive, concrete, and concrete curb
June 10, 1964	4th Street	Rehab, paving, remove wood block, Place bituminous concrete
May 4, 1966	Pier 1	Concrete deck
Sept. 28, 1966	Second Avenue	Re-surface
April 9, 1971	First Avenue	Bituminous concrete and granite bump strips
March 3, 1972	S.E. corner of Bldg. 109	Repair manhole cover with concrete
1973	Navy Yard	Asphalt (Dave Rose)
1974-75	Pier 1	Structure repair

Archaeological Investigation

Existing Conditions

The creation and maintenance of the utilities and many periods of rehabilitation and improvements at the Navy Yard led to the destruction of much of the older paving. The historic pavement would be torn up and *not* replaced with the existing material or in kind when the Navy performed utility work. The importance of the historic fabric has not been a concern to the Navy in the past.

Where there is exposed material, there was once asphalt covering it. The bond with the hot top did not hold but peeled away from the older paving. There were pits dug next to the exposed material that showed no older paving, only dirt or loose rock. This may be because holes were dug for utilities in these areas, and the paving was not replaced.

When the jackhammer was used during the archaeological investigation, historic material was found 9 to 12 inches below the surface. It was not possible to find this information with a chisel and hammer. The possibility of finding more historic pavement One foot below the surface is very good.

See Appendix B: for a photographic description and locations of existing materials
See Appendix C: for a photographic description and locations of key buildings and locations

Dates for graphic material analysis

It was decided that seven periods or dates would be chosen for a graphic presentation of the evolution of paving material on the Navy Yard. They were chosen because of their historic significance and for the archival information at hand.

Pre-1907:
Although there were no building records before 1902, there are a series of photographs which begin to tell the story of paving during the second half of the 19th Century. These photographs are used to illustrate locations of certain materials.

1902 - 1916:
This period was significant to the Navy Yard. A number of paving materials were used during this time. It has been interpreted as a period of experimentation for the Yard. The 1907 base map is a good representative of the variation of materials from this period. *(See Site Map #A-3 for 1907 Conditions.)*

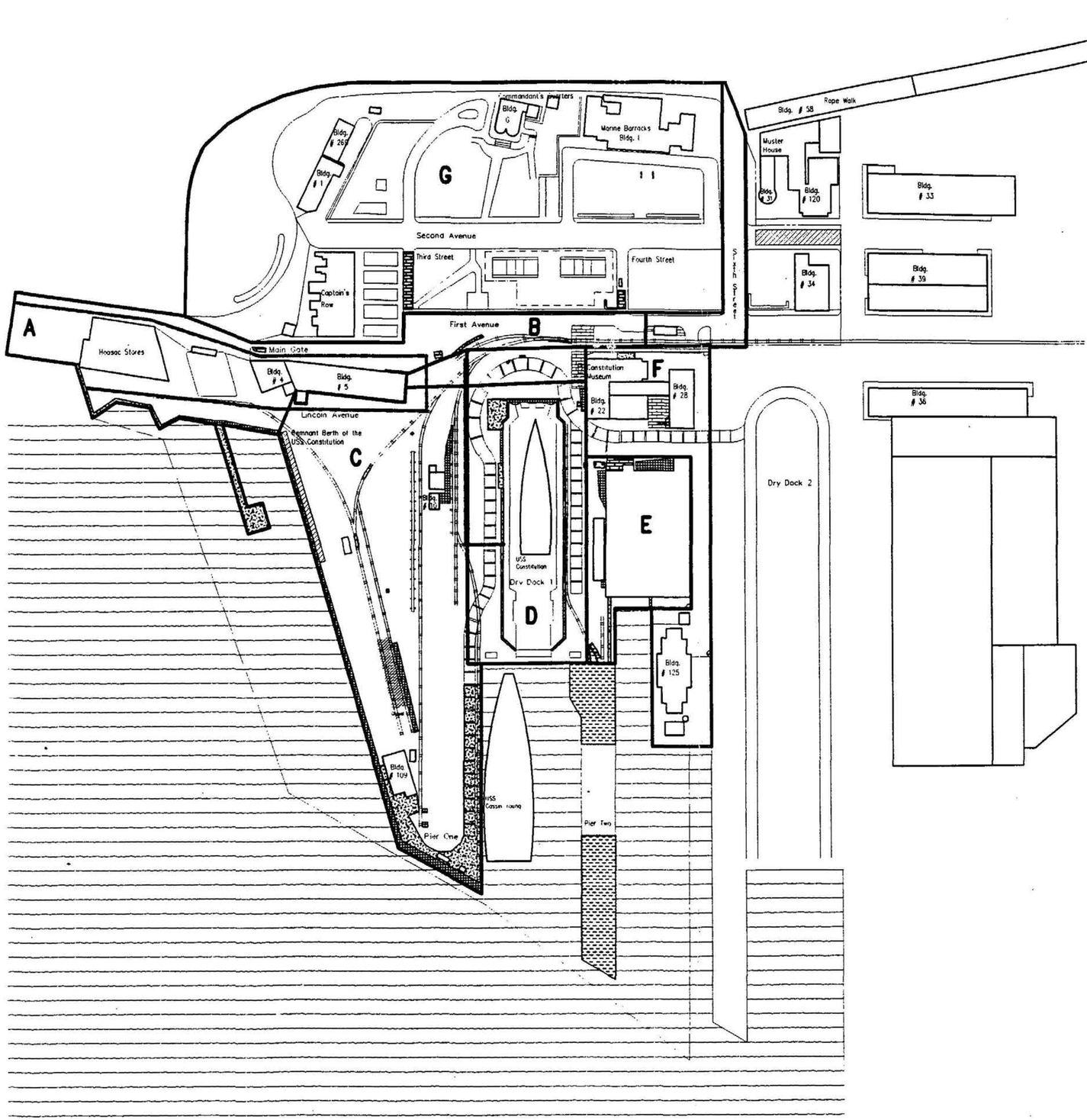
1928 and 1954:
These dates mark the ending of significant periods in the history of the Navy Yard. They were also chosen for the extensive archival information found. *(See Site Maps #A-4 and #A-5 for 1928 and 1954 Conditions.)*

1973:
Between 1958 and 1973 the roads were completely covered with asphalt and the sidewalks with concrete. The asphalt covered over historic material, but the historic pavement was also dug it up to create new foundations for the asphalt, leaving little older surfaces with which to work. The 1973 site map is significant, for that was when the Navy Yard was closed.

Pictorial Material Evolution

Through the archives at the Navy Yard, a number of historic photographs were found that begin to tell a story of the evolution of the paving. The earliest image is from November 1851 and is a wood carving. The pictures range in date from 1851 to 1974. Some of the images are not site specific to NPS property, but are historic Navy Yard property photographs. The set of pictures are used here to tell a story of the Navy Yard and to have an understanding of the changes made through history.

(See Appendix D for the Pictorial Material Evolution.)



Asphalt

Concrete

Large Granite

Small Granite

Brick

Wood Plank

Wood Block

Belgian Block

Freedom Trail

100 0 50 100

SCALE OF FEET

TRUE NORTH

DESIGNED: EQ
DRAWN: EQ
TECH. REVIEW: JB
DATE: 09/01/95

SUB SHEET NO. A 7

EXISTING EXPOSED CONDITIONS
1995 Site Plan
Charlestown Navy Yard
Charlestown MA

DRAWING NO. 457 62,590

REQ. NO. 2005

SHEET 8 OF 23

ON MICROFILM

B. Secretary of the Interior's Standards and Guidelines

The Secretary of the Interior Standards and Guidelines were created by the Department of the Interior through the National Park Service. These guidelines create a structure for archaeology and Historic Preservation in regards to; preservation, rehabilitation, restoration and reconstruction. Preservation and rehabilitation are the aspects of the guidelines that apply in this instance.

> ***Preservation*** *is the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction.*

The application of these guidelines include the preservation of significant historic pavement and surfaces on the Navy Yard. The first two 'Standards for Preservation' give a good synopsis for the treatment of the pavement.

1. A property shall be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property shall be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property shall be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.

> ***Rehabilitation*** *is the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historic, cultural, or architectural values.*

These standards give some lee-way in the use of substitute materials so long as they are used to create a surface that is historically accurate.

1. A property shall be used as it was historically, or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

2. The historic character of a property shall be retained and preserved. The removal of distinctive materials or alterations, features, spaces, and spatial relationships that characterize a property shall be avoided.

C. Handicap Accessibility Analysis

The American's with Disabilities Act Manual, "sets guidelines for accessibility to places of public accommodation and commercial facilities by individuals with disabilities. These guidelines are to be applied during the design, construction, and alteration of such buildings and facilities to the extent required by regulations issued by Federal agencies, including the Department of Justice, under the Americans with Disabilities Act of 1990." (ADA, pg. 1)

ADA requirements are applicable in the pavement project with respect to:
the change in level of surfaces of paving materials,
the sidewalk, curb ramps, and
handicap parking accessibility.

Since the Charlestown Navy Yard is Federal Property, the Massachusetts AAB codes are not applicable, as they are not required to be followed on Federal properties.

Section 4.1.7 discusses historic structures and facilities as exceptions to the general ADA code. As an historic facility, the Navy Yard must go through the Section 106 Review process, and an ADA Application in which, if the ADA requirements, "destroy the historic significance of the building or facility, the alternative requirements in 4.1.7(3) may be used for the feature."

4.1.7(3) Historic Preservation: Minimum Requirements:

(a) At least one accessible route complying with 4.3 from a site access point to an accessible entrance shall be provided.

EXCEPTION: A ramp with a slope no greater than 1:6 for a run of an accessible route to an entrance.

Applicable ADA Codes:

1. Level change in pavement

4.5 Ground and Floor Surfaces

4.5.1 General. Ground and floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs and curb ramps, shall be stable, firm, slip-resistant, and shall comply with 4.5.

4.5.2 Changes in Level. Changes in level up to 1/4 in (6mm) may be vertical and without edge treatment. Changes in level between 1/4 and 1/2 in (6mm and 13mm) shall be beveled with a slope no greater than 1:2. Changes in level greater than 1/2 in (13mm) shall be accomplished by means of a ramp that complies with 4.7 or 4.8.

4.5.4 Gratings. If gratings are located in walking surfaces, then they shall have spaces no greater than 1/2 in (13mm) wide in one direction. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

2. Curb Ramps

4.7 Curb Ramps

Curb ramps shall be provided wherever an accessible route crosses a curb.

Ramps shall comply with measurements from 4.8.2: The maximum slope shall be 1:12, maximum rise for any run, 30 in., minimum width 36 in.

4.7.5. Sides of Curb Ramps. If a curb ramp is located where pedestrians must walk across the ramp, or where it is not protected by hand rails or guard rails, it shall have flared sides; the maximum slope of the flare shall be 1:10. Curb ramps with returned curbs may be used where pedestrians would not normally walk across the ramp.

4.7.9. Location at Marked Crossings. Curb ramps at marked crossings shall be wholly contained within the markings, excluding and flared sides.

3. Parking

4.6 Parking and Passenger Loading Zones

Parking spaces to be located the shortest route of travel possible from an intended destination on the facility.

Accessible parking spaces: at least 96 inches wide.

Two spaces may share a common access aisle

Spaces shall be level, slopes will not exceed 1:50, or 2%.

Accessible parking spaces to be designated with signage, with the symbol of accessibility

Passenger loading zones: access aisle of at least 60 inches wide and 20 feet long.

(See Appendix E for more information about ADA Guidelines)

RECOMMENDATIONS

IV. PROPOSED ALTERNATIVES

INTRODUCTION: RECOMMENDATIONS FOR RE-SURFACING

In order to make recommendations about the paving at the Charlestown Navy Yard, it is important to understand the goals and objectives of the National Park Service. (See page 4) The self-imposed limitation through the General Management Plan may restrict the recommendation process of this project. It is also important to know that there were few existing paving plans of the Navy Yard after 1964 so recommendations about 1973 paving conditions will be conjectural.

There are many 'Site Themes' for the interpretation of the park. The history of the paving can be included in many of these:

History of growth, land/ technology
Human Occupation: technological advances and invention, ideas, systems, industrial creativity
Universal themes:
- U-1: The process of Change
- U-3: The yard as a symbol of technological change produced by the industrial revolution in America
- U-5: The changes produced by the industrial power and technological advances that effected the people of the United States. (Management Plan, 11)

The themes of the park will play a role in the interpretation of the alternatives. Although the National Park Service has decided to preserve the pavement back to 1973, this document has indicated that the history of paving at the Navy Yard, particularly in the first. 2 - 3 decades of the 20th Century, reflect the interpretive themes and the statement of significance of the park, (from the National Register of Historic Places.) This includes the experimentation with different types and forms of paving materials as can be seen in the building records and archaeological investigation of the site. They directly connect that period in the history of the site, and the Park's general history, to the importance of the Yard and its connection to the Industrial and Technological Revolutions.

Priorities for the alternatives:
To create a safe site for tourists,
To create a functional surface for crane rails and dry dock areas,
To create a landscape that reflects the evolution of the history of the paving material and the industrial and technological characters and history of the Navy Yard,
To design a landscape that is functional and can be incorporated into the interpretive themes of the park.

The alternatives for re-paving will include those materials which have been found to be significant to the site and the current exposed historic material while keeping in mind the large tourist location, including handicap access, durability, function and safety requirements of the site.

Three proposed alternatives will be made to give the National Park Service a choice of intensity of intervention, and the interpretation of the General Management Plan.

For every Alternative proposed, Section 106 and The Secretary of Interior's Standards Guidelines in regards to excavation, manner of laying material and use of substitute material should be followed. Also to be followed are the ADA pavement guidelines for handicap accessibility.

For Alternatives II and III, it will be necessary to lift the existing asphalt and work with the exposed historic fabric. The following are technical recommendations for these processes.

Proposal for lifting current asphalt

Make sure there is an archaeologist to oversee the lifting of the asphalt

Types of machinery to safely lift the asphalt:

1. Grade-all Bucket with a straight blade
   Scratch the surface and strip back the asphalt
   The asphalt is not bonded to the historic pavement underneath, so it will not be damaged
2. Milling machine
   set milling depth to just above the under material
   will pull up the asphalt and break any bond between the two materials
3. Front End Loader with buckets with teeth
   slide teeth across the pavement
   there may be areas where the asphalt will have to be pulled by hand
   this method is good for stone blocks such as granite, but is not good on materials like slate

Remove and Re-set the historic material

Be sure to number the pavement pieces so there will be a mapping order. It is possible to lift the pavement and reset it in the same position. The material should be lifted flush with the new surface and jointed appropriately to prevent buckling due to temperature changes or the wet/dry cycle. Proper resetting of the existing material would prevent tripping, poor snow removable or handicap access.

Freedom Trail Considerations

The Freedom Trail is a program of the City of Boston. A One Million Dollar Study of the Freedom Trail is underway to better use the trail and landscape amenities along it. The red line which designates the path, runs through the Navy Yard, and certain considerations need to be made and organizations contacted if any National Park Service work or construction were to involve the trail.

If re-paving effects the Freedom Trail, notify the following:

Council of Freedom Trail Sites
c/o Joan Hull ED
The Bostonian Society
206 Washington Street
Boston MA 02108

NPS Visitors Information Center
c/o John Pittzecker, NPS
15 State Street, 4th Floor
Boston MA 02109

Greater Boston Convention and Visitors Bureau
Mary Lou Crane, Director
Prudential Center, 4th Floor
Boston MA

Public Works Department
Michael Galvin
Chief of Basic City Services

For inquiries about the Study of the Freedom Train contact:

David Dixon, Goody Clancy
David Dixon or Catherine Firth
Boylston Street
Boston MA

Heritage Partners, Inc.
Michael Kauffman
Old City Hall
Boston MA

PROPOSED ALTERNATIVE I
PROPOSAL FOR PRESERVING ORIGINAL HISTORIC PAVEMENT

This first proposal is one of complete preservation of the historic material that is currently exposed. There is a limited amount of archival space at the Navy Yard, therefore it may be an unattractive alternative to lift out the pavement and place it in an enclosed area with proper humidity and temperature controls for appropriate preservation.

In that case, the best way to preserve the existing material is to pave over it and the current asphalt. The material should be mapped so when the Navy Yard is prepared to work with it, or until policy changes about preserving to 1973 changes, it will remain in relatively good health.

By paving the Navy Yard in asphalt, the General Management Plan would be followed in that the Yard would be paved to its 1973 appearance.

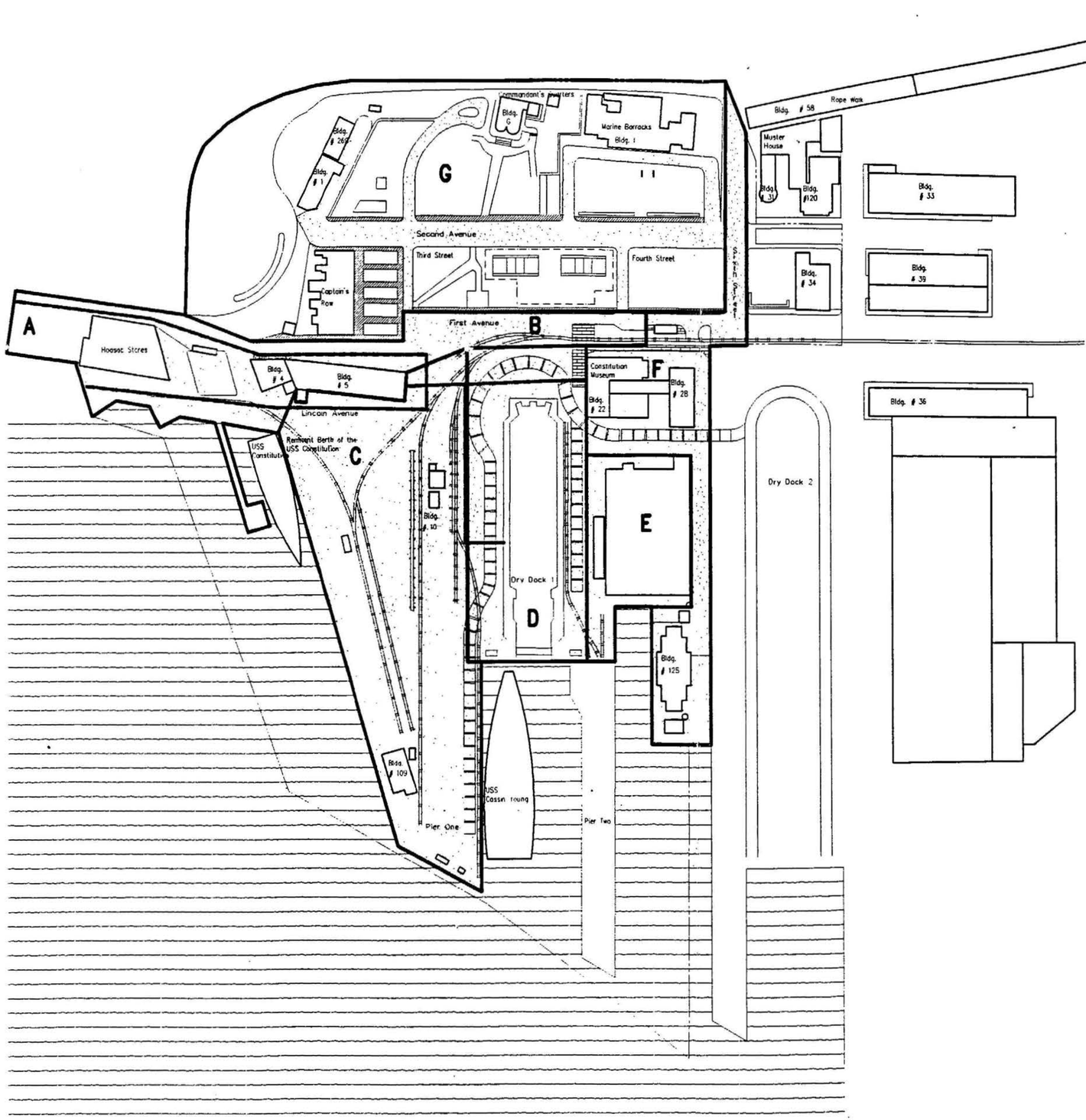
Objectives of Proposed Alternative I:

To fully preserve the historic material
To create a functional and safe paved environment for visitors and Park staff.

Evaluation of Proposed Alternative I

Alternative I would create a functional landscape for the NPS. It would be a good surface for handicap accessibility, durability, and overall site safety. This alternative would be inexpensive to lay and maintain.

Totally re-paving in asphalt to preserve the historic material though does not fully comply with the General Management Plan in keeping existing historic pavement exposed. It also does not reflect the historic qualities or the interpretive themes of the park. Practically, the asphalt will most likely begin to crack as it does now, due to differences in sub-straits throughout the park. Moreover, in the process of re-paving, the extant historic paving may be further damaged. Overall, re-paving the park in asphalt would create an uninteresting space.



Proposed Alternative I:
Pave over all of the historic material and current asphalt with new asphalt to archaeologically preserve the pavement.

Asphalt

Concrete Sidewalk

Freedom Trail

100 0 50 100
SCALE OF FEET

TRUE NORTH

DESIGNED: EG DRAWN: EG TECH. REVIEW: JB DATE: 09/01/95	SUB SHEET NO. A17	PROPOSED ALTERNATIVE I Site Plan Charlestown Navy Yard Charlestown MA	DRAWING NO. 457 62,590 PROJ. NO. 0000 SHEET 18 OF 23

ON MICROFILM

PROPOSED ALTERNATIVE II
PROPOSAL TO KEEP EXISTING MATERIAL EXPOSED AS DESCRIBED IN THE MANAGEMENT PLAN

Alternative II is a preservation plan of the existing material, historic and non-historic. It most strictly adheres to the GMP. The material will be at the 1973 appearance, granite curbing and historic paving will remain where exposed. Refer to the methods of lifting asphalt and lifting and replacing the historic material from the Introduction of this section.

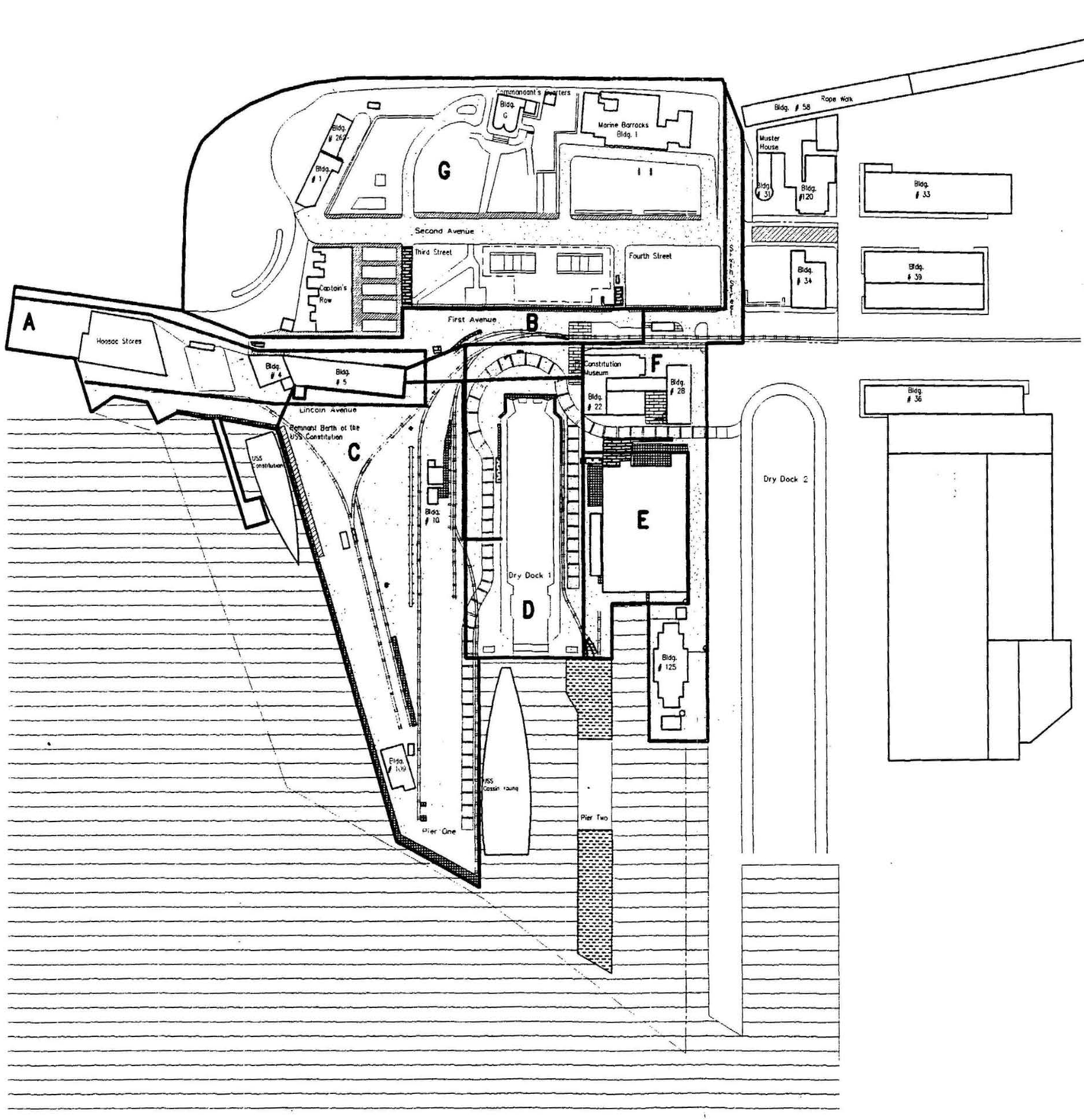
A slight variation to the above recommendation would be to further exposed certain materials in 'strategic' locations. This would allow the pavement to be used as an interpretive tool as well as create a more attractive road surface for the park.

Objectives of Proposed Alternative II:

To preserve the surface materials found at the Navy Yard.
To create a functional and safe surface for the visitors and Park staff.

Evaluation of Proposed Alternative II

Alternative II follows the Management Plan which may be the most appropriate route to follow. A problem with this plan though is that there is too limited an area where the historic fabric is exposed. It would be difficult to create an attractive and functional landscape plan and design with the amount of material that is known to currently exist. Following the guidelines of the General Management Plan in this case would not assist the park in using the pavement as an interpretive tool nor would it allow the park to create an attractive outdoor museum.



Proposed Alternative II:
Keep the existing historic material exposed and pave up to those boundaries with asphalt.

Asphalt	
Concrete Sidewalk	
Large Granite	
Small Granite	
Brick	
Wood Plank	
Wood Block	
Belgian Block	
Freedom Trail	

100 0 50 100
SCALE OF FEET

TRUE NORTH

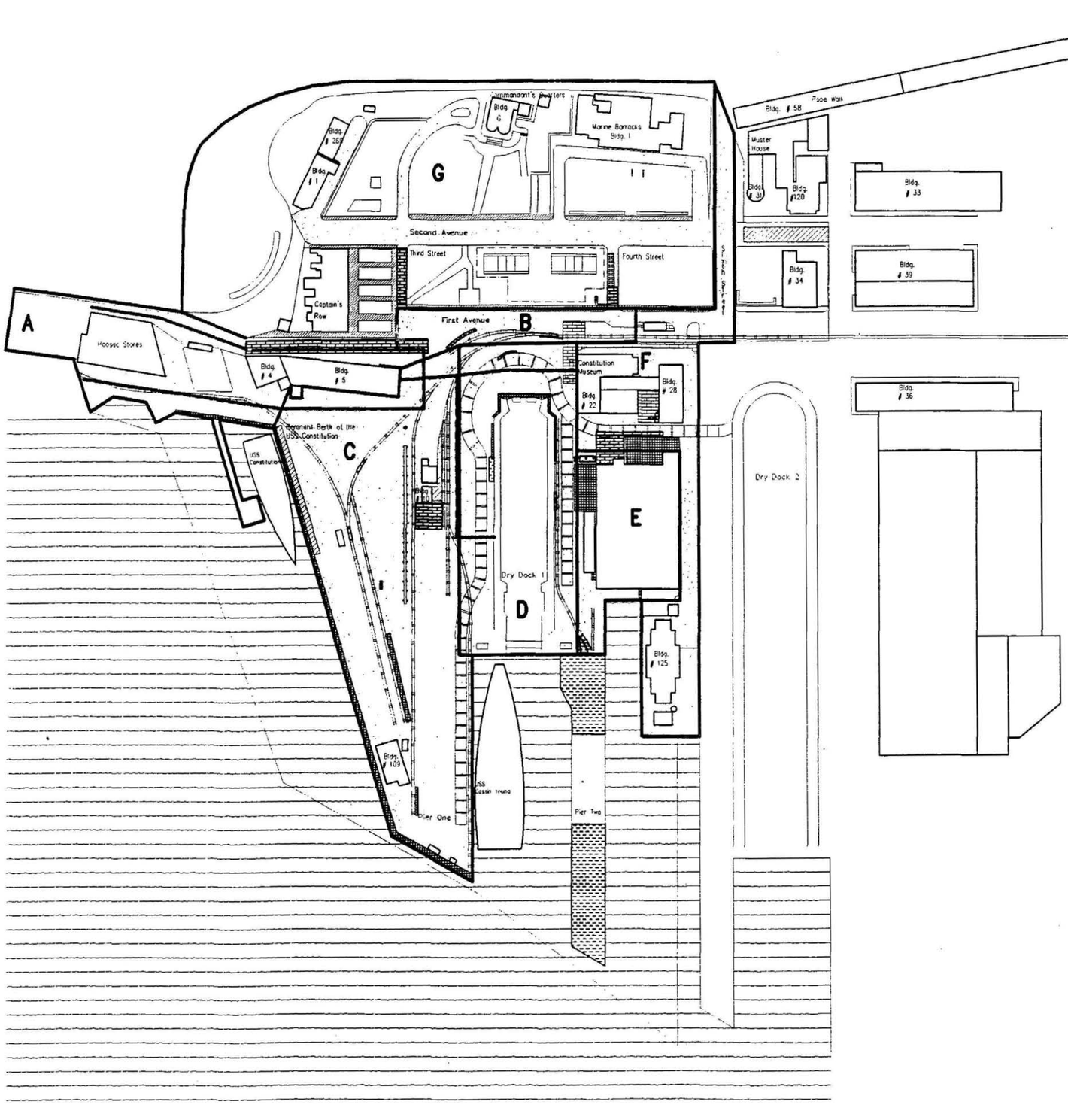
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DRAWN: EG
TECH. REVIEW:

SUB SHEET NO. A18

PROPOSED ALTERNATIVE II
Site Plan
Charlestown Navy Yard

DRAWING NO. 457 62,590

ON MICROFILM



Proposed Alternative IIB:
Further expose the historic material in strategic locations by removing asphalt that was found to be covering the pavement. Pave up to these boundaries with new asphalt.

Asphalt

Concrete Sidewalk

Large Granite

Small Granite

Brick

Wood Plank

Wood Block

Belgian Block

Freedom Trail

100 0 50 100
SCALE OF FEET

TRUE NORTH

DESIGNED: EG
DRAWN: EG
TECH. REVIEW: JB

SUB SHEET NO. A19

PROPOSED ALTERNATIVE IIB
Site Plan
Charlestown Navy Yard

DRAWING NO. 457 62,590
PROJ. NO. 00021
SHEET 20

ON MICROFILM

PROPOSED ALTERNATIVE III
PROPOSAL TO FURTHER EXTEND THE THEMES OF THE PARK THROUGH RE-PAVING

If the decision is to keep the existing historic material exposed, use the paving as a part of the site's overall interpretive plan utilizing the themes discussed earlier. The pavement can be used as part of the outdoor museum in which it tells a story of the Navy Yard during the significant period(s) which correspond to the waves of activity; experimental, industrial and technological aspects of the park. Use the park's interpretive tools; brochures, tours, signage, to include the pavement as a part of the story of the Navy Yard. The pavement can be a positive experience of interpretation and discovery which can be subtle yet interesting and exciting for the visitor.

The general recommendations are to lift the asphalt to examine, more fully, the existing historic pavement. Once the examination is complete, use the existing historic fabric in conjunction with new, similar materials to create, in certain areas, new landscape design. Be sure though when substitute and original fabric is used together, that the materials can be differentiated visually from one another for later, more accurate research, archival documentation, and to have easily recognizable historic material for the public.

The overall objectives of Proposed Alternative III includes the use of historic and similar fabric. They are not used necessarily to recreate a period earlier than 1973, but to:

show the variety of materials used throughout the history of the yard, its evolution
add another dimension to the interpretive themes of the park
create definition to important and functional areas of the park
create paving that is functional and easily navigable to pedestrians, vehicles, heavy machinery and the crane rail

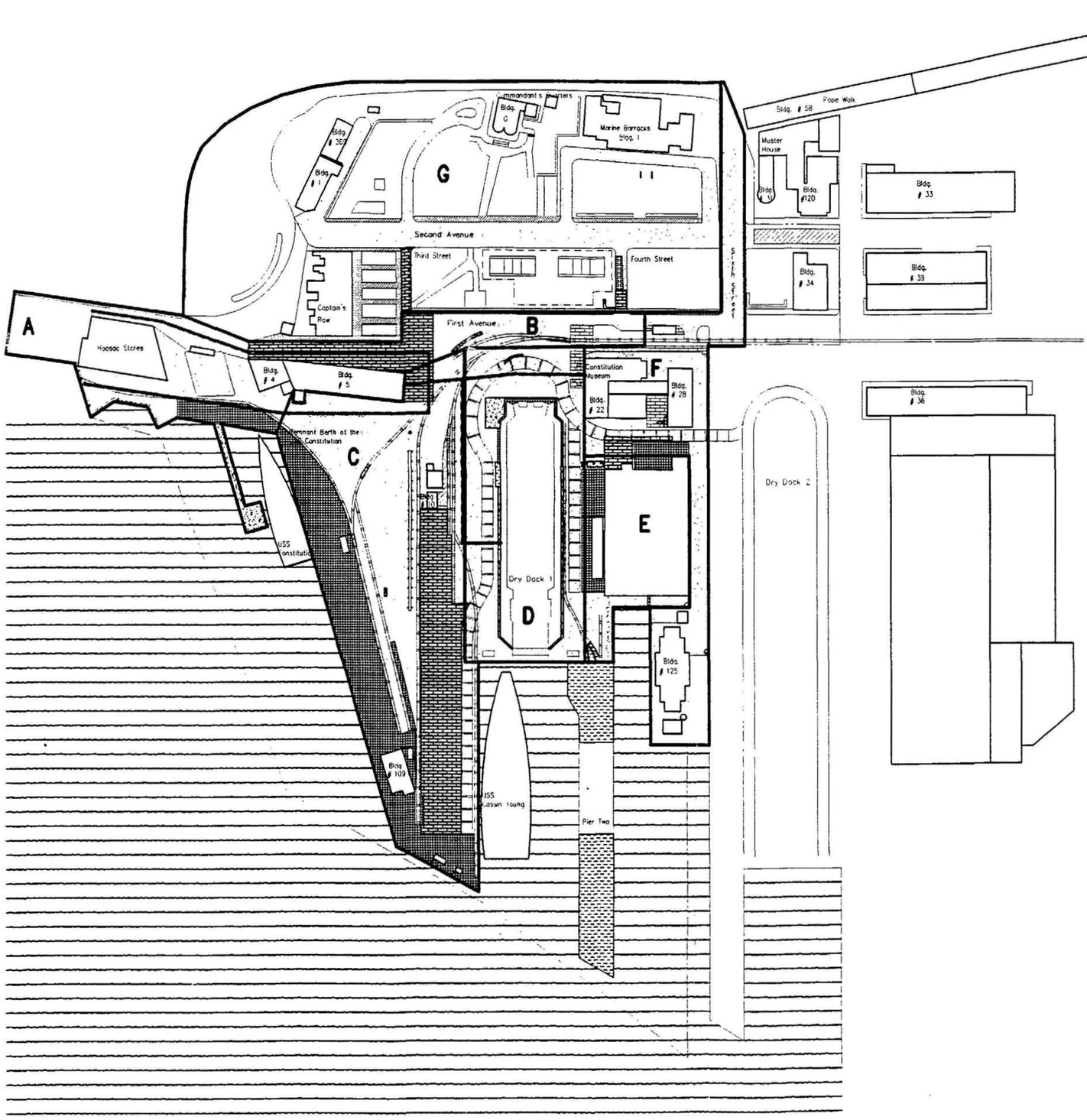
If substitute materials are used, the pavement can still be used as part of an interpretative plan. It may be a more effective interpretive tool if there are larger, more visible and definable areas of historic materials than currently exists. Visitors will be better able to understand the connections of the pavement to the history of the Navy Yard.

Evaluation of Proposed Alternative III

Although this last alternative does not strictly follow the General Management Plan, it seems to be the best use of the site's materials. It creates a better developed interpretive platform, and a better visual impact and experience for the visitor.

If the NPS decides to use this alternative, it may be necessary to create an GMP Amendment to allow for greater use and interpretation of the existing historic materials.

This alternative may be a more complicated and expensive process than the previous two, but it best enhances the park visually and historically.



Proposed Alternative III:
Use the existing historic material in conjunction with new, similar materials to create, in certain areas, new landscape design.

Asphalt	
Concrete Sidewalk	
Concrete	
Large Granite	
Small Granite	
Brick	
Wood Plank	
Wood Block	
Belgian Block	
Freedom Trail	

100 0 50 100
SCALE OF FEET

TRUE NORTH

DESIGNED: EG DRAWN: EG TECH. REVIEW: JB DATE: [illegible]	SUB SHEET NO. A20	PROPOSED ALTERNATIVE III Site Plan Charlestown Navy Yard Charlestown MA	DRAWING NO. 457 62,590 PKG. NO. 0006 SHEET 21

ON MICROFILM

PREFERRED ALTERNATIVE

V. PREFERRED ALTERNATIVE

After considering the Proposed Alternatives with members of the National Park Service, landscape architects, Navy Yard maintenance, and workers for the USS Constitution, a Preferred Alternative was created. This final proposal is a hybrid of Alternatives I, II and III. Although recommendations were made to create certain landscape issues, this final proposal is still considered to be a re-paving plan as opposed to a rehabilitation or restoration of the site.

The Preferred Alternative calls for the repair or replacement of existing exposed materials as stated in the General Management Plan. All other areas are to be paved with asphalt except in those locations that will assist in the safety of visitors to the park, facilitate pedestrians through the park, or those areas which were felt to be important as key locations of the Navy Yard. The materials which have been proposed for these chosen sites are historical elements used in the Navy Yard. A more detailed description of the Preferred Alternative is as follows:

1. Freedom Trail:

   It is felt that the Freedom Trail should become an intertwined element with the Navy Yard. It should be a visual visitor flow path from the Main Gate, to the Visitor Center, USS Constitution, USS Cassin Young and the Constitution Museum. The trail should be slightly altered so as to lessen the change of accidents due to the intersection of rail lines and trail.

   The proposal to pave the Freedom Trail comes from the Boston Redevelopment Authority. This study is an attempt to create a unified trail throughout the City of Boston. To remain consistent with the entire trail, the red line through the Navy Yard will be two wythes of brick wide. Where the Freedom Trail runs through brick, the bricks will be framed by strips of granite on either side.

   <u>Compliance</u>

   There is no historic precedent for the Freedom Trail. Since it is now a part of the site, it must be addressed. The materials proposed to be used in conjunction with the Freedom Trail have bee used on the site since the first decade of the 20th Century.

2. First Avenue:

   Historically, red brick was used to pave the entire length of First Avenue. Brick still exists, exposed and under the asphalt, running about fifty feet past Building 5. The Preferred Alternative proposes that brick be re-paired, replaced and newly laid beginning at Gate One and continuing the entire length of First Avenue. The brick will not cover the locomotive scale which is in front of the Scale House.

   The brick to be used will be smooth and meet ADA code. On either side of the new pedestrian road, concrete sidewalks can also assist visitors with wheelchairs or disabilities.

   <u>Compliance</u>

   Brick has been used on First Avenue as early as 1865 and from the Main Gate to Building 5 since at least 1907. The sidewalks were paved with granolithic paving as early as 1907. As with almost all of the sidewalks, the curbs were granite and the walks were granolithic paving since at least the end of the 19th Century. The concrete-like surface of granolithic paving is similar to the concrete that now exists and is proposed in the alternative. The use of red brick in this proposal is a replacement of the historic original.

3. Third Street:

The yellow brick on Third Street is in satisfactory condition. It is proposed that bricks remain and be repaired or replaced as needed. The Southern portion of the road is asphalt. A completion of the surface would be to lay brick from its existing border to the end of Third Street.

Compliance

The yellow brick on Third Street has been there since at least 1907. The only material that will be added is where yellow brick has been removed or where the existing material is no longer functional.

4. Fourth Street:

Fourth Street contains existing and covered yellow brick and wood block. The brick is in good condition and the wood block is in satisfactory condition but may be deteriorated in patches under the surface. It is proposed that the brick and wood block be fully exposed, repaired and replaced as needed.

Compliance

Fourth Street has been paved with wood block and yellow brick since at least 1904. The material that will be added is where brick or wood block have been removed or is no longer functional.

5. Building 22, Constitution Museum:

On the Western side of the Constitution Museum, a granite side walk abuts exposed brick. Some of the brick is covered with a layer of asphalt. It is proposed that the covered brick be exposed, and the granite and brick be repaired and replaced as needed.

Compliance

There is no introduction of new materials accept where the brick or granite block is no longer functional. A small section of the granite has been replaced or patched with concrete. This material will be replaced with granite similar to what had originally been used to paved this side walk.

6. Pier I:

Railroad Tracks:

The tracks pose a threat to the safety of the visitors to the site. Every week people trip and hurt themselves causing law suits. It is proposed that portions of the rail that are in the immediate walking path of the visitors or join with the Freedom Trail be removed. In particular, remove those sections which are in the path between the future USS Constitution Dock and the USS Cassin Young.

The remaining tracks should be paved level with the tops of the rail to prevent tripping and to comply with ADA Accessibility Codes. The tops of the rails need to be exposed because of the historic significance of the tracks.

Since the crane rail tracks need to remain operational, it is not possible to remove portions of it. To prevent tripping, the rail, in certain locations, will be covered with 'Full Depth Rubber Crossing Pads'. This rubber material is put on the track to allow full operation of the crane but will create a smoother surface for pedestrians. It is known to be one of the best solutions to this type of problem.

Compliance

The railroad tracks are an historic element on the site. It is proposed that most of the tracks remain and are paved in such a way that they remain exposed. The priority of the Navy Yard is site safety for the visitor. It was felt that by strategically removing some of the track while exposing others, the site can be a less hazardous walking area for the visitors.

Future Dock for the USS Constitution:

The dock of the USS Constitution is an important site on the Yard for it is the main visitor attraction. Because the adjacent pier is needed for heavy industrial equipment that services the boat, the landscape will have to include materials that can withstand the 70 ton crane. It is proposed that smooth large granite blocks be placed around the upper Western portion of the pier and wrap around toward the finger pier. The granite will run down the Western edge of the pier and wrap around its Southern tip.

Compliance

Granite block has been used on Pier 1 and in this location since at least 1907. The proposal does suggest that the material be paved in a wider area than it was historically. Granite block though was an industrial material used on the pier to withhold the stresses of the cranes and trains. The granite block was proposed in this area because the crane rail will be used on the Western section of the pier. The proposal to use granite is similar to the decisions to use the material originally.

Visitor Amenities:

The current parking lot to the North of the future USS Constitution dock has been chosen as a visitors amenities site. It is proposed that this site be paved with brick and to create a space that is comfortable to sit, relax, and watch the ship.

Compliance

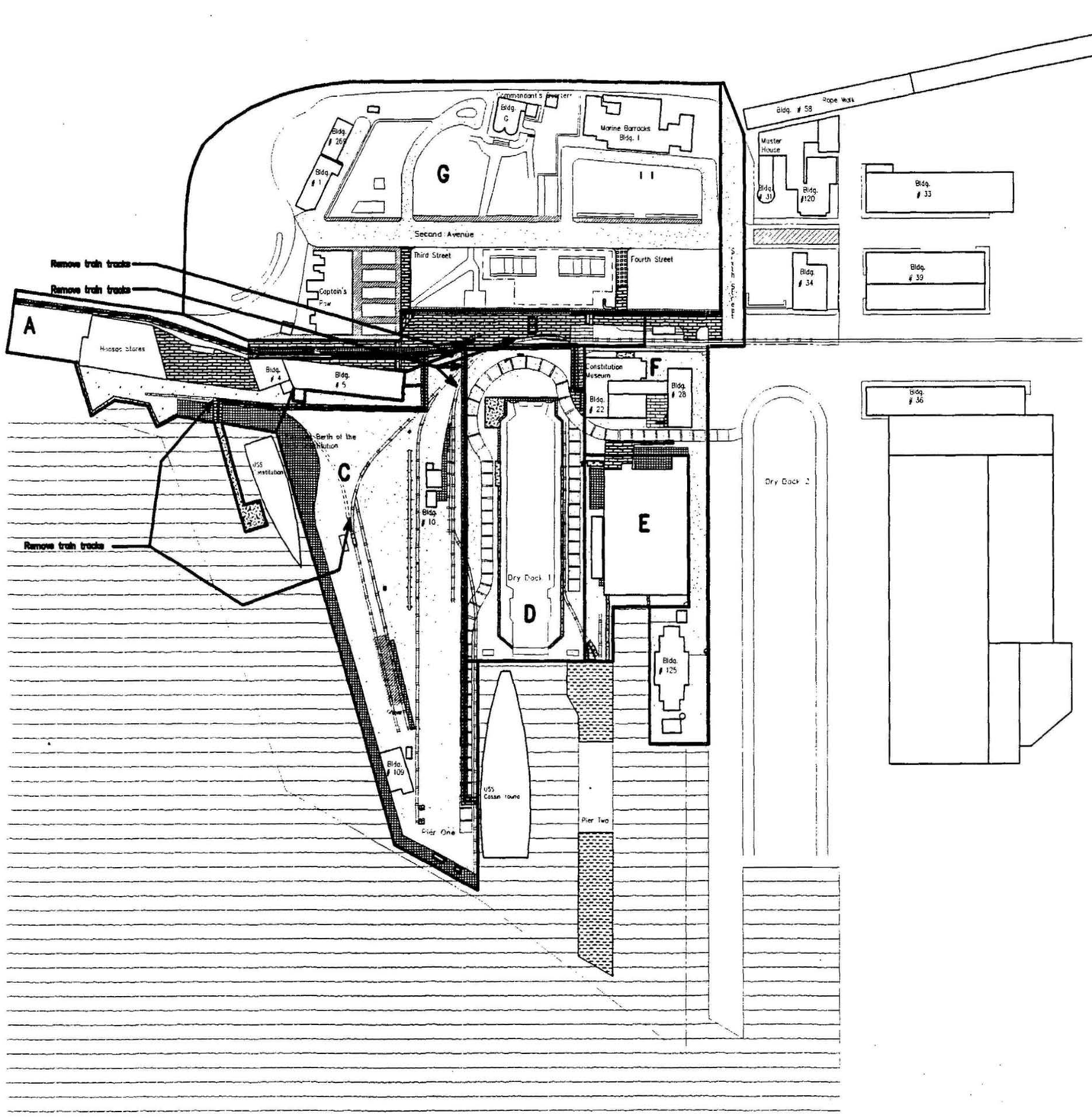
Brick was used along Lincoln Avenue in the first decade of the 20th Century. Half of this area had been paved with brick, the other half housed the Store House from 1870 to about 1910. Although there was no paving where the building was placed, brick was a prominent surface material in the immediate vicinity. The brick paving can be seen in a 1901 photograph of Lincoln Avenue. *(See Appendix D)*

7. Crosswalks

The crosswalks are currently wide green painted strips. They appear: at the intersection of Third Street and First Avenue, between Building Five and Third Avenue, and at the Scale House on First Avenue. It is proposed that these crosswalks be red brick. This installation of paving material would lessen maintenance, be more understandable to driver and pedestrian, and would be more attractive then painted road surfaces.

Compliance

There are no recorded means of creating cross walks on the site. Crosswalks though are necessary for site safety. It was decided to use brick because it is a smooth material that is appropriate for such a use, and brick is historically a material used on First Avenue.



Preferred Alternative:
Repair and/or replace existing exposed materials as stated in the General Management Plan. All other areas are to be paved with asphalt except in those locations that will assist in the safety of visitors to facilitate pedestrians through the park, or those areas which were felt to be key locations of the Navy Yard.

Asphalt	
Concrete Sidewalk	
Concrete	
Large Granite	
Small Granite	
Brick	
Wood Plank	
Wood Block	
Belgian Block	
Freedom Trail	

100 0 50 100
SCALE OF FEET

TRUE NORTH

DESIGNED: EG DRAWN: EG TECH. REVIEW: JB DATE:	SUB SHEET NO. A21	PREFERRED ALTERNATIVE Site Plan Charlestown Navy Yard Charlestown MA	DRAWING NO. 457 62,590 PKG. NO. SHEET 22

ON MICROFILM

COST ESTIMATES

VI. COST ESTIMATES

The structure for the cost estimate for the Preferred Alternative has been taken from the estimate created by the Federal Highways Administration. In order to have an accurate comparison between proposals, the same prices, square footage and steps were used. The estimations are consistent with one another, hence the final cost for the two may be compared and weighed equally.

Included in the cost estimate:

Removal of current asphalt
Regrading the base
Aggregate base
New pavement structure
Removal of concrete curb
Replacement of curb with granite
Crane rail safety adjustment
Pavement markings and symbols
Drainage
Manhole adjustment
Signage
35% of cost for construction incidentals
30% of cost for planning, administration and construction supervision

	Federal Highways	Preferred Alternative	Preferred Alternative
	COST OF WORK	COST OF WORK	COST OF WORK
LOCATION		Pave all of First Avenue	Pave First Avenue with brick
		with brick	Main Gate to Blgd. 5
First Avenue	$ 230,000.00	$ 457,926.00	$ 311,397.00
Lincoln Avenue/ Pier 1	$ 1,587,140.00	$ 2,052,851.00	$ 2,052,851.00
Second Avenue	$ 146,021.00	$ 146,021.00	$ 146,021.00
Fourth Street	$ 110,211.00	$ 91,823.00	$ 91,823.00
Third Street	$ 107,972.00	$ 107,972.00	$ 107,972.00
Baxter Avenue	$ 143,758.00	$ 143,758.00	$ 143,758.00
Service Drive	$ 34,142.00	$ 34,142.00	$ 34,142.00
Service Loop	$ 6,530.00	$ 6,530.00	$ 6,530.00
Pier 2 South	$ 108,626.00	$ 108,626.00	$ 108,626.00
Pier 2 North	$ 165,755.00	$ 205,386.00	$ 205,386.00
Connector Road	$ 60,467.00	$ 123,305.00	$ 123,305.00
Terminus of Route 400	$ 46,001.00	$ 46,001.00	$ 46,001.00
TOTAL COST	$ 2,746,623.00	$ 3,524,341.00	$ 3,377,812.00
SAY	$ 2,800,000.00	$ 3,600,000.00	$ 3,400,000.00
DIFFERENCE IN COST		$ 800,000.00	$ 600,000.00

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BIBLIOGRAPHY

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Historic Photographs of pavement
Historic Pavement specifications: plans site maps, details

Correspondence

Memorandum: March 3, 1995
To: Acting Regional Director, North Atlantic Region
From: Superintendent, Boston National Historical Park

Oral History

Mr. Dave Rose
Chief of Maintenance, Boston National Historical Park
(Navy Yard employee since 1955)

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APPENDIX

Appendix A: Charlestown Navy Yard Development Subzones

Appendix B: Existing Materials and Locations

Appendix C: Key Buildings and Locations

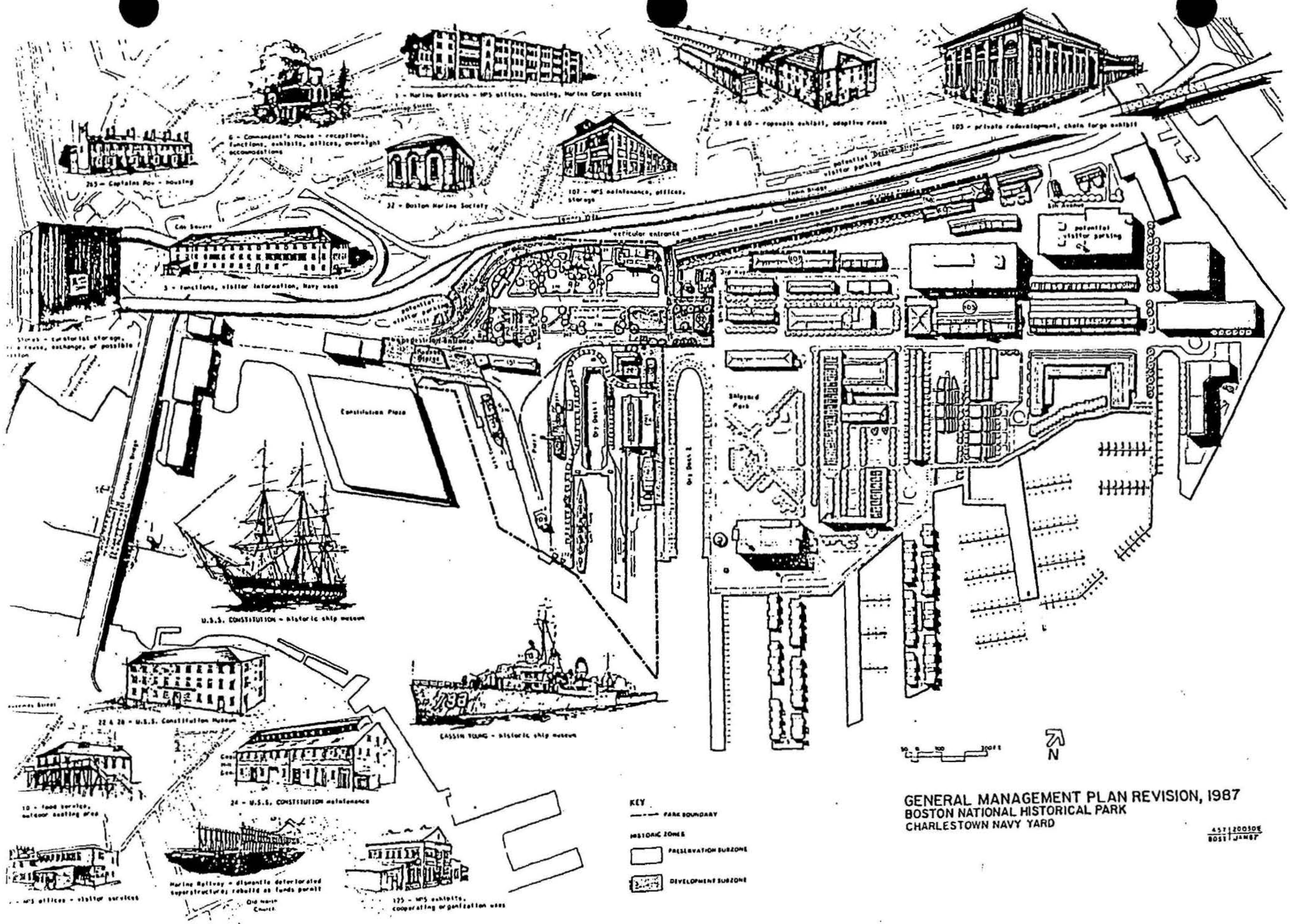
Appendix D: Pictoral Materials Evolution

Appendix E: American with Disabilities Acts Manual Exerts

Appendix F: Cost Estimates

1. Federal Highway Administration Cost Estimate
2. Preferred Alternative Cost Estimate
3. Map of Federal Highway Administration Zones for Cost Estimates

Appendix A: National Park Service Development Subzones



GENERAL MANAGEMENT PLAN REVISION, 1987
BOSTON NATIONAL HISTORICAL PARK
CHARLESTOWN NAVY YARD

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Appendix B: Existing Materials and Locations



Yellow brick on Third Avenue



Wood block on Fourth Avenue



Yellow brick on Fourth Avenue



Red brick and asphalt North of Dry Dock One



Concrete on Dry Dock One



Wood plank North of Dry Dock One



Large granite block and red brick outside the Constitution Museum



Large and small granite block on Pier One



Small granite block one Pier One



Wood plank on Pier One



Small granite block on Pier One

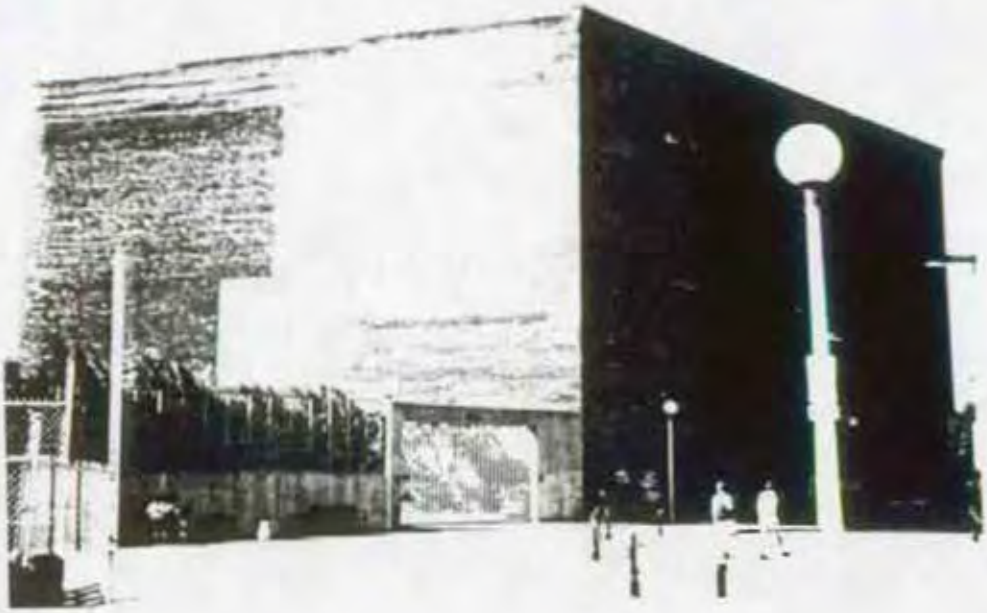


Red brick on Pier One



Large granite block at the Southern tip of Pier One

Appendix C: Key Buildings and Locations



Borden's Warehouse, Main Entrance



Gate One and view down First Avenue



Building Five, Visitor's Center



Uss Constitution from Pier One



The Scale House on First Avenue



View of the crane rail on Dry Dock One



Remnant Berth of the USS Constitution





Sand Hopper on Pier One



Building Ten on Pier One



Building 109 on Pier One



The USS Cassin Young



Building 28 on First Avenue



Captain's Row on Third Street



Commandant's Quarters on Second Avenue



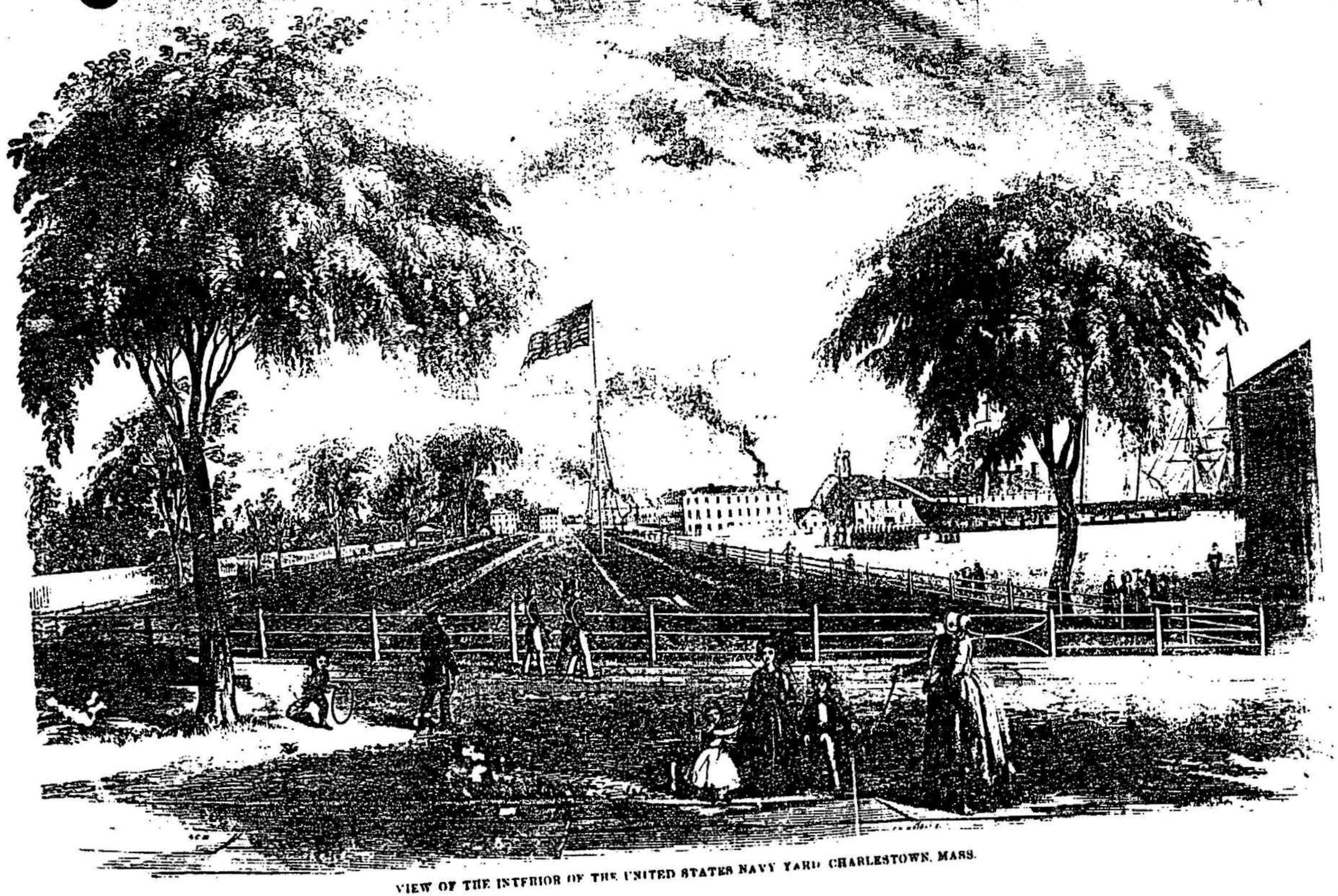
Marine Barracks on Second Avenue



The Muster House on Sixth Street

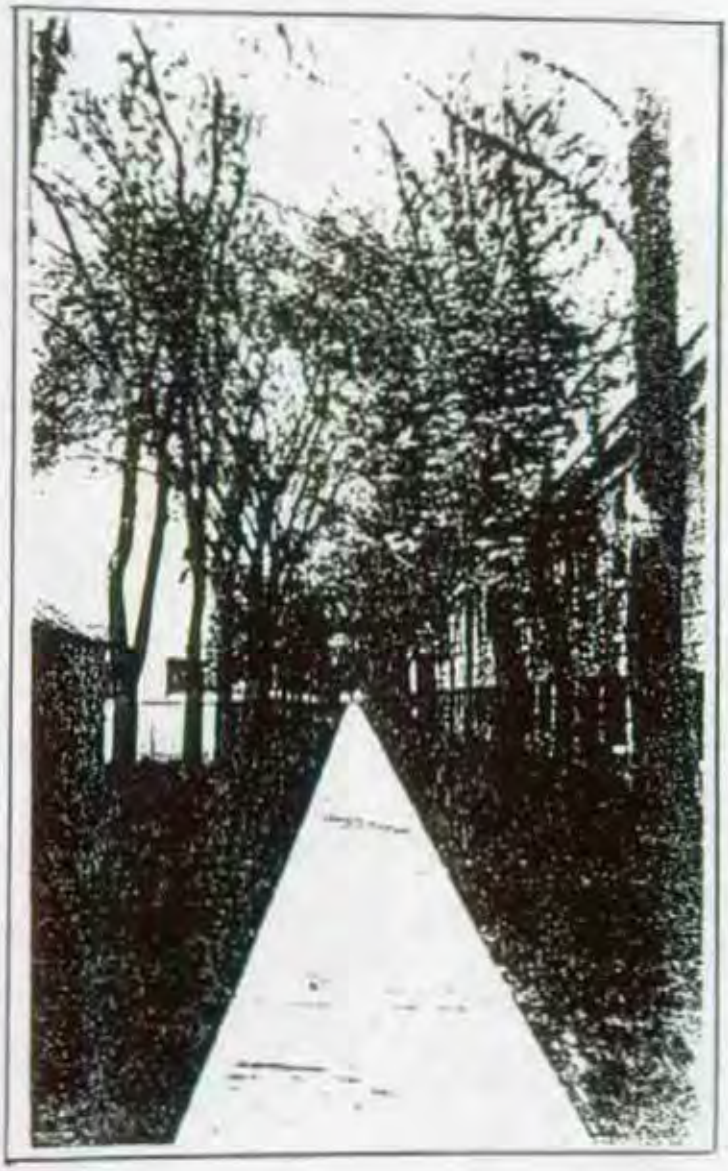
Appendix D: Pictoral Materials Evolution*

* The images from 1860-65 are courtesy the Massachusetts Commandery Military Order of the Loyal Legion and the US Army Military History Institute.



VIEW OF THE INTERIOR OF THE UNITED STATES NAVY YARD, CHARLESTOWN, MASS.

1851: View of First Avenue, dirt road

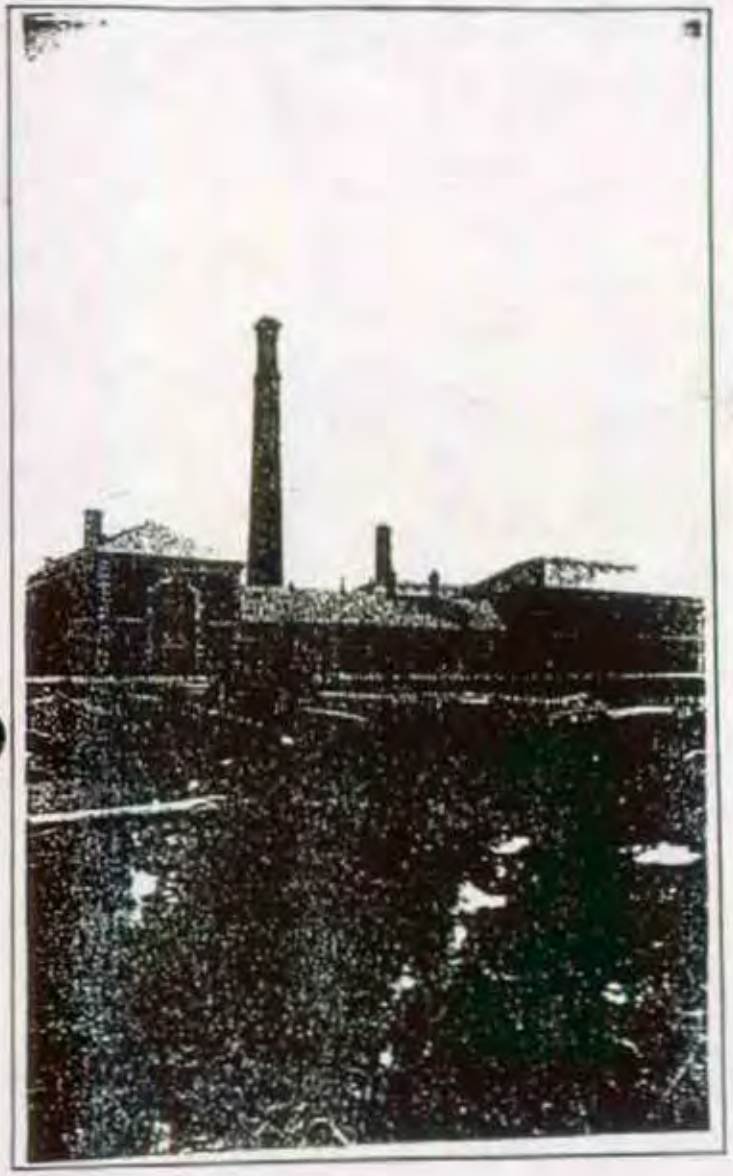




1860-65: First Avenue with brick or stone block

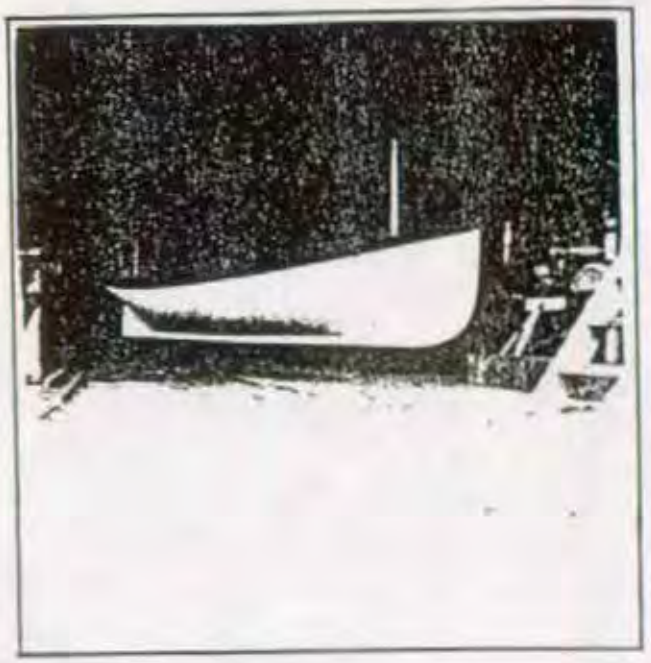


Boston Navy Yard.



1860-65: Unknown pier, dirt road





Boston Navy Yard.





1860-65: First Avenue, brick or stone block

Boston Navy Yard.







1860-65: Rope Walk, dirt road



Boston Navy Yard



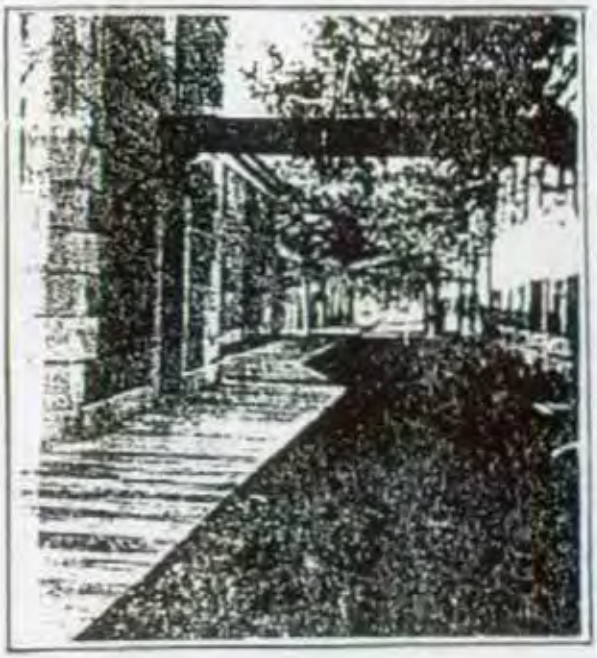
DIRT



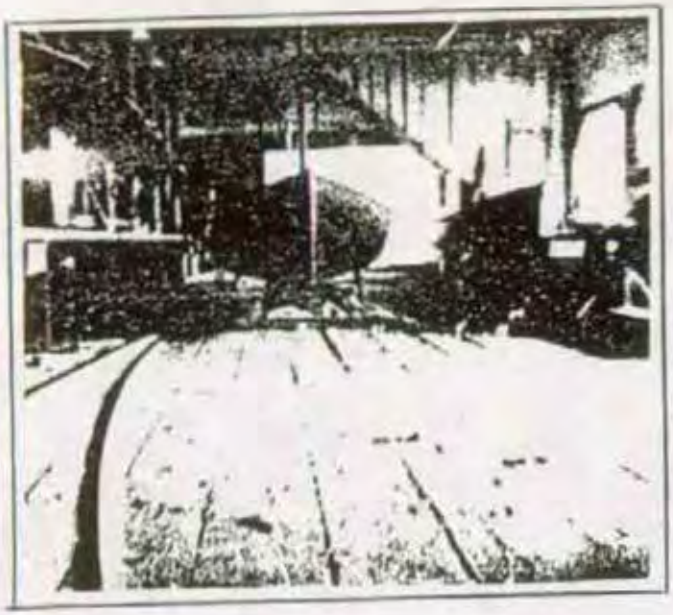
DIRT







1860-65: Dirt road with granolithic sidewalks





1860-65: Unknown pier, wood plank

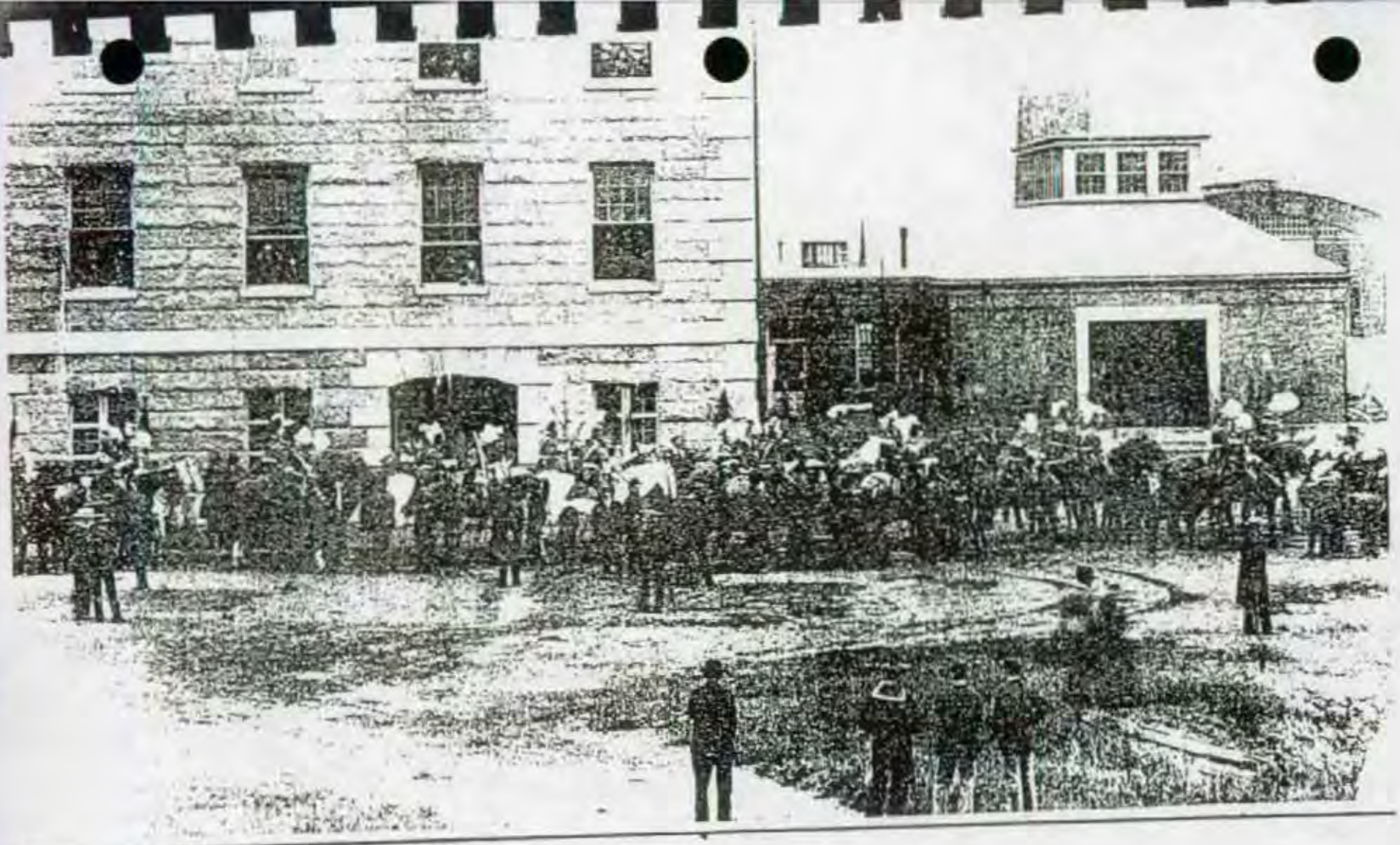




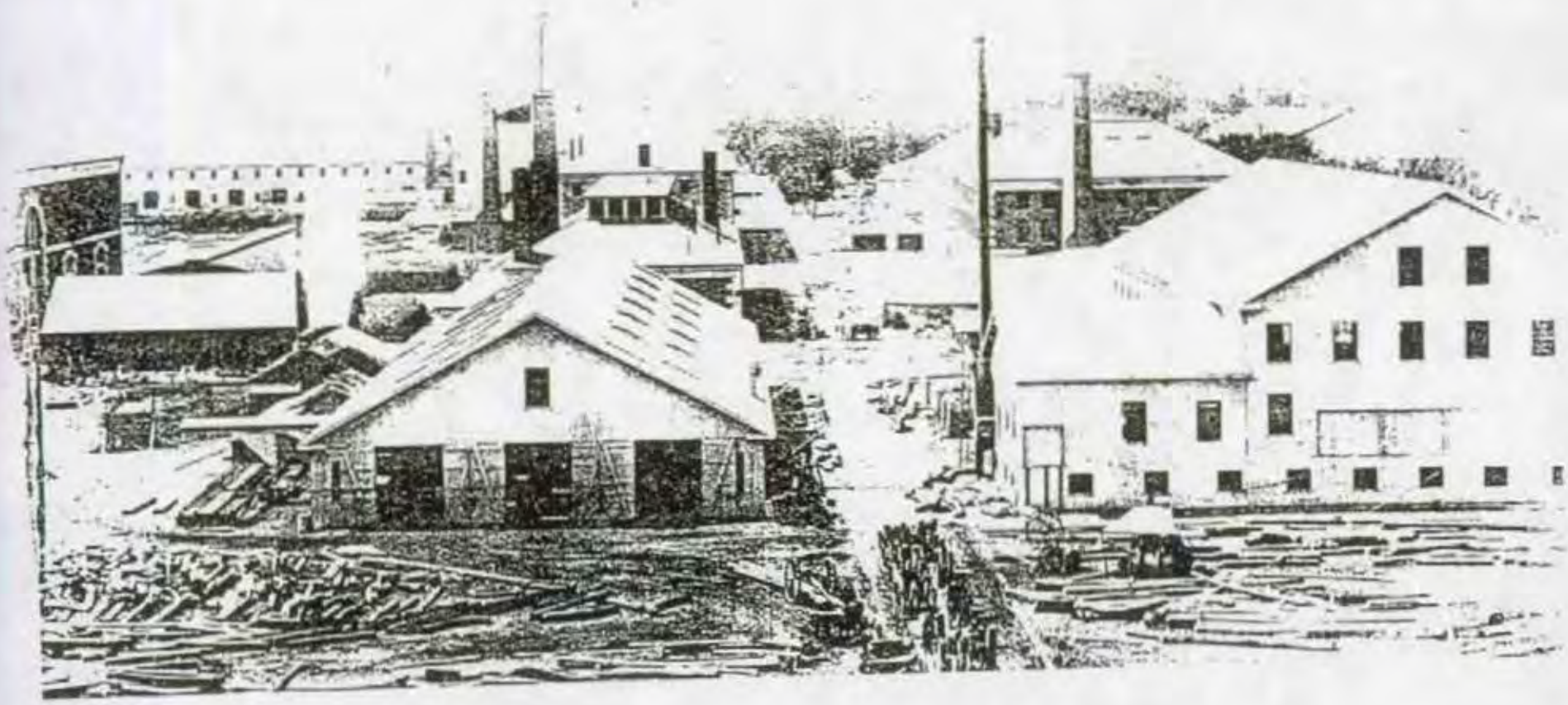
1860-65: Unknown location, dirt road

Boston Navy Yard

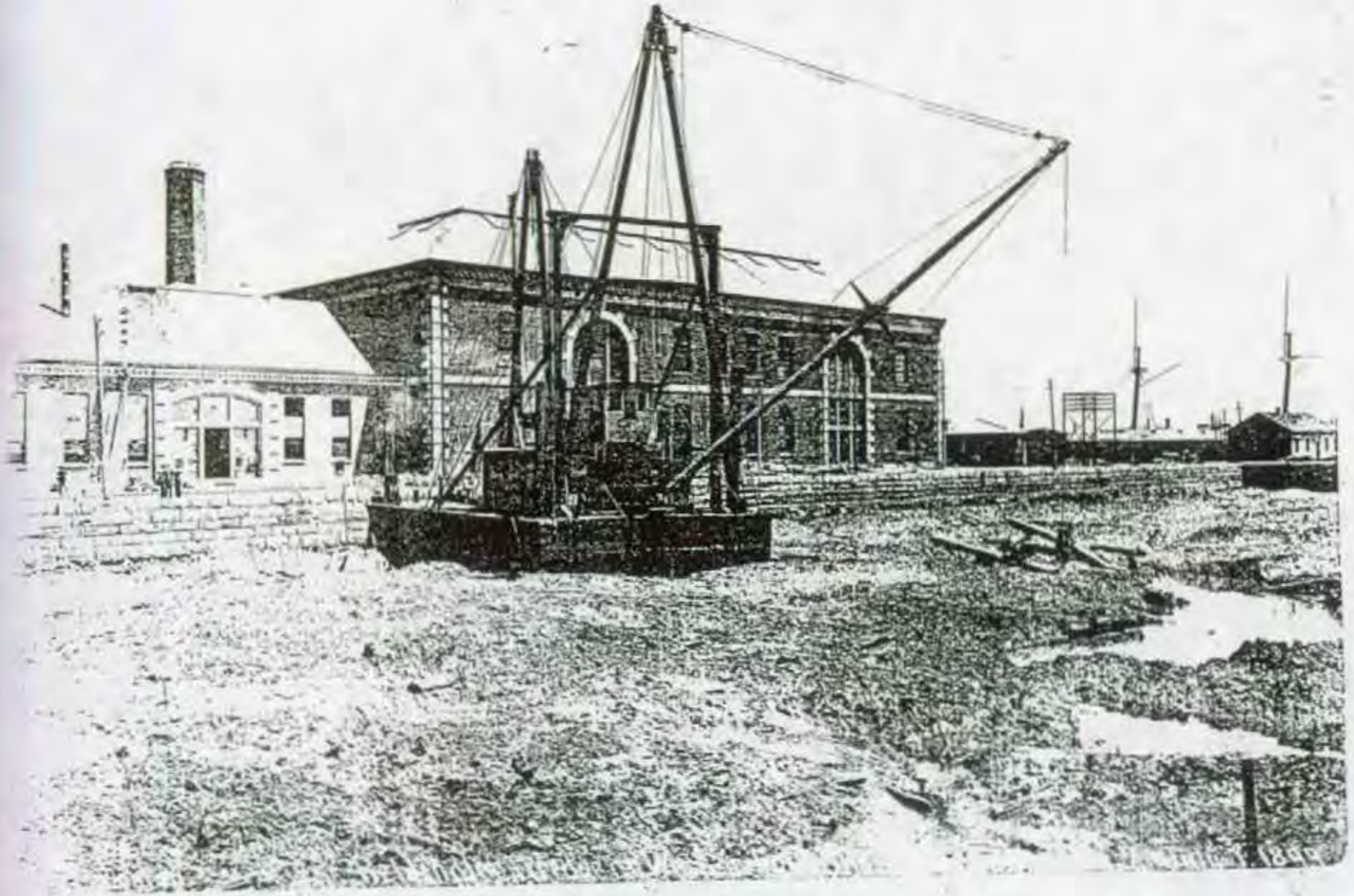




1860-65: Unknown location, dirt road



1876: View from the top of the lower Ship House, dirt roads



1899: East Shallow Basin, dirt road



1901: Lincoln Avenue at Building #3, brick road



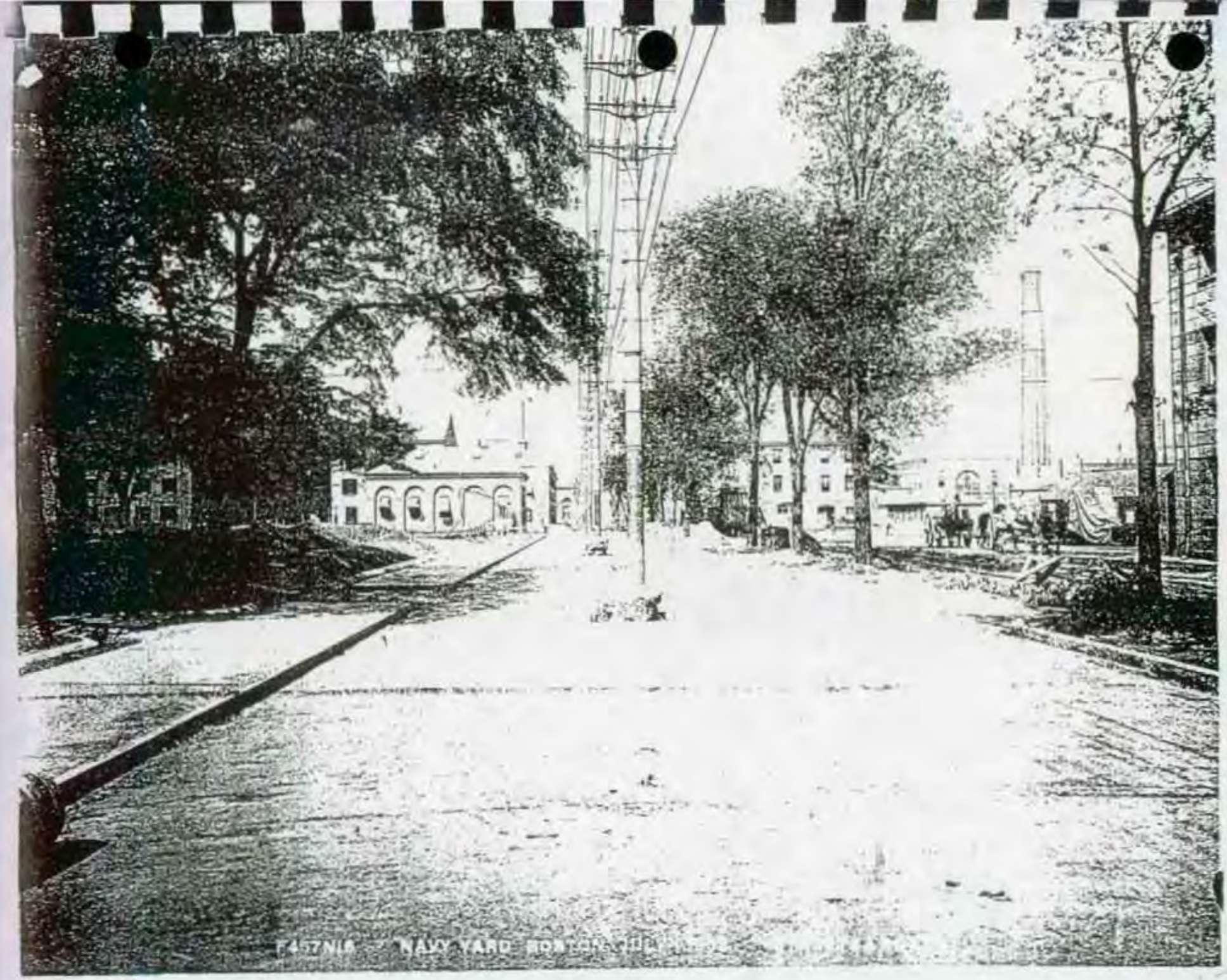
1902: First Avenue, dirt road and granite curbing



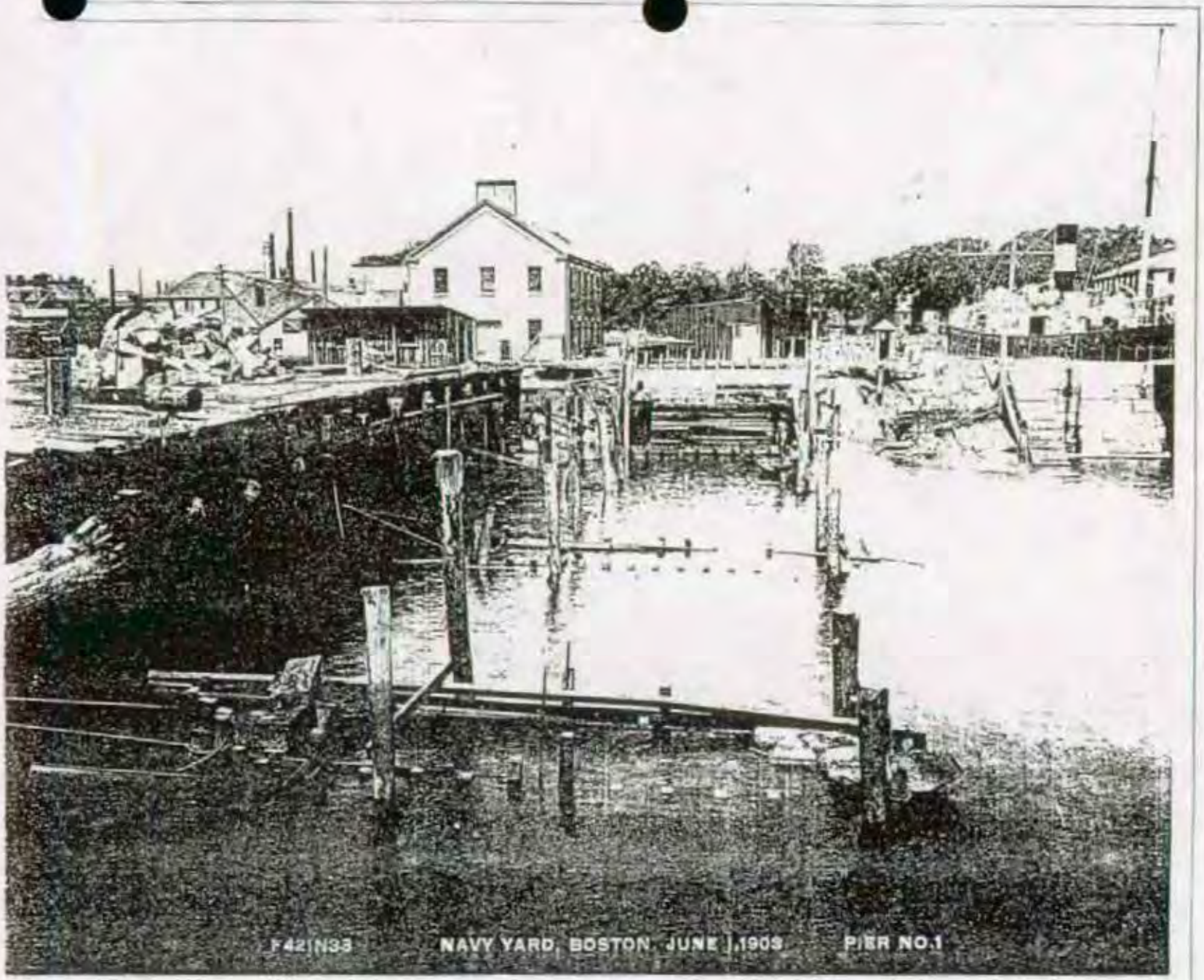
1902: Sixth Street, dirt road and train track with wood plank



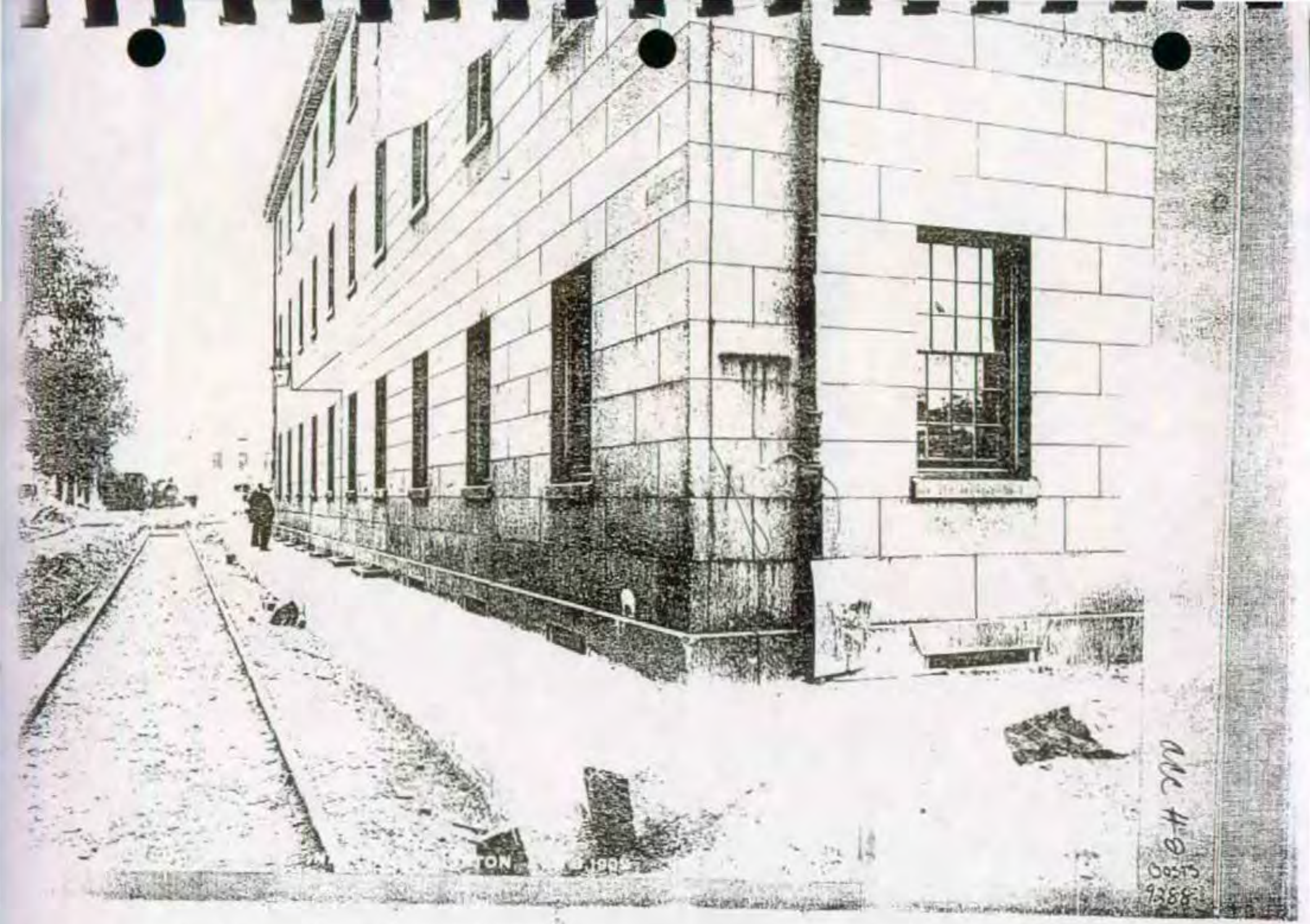
1902: View of First Avenue and Fourth Street. large granite block road



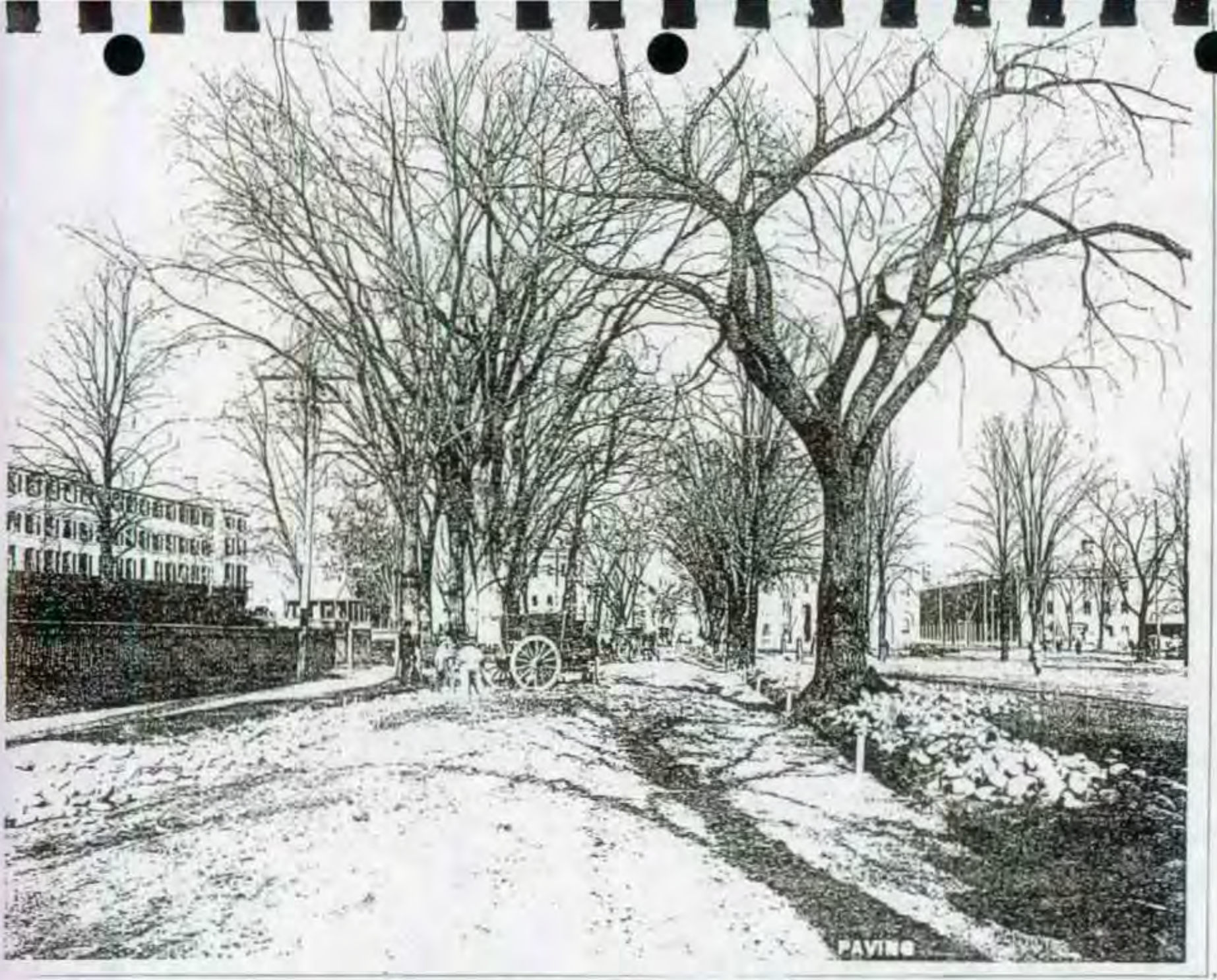
1903; West Fourth Street looking North East, brick road and granolithic sidewalk



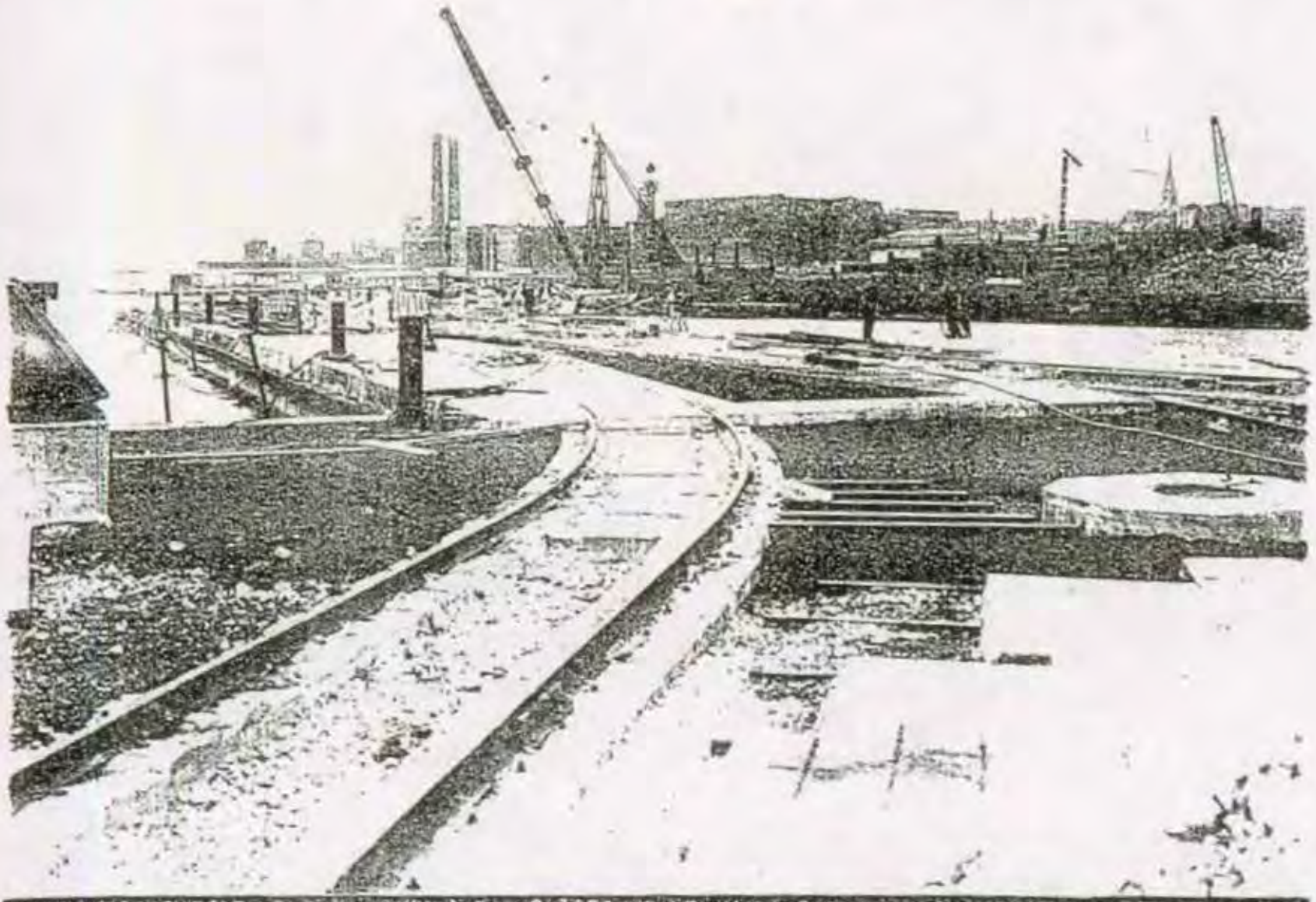
1903: Pier One, wood plank



1903: First Avenue, dirt road and granolithic sidewalk with granite curbing

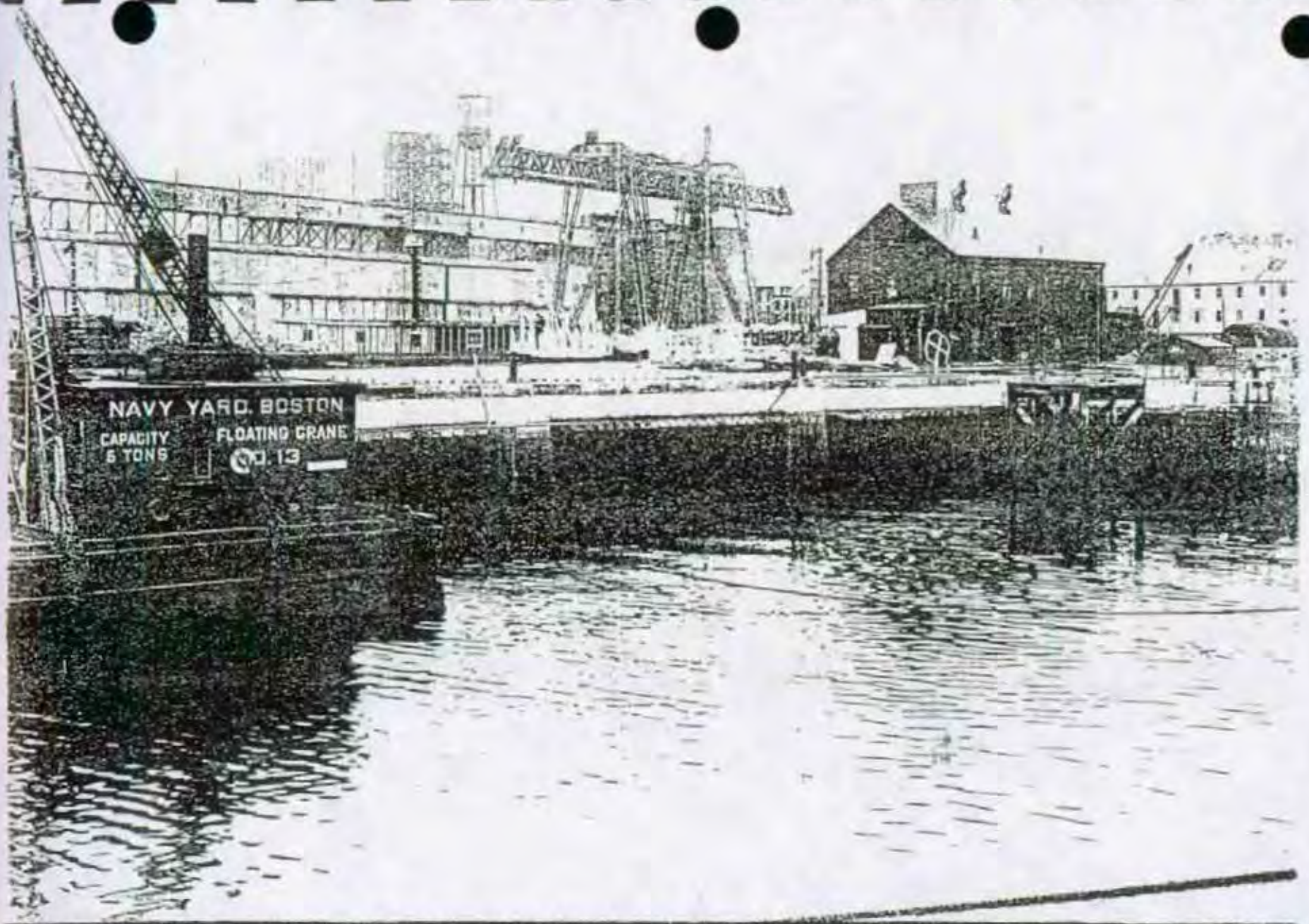


1904. Second Avenue by the Marine Barracks, dirt road with cobble stone



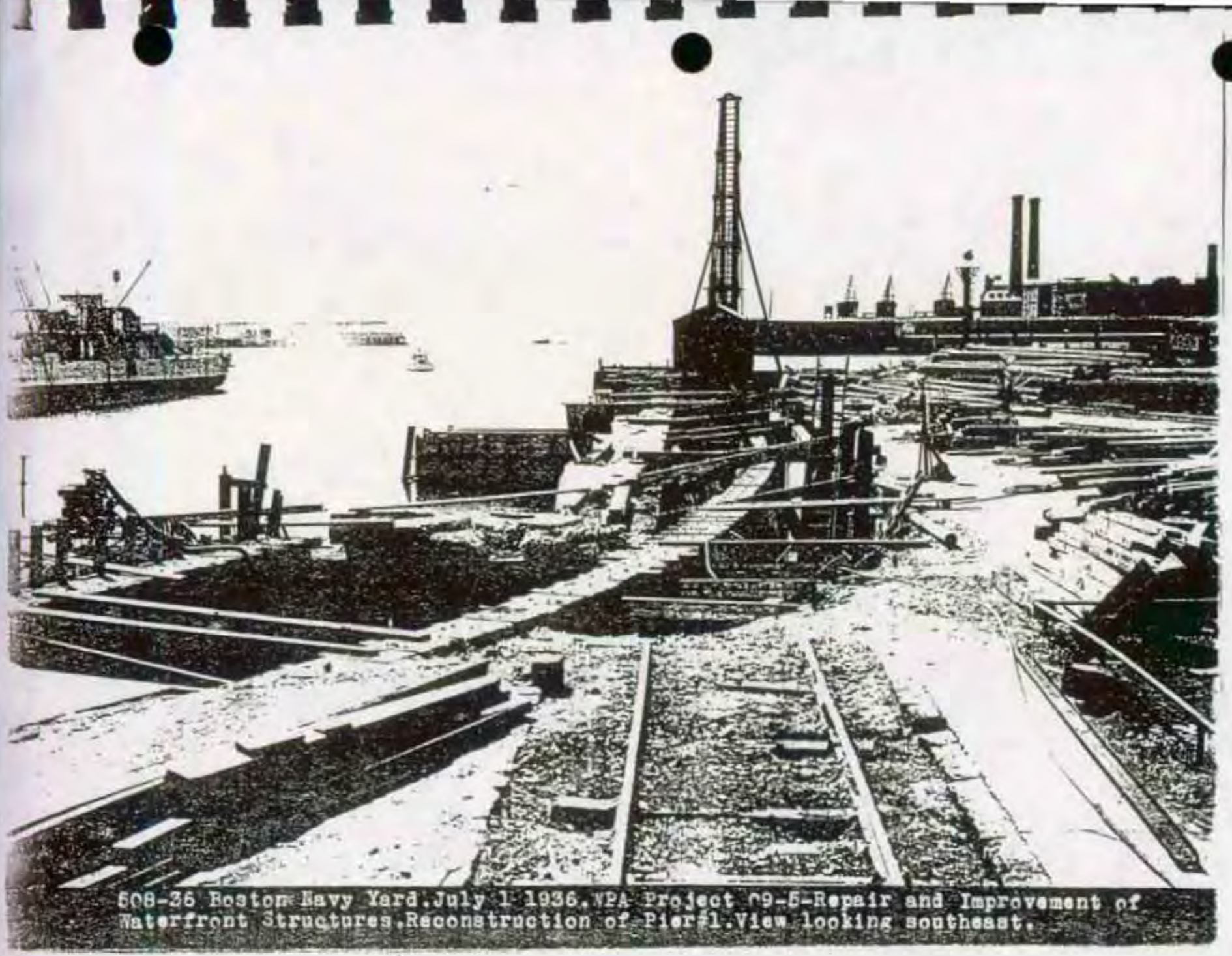
1002-36 Boston Navy Yard, Dec 8 1936. WPA Project 209-B006-Repair and improvement and extension of miscellaneous property including waterfront structures. Reconstruction of Pier #1, inshore end, view looking south.

1936: Pier One



824-36 Boston Navy Yard.Oct.7 1936.WPA Project 209-8006-Repair,improvement and extension of miscellaneous property including waterfront structures.Reconstruction of Pier #1. View looking west

1936: Pier One



1936: Pier One



Navy Yard, Boston, Mass. May 19 1936. WPA Project #09-06 - Repair and Improvement of Waterfront structures. Reconstruction of Pier #1. Looking southeast.

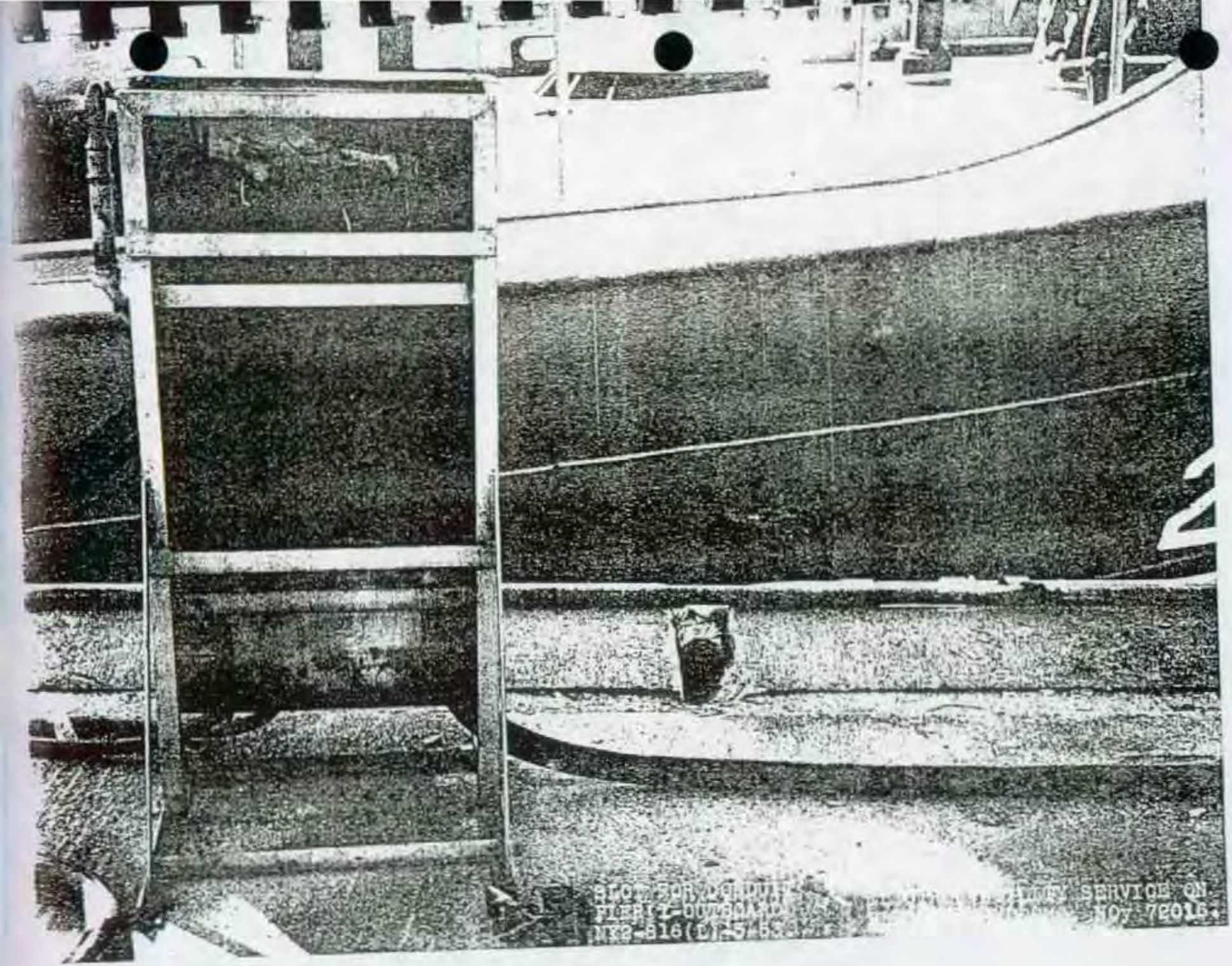
1936: Pier One



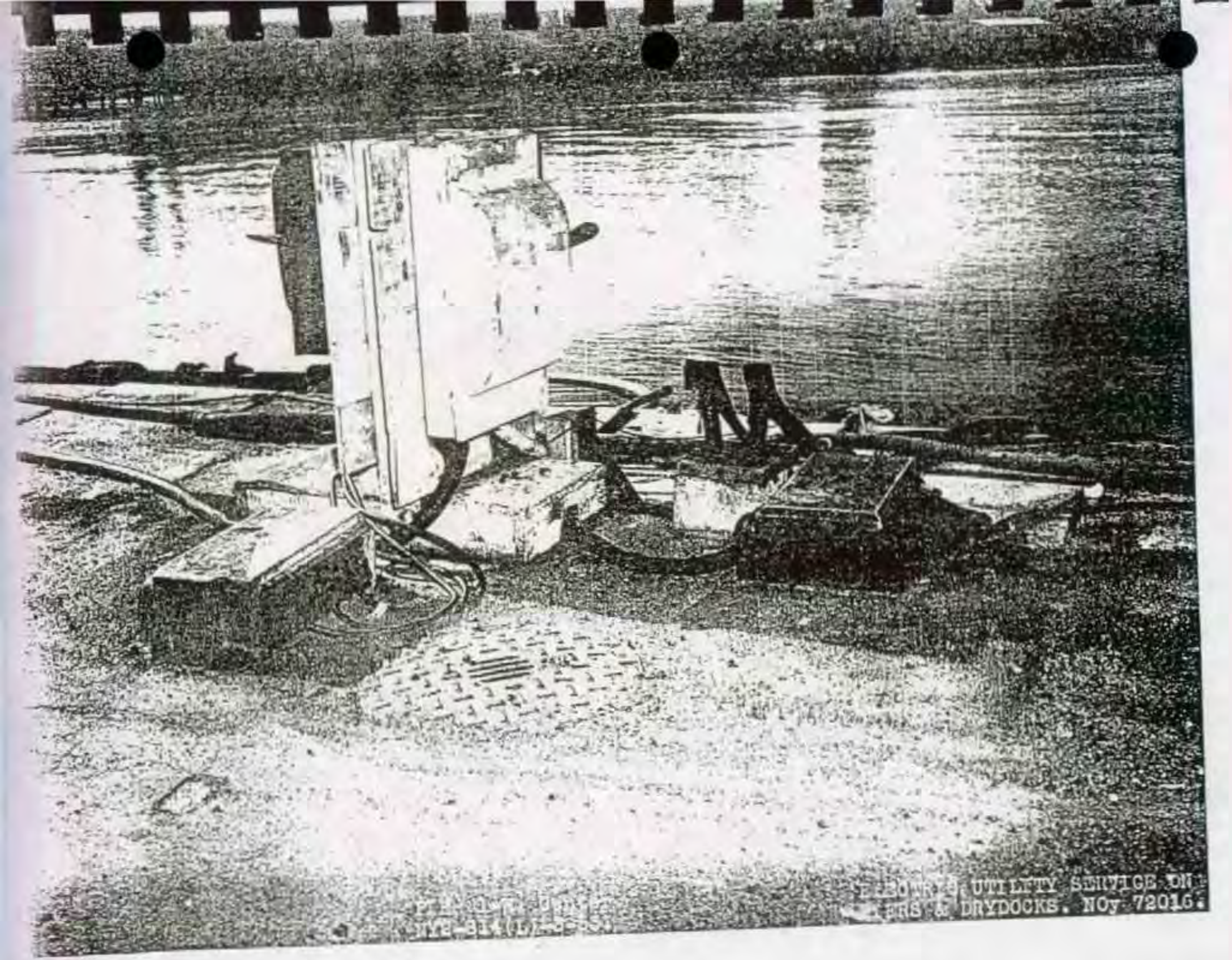
1905: 1936-40. Pier One, dirt road with stone block



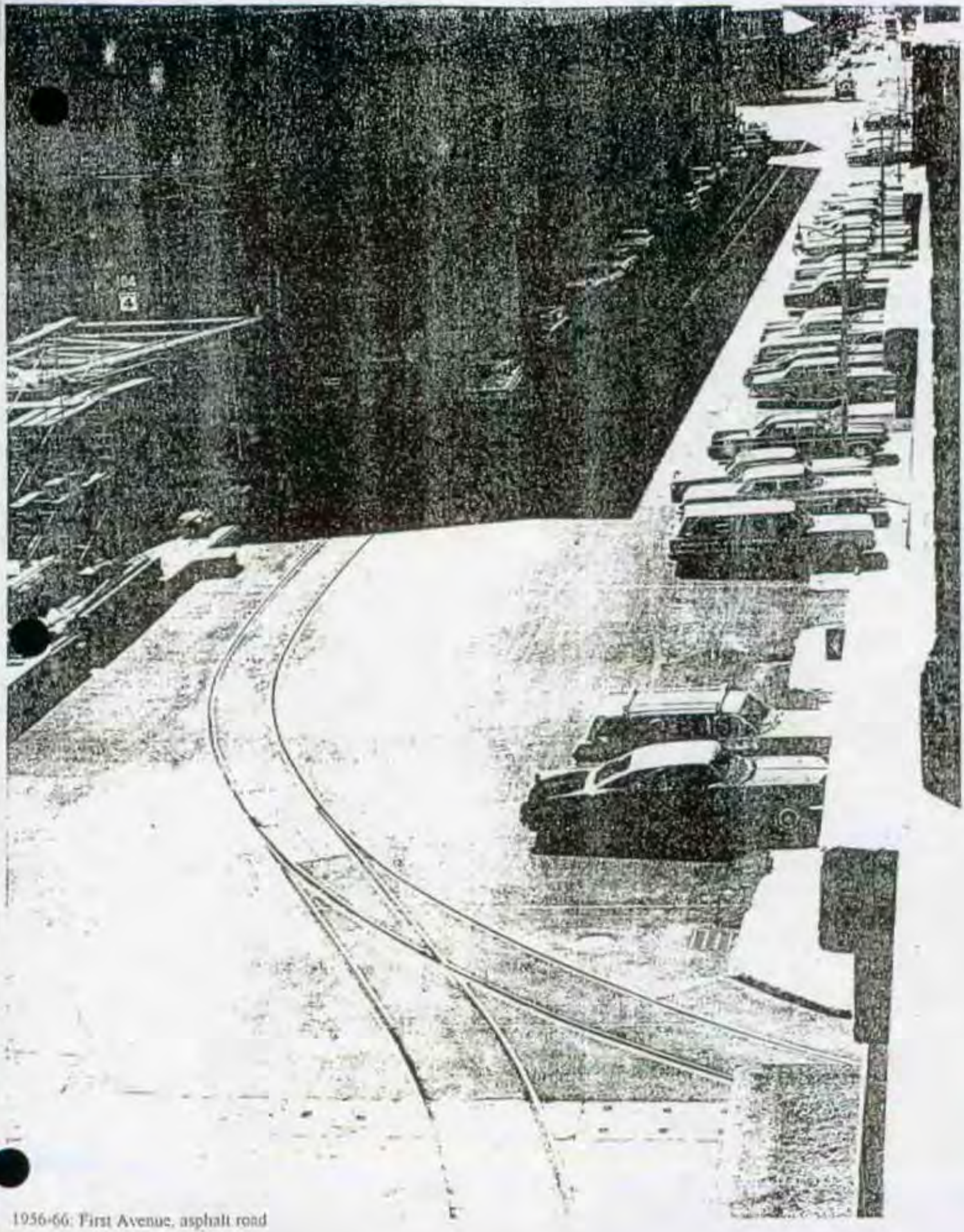
1937: Pier One, concrete



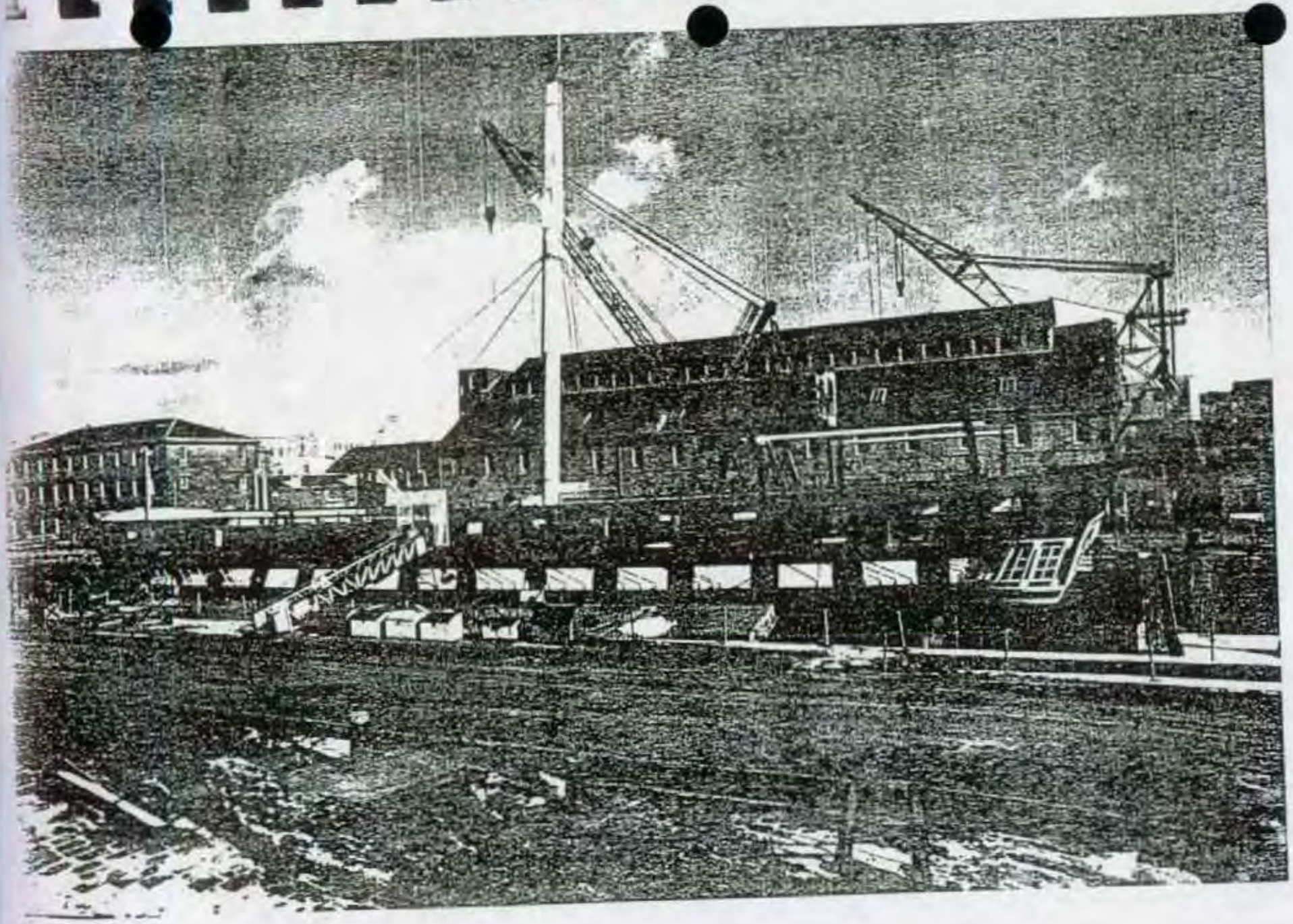
1953: Pier One, granite block



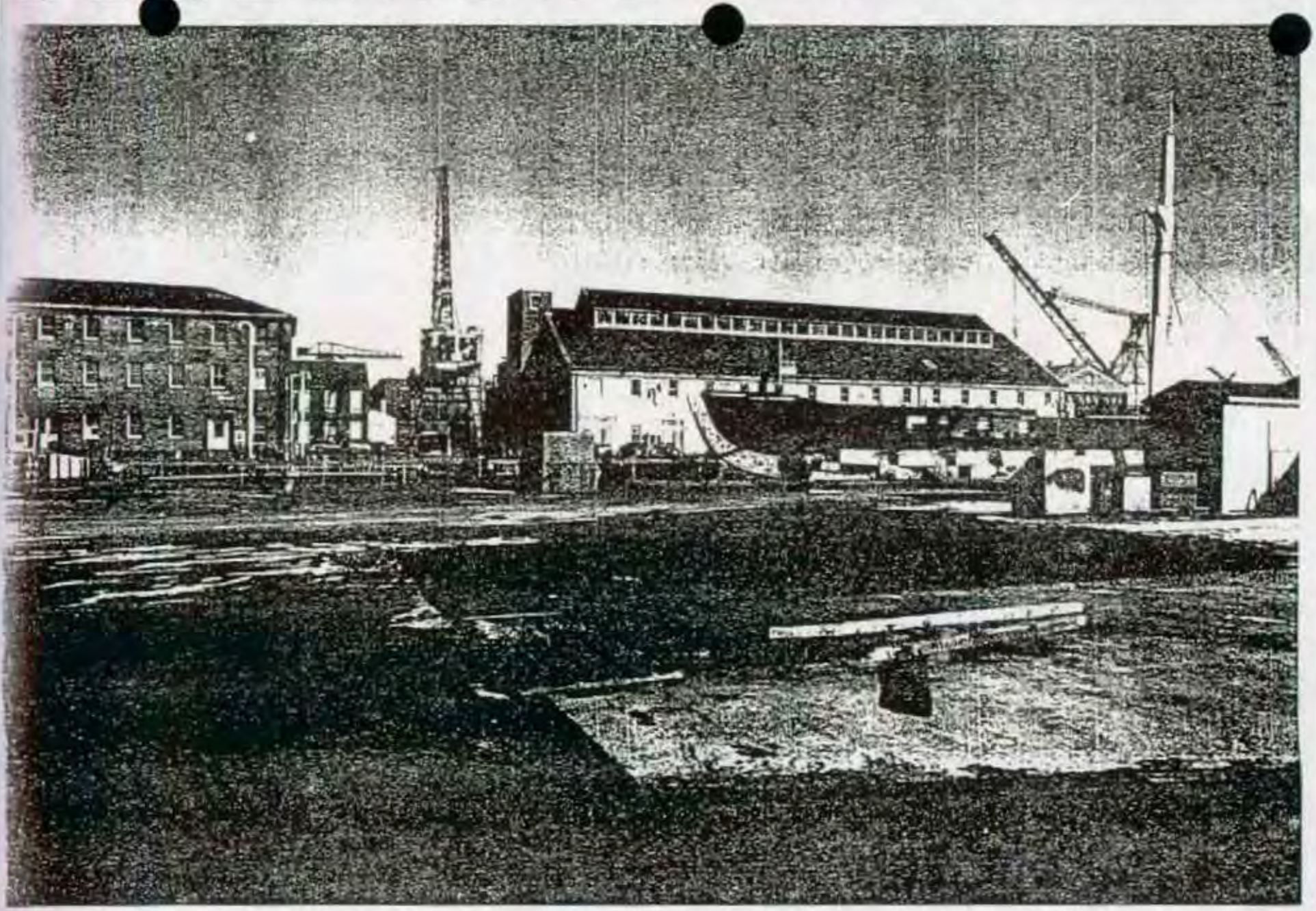
1953: Pier One, asphalt



1956+66: First Avenue, asphalt road



1974: Pier One looking West



1974: Pier One looking North East

Appendix E: American with Disabilities Act Manual Exerts

4.4 Protruding Objects

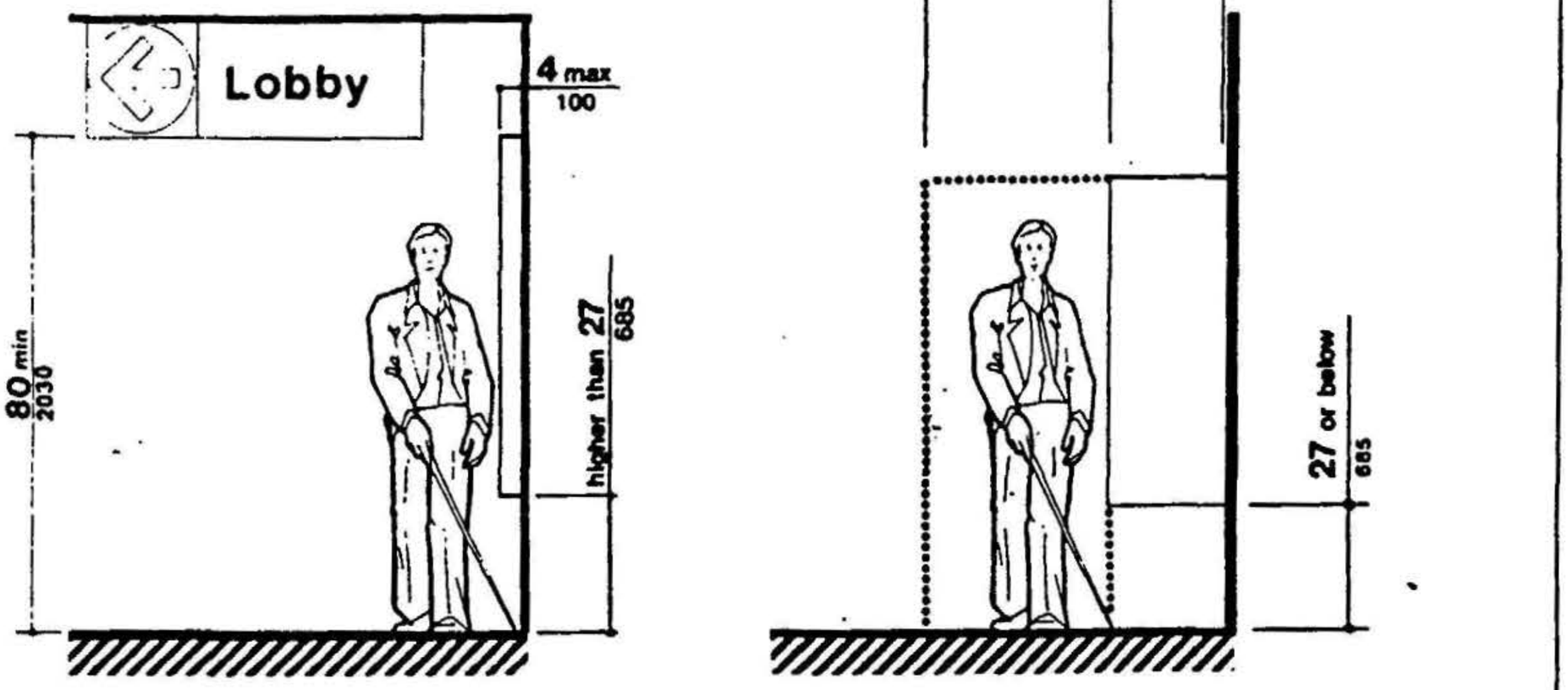


Fig. 8 (a)
Walking Parallel to a Wall

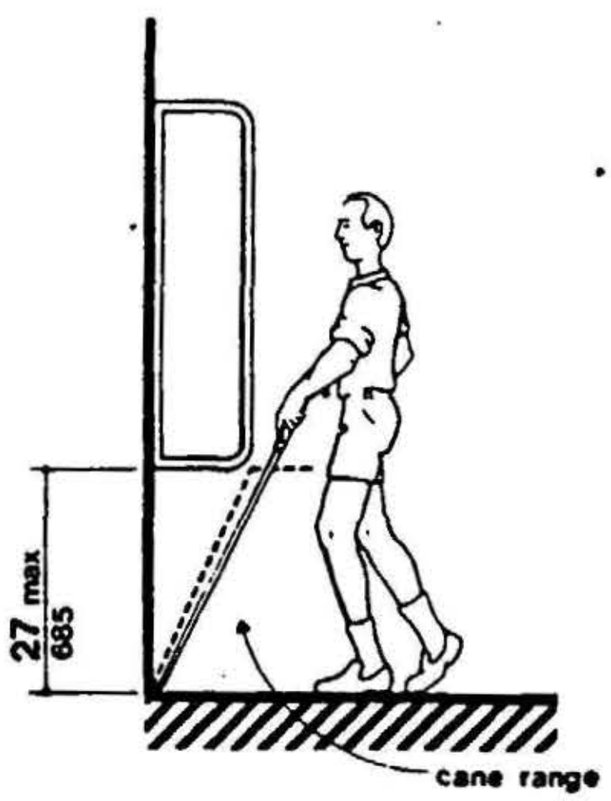


Fig. 8 (b)
Walking Perpendicular to a Wall

Fig. 8
Protruding Objects

finished floor (see Fig. 8(c) and (d)). Protruding objects shall not reduce the clear width of an accessible route or maneuvering space (see Fig. 8(e)).

4.4.2 Head Room. Walks, halls, corridors, passageways, aisles, or other circulation spaces shall have 80 in (2030 mm) minimum clear head room (see Fig. 8(a)). *If vertical clearance of an area adjoining an accessible route is reduced to less than 80 in (nominal dimension), a barrier to warn blind or visually-impaired persons shall be provided (see Fig. 8(c-1)).*

4.5 Ground and Floor Surfaces.

4.5.1* General. Ground and floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs, and curb ramps, shall be stable, firm, slip-resistant, and shall comply with 4.5.

4.5.2 Changes in Level. Changes in level up to 1/4 in (6 mm) may be vertical and without edge treatment *(see Fig. 7(c))*. Changes in level between 1/4 in and 1/2 in (6 mm and 13 mm)

4.5 Ground and Floor Surfaces

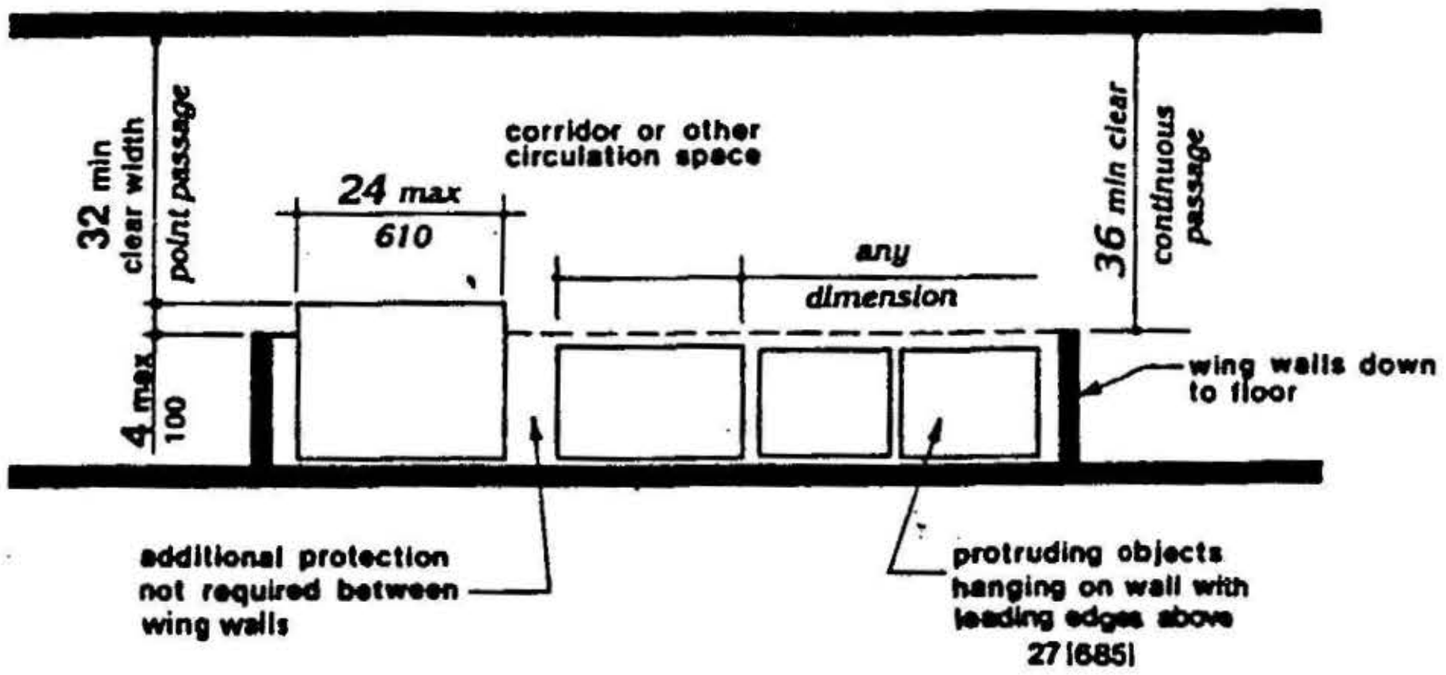


Fig. 8 (e)
Example of Protection around Wall-Mounted Objects and Measurements of Clear Widths

Fig. 8
Protruding Objects *(Continued)*

shall be beveled with a slope no greater than 1:2 *(see Fig. 7(d))*. Changes in level greater than 1/2 in (13 mm) shall be accomplished by means of a ramp that complies with 4.7 or 4.8.

4.5.3* Carpet. If carpet or carpet tile is used on a ground or floor surface, then it shall be securely attached; have a firm cushion, pad, or backing, or no cushion or pad; and have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. The maximum pile *thickness* shall be 1/2 in (13 mm) (see Fig. 8(f)). Exposed edges of carpet shall be fastened to floor surfaces and have trim along the entire length of the exposed edge. Carpet edge trim shall comply with 4.5.2.

4.5.4 Gratings. If gratings are located in walking surfaces, then they shall have spaces no greater than 1/2 in (13 mm) wide in one direction *(see Fig. 8(g))*. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel *(see Fig. 8(h))*.

4.6 Parking and Passenger Loading Zones.

4.6.1 Minimum Number. *Parking spaces required to be accessible by 4.1 shall comply with 4.6.2 through 4.6.5. Passenger loading zones required to be accessible by 4.1 shall comply with 4.6.5 and 4.6.6.*

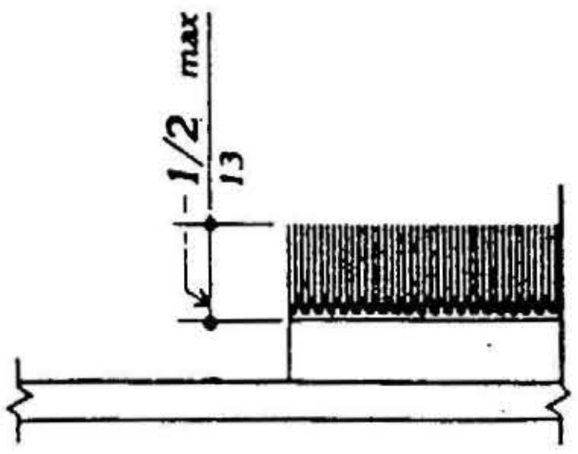


Fig. 8 (f)
Carpet Pile Thickness

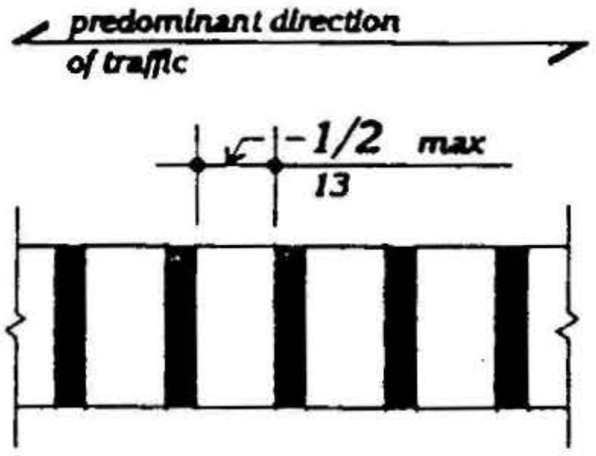


Fig. 8 (g)
Gratings

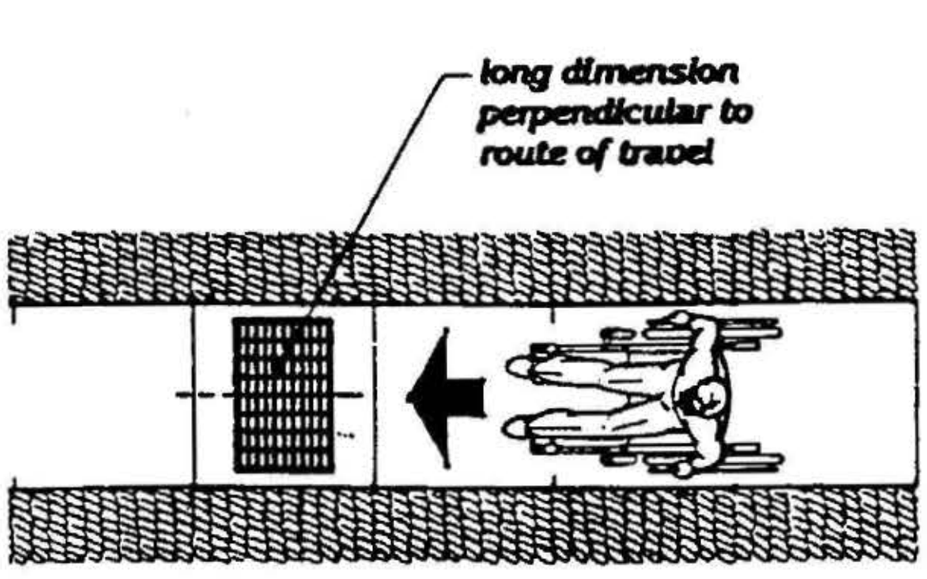


Fig. 8 (h)
Grating Orientation

4.6.2 Location. *Accessible parking spaces serving* a particular building shall be located on the shortest accessible route of travel *from adjacent parking* to an accessible entrance. *In parking facilities* that do not serve a particular building, *accessible parking* shall be located on the shortest accessible route *of travel* to an accessible pedestrian entrance of the parking facility. *In buildings with multiple accessible entrances with adjacent parking, accessible parking spaces shall be dispersed and located closest to the accessible entrances.*

4.6.3* Parking Spaces. *Accessible* parking spaces shall be at least 96 in (2440 mm) wide. Parking access aisles shall be part of an accessible route to the building or facility entrance and shall comply with 4.3. Two accessible parking spaces may share a common access aisle (see Fig. 9). Parked vehicle overhangs shall not reduce the clear width of an accessible route. *Parking spaces and access aisles shall be level with surface slopes not exceeding 1:50 (2%) in all directions.*

4.6.4* Signage. Accessible parking spaces shall be designated as reserved by a sign showing the symbol of accessibility (see 4.30.7). *Spaces complying with 4.1.2(5)(b) shall have an additional sign "Van-Accessible" mounted below the symbol of accessibility.* Such signs shall be *located so they cannot* be obscured by a vehicle parked in the space.

4.6.5* *Vertical Clearance.* *Provide minimum vertical clearance of 114 in (2895 mm) at accessible passenger loading zones and along at least one vehicle access route to such areas from site entrance(s) and exit(s). At parking spaces complying with 4.1.2(5)(b), provide minimum vertical clearance of 98 in (2490 mm) at the parking space and along at least one vehicle access route to such spaces from site entrance(s) and exit(s).*

4.6.6 Passenger Loading Zones. Passenger loading zones shall provide an access aisle at least 60 in *(1525 mm)* wide and 20 ft *(240 in) (6100 mm)* long adjacent and parallel to the vehicle pull-up space (see Fig. 10). If there are curbs between the access aisle and the vehicle pull-up space, then a curb ramp complying with 4.7 shall be provided. *Vehicle standing spaces and access aisles shall be level with*

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4.7 Curb Ramps

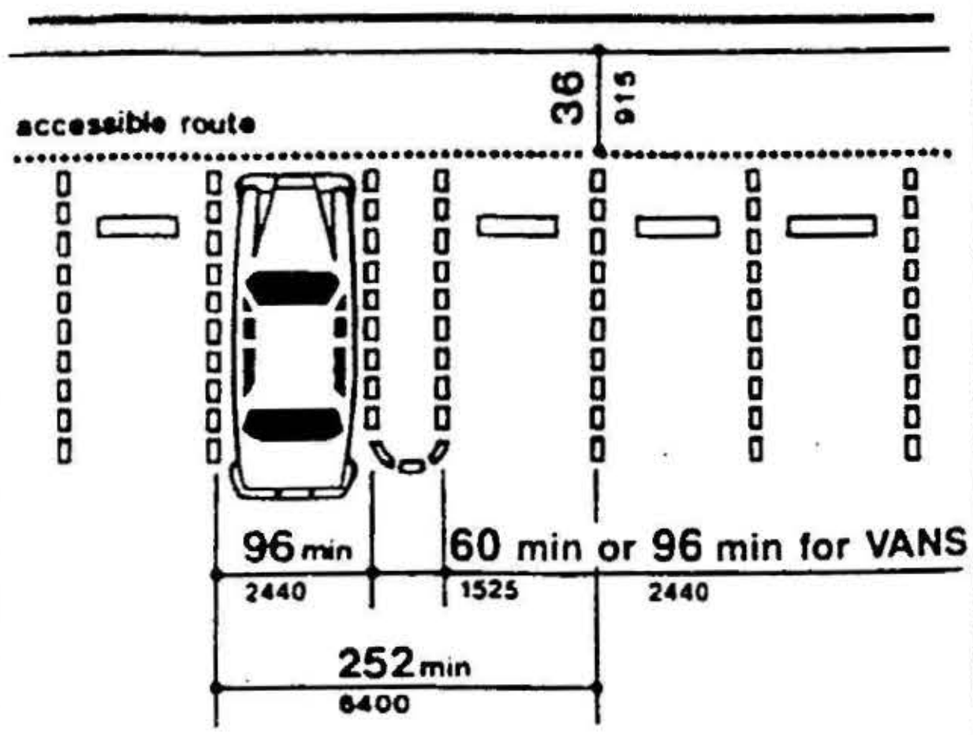


Fig. 9
Dimensions of Parking Spaces

surface slopes not exceeding 1:50 (2%) in all directions.

4.7 Curb Ramps.

4.7.1 Location. Curb ramps complying with 4.7 shall be provided wherever an accessible route crosses a curb.

4.7.2 Slope. Slopes of curb ramps shall comply with 4.8.2. The slope shall be measured as shown in Fig. 11. *Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes. Maximum slopes of adjoining gutters, road surface immediately adjacent to the curb ramp, or accessible route shall not exceed 1:20.*

4.7.3 Width. The minimum width of a curb ramp shall be 36 in (915 mm), exclusive of flared sides.

4.7.4 Surface. Surfaces of curb ramps shall comply with 4.5.

4.7.5 Sides of Curb Ramps. If a curb ramp is located where pedestrians must walk across the ramp, *or where it is not protected by handrails or guardrails*, it shall have flared sides; the maximum slope of the flare shall be 1:10 (see Fig. 12(a)). Curb ramps with returned curbs may be used where pedestrians would not normally walk across the ramp (see Fig. 12(b)).

4.7.6 Built-up Curb Ramps. Built-up curb ramps shall be located so that they do not project into vehicular traffic lanes (see Fig. 13).

4.7.7 *Detectable Warnings.* A curb ramp shall have a *detectable* warning complying with 4.29.2. *The detectable warning shall extend* the full width and depth of the curb ramp.

[Suspended until July 26, 1996 (59 FR 17442)]

4.7.8 Obstructions. Curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

4.7.9 Location at Marked Crossings. Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides (see Fig. 15).

4.7.10 Diagonal Curb Ramps. If diagonal (or corner type) curb ramps have returned curbs or other well-defined edges, such edges shall be parallel to the direction of pedestrian flow. The bottom of diagonal curb ramps shall have 48 in (1220 mm) minimum clear space as shown in Fig. 15(c) and (d). If diagonal curb ramps are provided at marked crossings, the 48 in (1220 mm) clear space shall be within the markings (see Fig. 15(c) and (d)). If diagonal curb ramps have flared sides, they shall also have at least a 24 in (610 mm) long segment of straight curb located on each side of the curb ramp and within the marked crossing (see Fig. 15(c)).

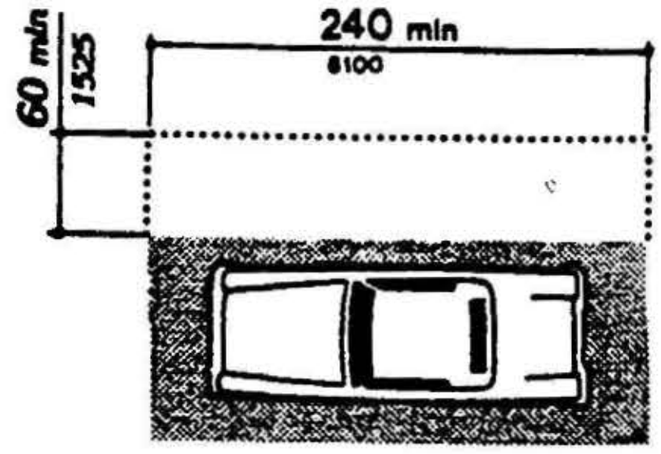


Fig. 10
Access Aisle at Passenger Loading Zones

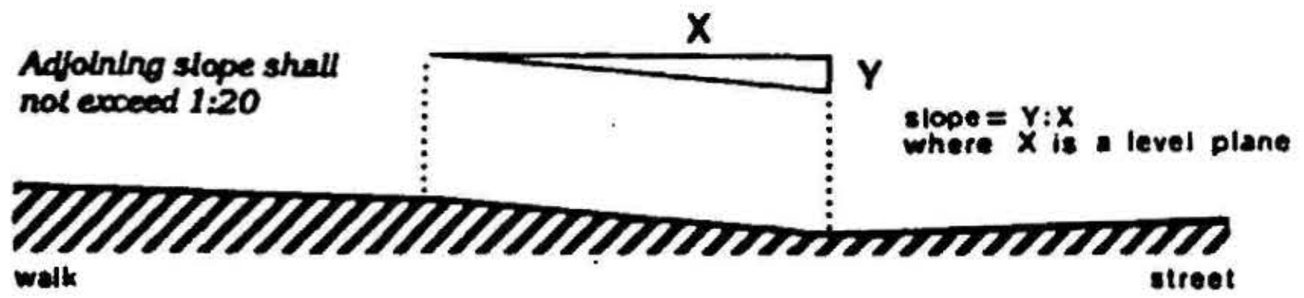
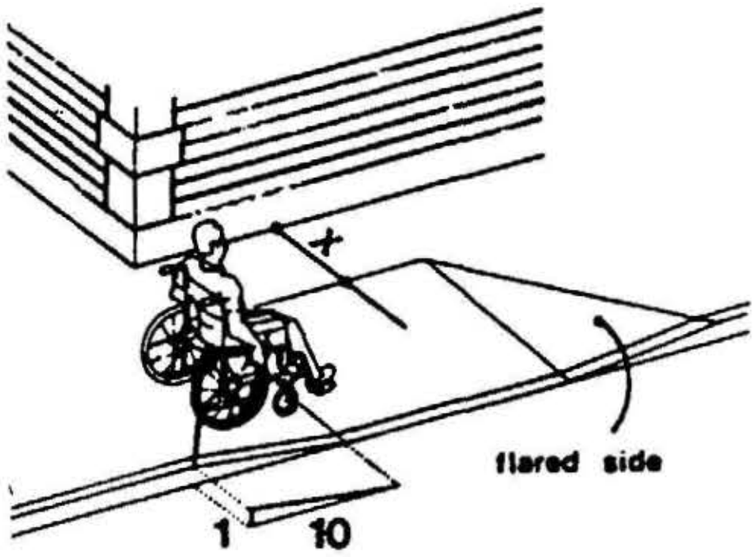
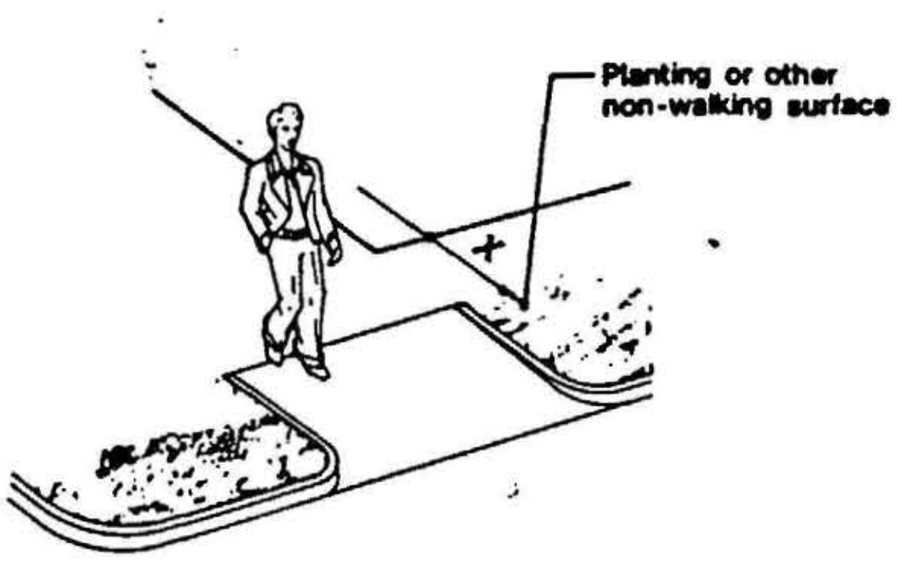


Fig. 11
Measurement of Curb Ramp Slopes



(a)
Flared Sides

If X is less than 48 in, then the slope of the flared side shall not exceed 1:12.



(b)
Returned Curb

Fig. 12
Sides of Curb Ramps

4.7.11 Islands. Any raised islands in crossings shall be cut through level with the street or have curb ramps at both sides and a level area at least 48 in (1220 mm) long between the curb ramps in the part of the island intersected by the crossings (see Fig. 15(a) and (b)).

4.8 Ramps.

4.8.1* General. Any part of an accessible route with a slope greater than 1:20 shall be considered a ramp and shall comply with 4.8.

4.8.2* Slope and Rise. The least possible slope shall be used for any ramp. The maximum slope of a ramp in new construction shall be 1:12. The maximum rise for any run shall be 30 in (760 mm) (see Fig. 16). Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as *allowed in 4.1.6(3)(a)* if space limitations prohibit the use of a 1:12 slope or less.

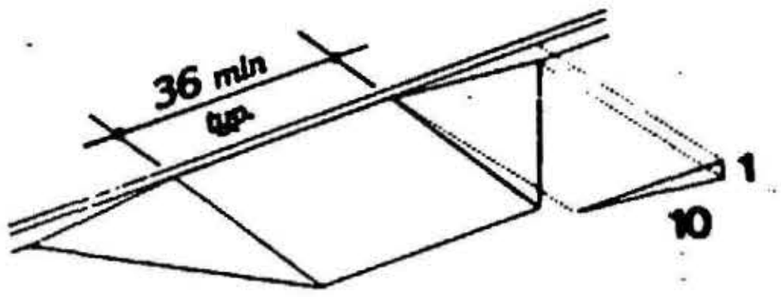


Fig. 13
Built-Up Curb Ramp

4.8 Ramps

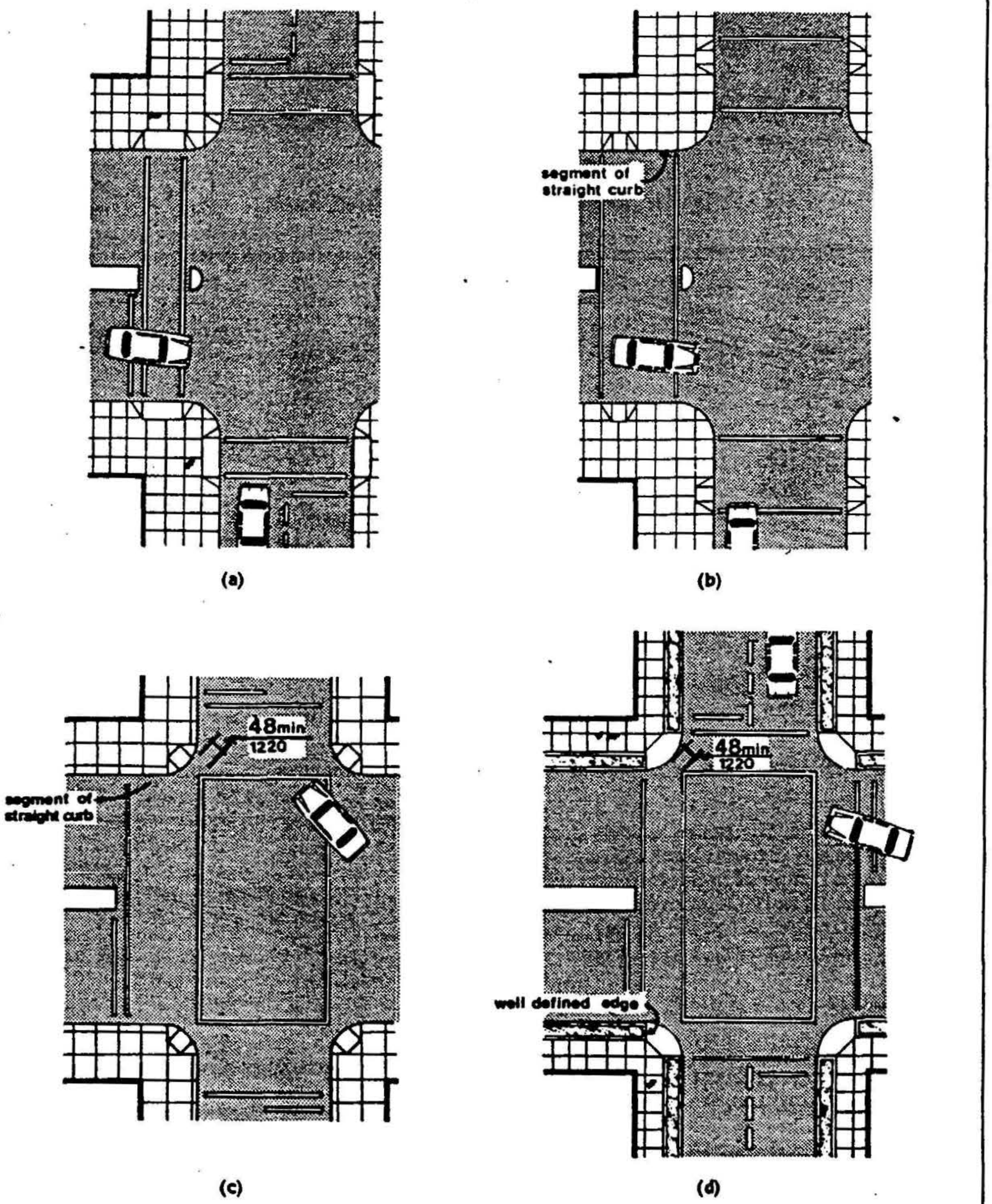
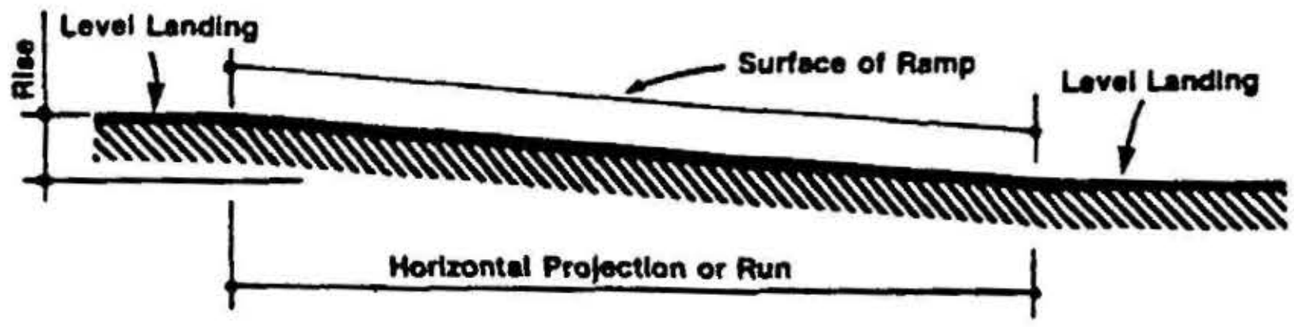


Fig. 15
Curb Ramps at Marked Crossings



Slope	Maximum Rise in	Maximum Rise mm	Maximum Horizontal Projection ft	Maximum Horizontal Projection m
1:12 to < 1:16	30	760	30	9
1:16 to < 1:20	30	760	40	12

Fig. 16
Components of a Single Ramp Run and Sample Ramp Dimensions

4.8.3 Clear Width. The minimum clear width of a ramp shall be 36 in (915 mm).

4.8.4* Landings. Ramps shall have level landings at bottom and top of *each ramp and* each *ramp* run. Landings shall have the following features:

(1) The landing shall be at least as wide as the ramp run leading to it.

(2) The landing length shall be a minimum of 60 in (1525 mm) clear.

(3) If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

(4) If a doorway is located at a landing, then the area in front of the doorway shall comply with 4.13.6.

4.8.5* Handrails. If a ramp run has a rise greater than 6 in (150 mm) or a horizontal projection greater than 72 in (1830 mm), then it shall have handrails on both sides. Handrails are not required on curb ramps *or adjacent to seating in assembly areas*. Handrails shall comply with 4.26 and shall have the following features:

(1) Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall always be continuous.

(2) If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface (see Fig. 17).

(3) The clear space between the handrail and the wall shall be 1 - 1/2 in (38 mm).

(4) Gripping surfaces shall be continuous.

(5) Top of handrail gripping surfaces shall be mounted between 34 in and 38 in (865 mm and 965 mm) above ramp surfaces.

(6) Ends of handrails shall be either rounded or returned smoothly to floor, wall, or post.

(7) Handrails shall not rotate within their fittings.

4.8.6 Cross Slope and Surfaces. The cross slope of ramp surfaces shall be no greater than 1:50. Ramp surfaces shall comply with 4.5.

Appendix F: Cost Estimates

Federal Highway Administration Cost Estimate

COST ESTIMATE

ROUTE 10 - FIRST AVENUE

A. Removal of asphalt pavement
(43,800sf) x (1sy/9sf) x ($3.50/sy) = $17,033

B. Aggregate base, 8" depth
(43,800sf) x (8" depth) x (1ft/12") = 29,200cf
(29,200cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton) = $42,340

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(43,800sf) x (4" depth) x (1ft/12") = 14,600cf
(14,600cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $54,750

D. Pavement markings
(500lf) x ($0.45/lf) = $225

E. Removal of existing concrete curb, length assumed
(100lf) x ($4.50/lf) = $450

F. Place granite curb, length assumed
(100lf) x ($50.00/lf) = $5,000

G. Drainage
(7 inlets) x ($1,600.00/inlet) = $11,200

H. Manhole Adjustment
(4 inlets) x ($1,600.00/inlet) = $6,400

I. Signs
(2 signs) x (4sf/sign) x ($27/sf) = $216

Subtotal = $137,614
Add 35% for construction incidentals = $48,165
Add 30% for Planning, Administration,
and Construction Supervision = $41,284

Total = $227,063

Estimated Cost = $230,000

COST ESTIMATE

ROUTE 11 - LINCOLN AVENUE/PIER 1

A. Removal of asphalt pavement
(266,000sf) x (1sy/9sf) x ($3.50/sy) = $103,444

B. Removal of concrete pavement between crane rails
(1,000ft) x (20ft) x (1sy/9sf) x ($6.50/sy) = $14,444

C. Regrade base
(266,000sf) x (1sy/9sf) x ($5.00/sy) = $147,778

D. Aggregate base, 8" depth
(266,000sf) x (8" depth) x (1ft/12") = 177,333cf
(177,333cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton) = $257,133

E. Pavement, 4" hot asphaltic concrete pavement (HACP)
(246,000sf) x (4" depth) x (1ft/12") = 82,000cf
(82,000cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $307,500

F. Concrete pavement between crane rails
(1,000ft) x (20ft) x (1sy/9sf) x ($40.00/sy) = $88,889

G. Crane rails safety adjustment, concrete
(2,000ft) x ($17.50/ft) = $35,000

H. Crane rails safety adjustment, wood
(4,000ft) x (12"/ft) x (3"x2") = 288,000 in^3
(288,000in^3) x (1 board ft/144 in^3) = 2,000bf
(2,000bf) x (1 mfbm/1,000bf) x ($1,400/mfbm) = $2,800

I. Pavement markings
(2,700lf) x ($0.45/lf) = $1,215

J. Pavement symbols
(4 Handicap parking symbols) x ($25.00/ea) = $200

K. Reset granite curb, length assumed
(100lf) x ($35.00/lf) = $3,500

(Continued)

total	=	$961,903
Add 35% for construction incidentals	+	$336,666
Add 30% for Planning, Administration, and Construction Supervision	+	$288,571
Total	=	$1,587,140

Estimated Cost = $1,600,000

COST ESTIMATE

ROUTE 12 - SECOND AVENUE

A. Removal of asphalt pavement
(40,000sf) x (1sy/9sf) x ($3.50/sy) = $15,556

B. Regrade base
(40,000sf) x (1sy/9sf) x ($5.00/sy) = $22,222

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(40,000sf) x (4" depth) x (1ft/12") = 13,333cf
(13,333cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $50,000

D. Pavement markings
(1,600lf) x ($0.45/lf) = $720

Subtotal	=	$88,498
Add 35% for construction incidentals	+	$30,974
Add 30% for Planning, Administration, and Construction Supervision	+	$26,594
Total	=	$146,021

Estimated Cost = $150,000

COST ESTIMATE

ROUTE 100 - FOURTH STREET

A. Removal of asphalt pavement overlay
(2 loader hrs.) x ($75.00/loader hr.) = $150

B. Removal of existing wood pavement structure, assumed area
(1,350sf) x ($3.00/sf) = $4,050

C. Removal of existing brick pavement structure
(3 loader hrs.) x ($75.00/loader hr.) = $225

D. Removal of existing concrete pavement structure
(2,700sf) x (1sy/9sf) x ($6.50/sy) = $1,950

E. Removal of existing base
(2,700sf) x (1sy/9sf) x ($1.50/sy) = $450

F. Aggregate base, 8" depth
(2,700sf) x (8" depth) x (1ft/12") = 1,800cf
(1,800cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton) = $2,610

G. Reinforced concrete pavement
(2,700sf) x (1sy/9sf) x ($40.00/sy) = $12,000

H. Wood-on-end pavement structure
(2,700cf) x (1,728in^3/cf) x (1 board ft./144in^3) = 32,400bf
(32,400bf) x (1 mfbm/1000bf) x ($1,400.00/mfbm) = $45,360

Subtotal	=	$66,795
Add 35% for construction incidentals	+	$23,378
Add 30% for Planning, Administration, and Construction Supervision	+	$20,038
Total	=	$110,211

Estimated Cost = $110,000

COST ESTIMATE

ROUTE 101 - THIRD STREET

A. Removal of asphalt pavement patch
(96sf) x (1sy/9sf) x ($3.50/sy) = $37

B. Removal of existing brick pavement structure
(5 loader hrs.) x ($75.00/loader hr.) = $375

C. Removal of existing concrete pavement structure
(3,500sf) x (1sy/9sf) x ($6.50/sy) = $2,528

D. Removal of existing base
(3,500sf) x (1sy/9sf) x ($1.50/sy) = $583

E. Aggregate base, 8" depth
(3,500sf) x (8" depth) x (1ft/12") = 2,333cf
(2,333cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton) = $3,383

F. Reinforced concrete pavement
(3,500sf) x (1sy/9sf) x ($40.00/sy) = $15,555

G. Brick pavement structure
(3,500sf) x (1sy/9sf) x ($100.00/sy) = $38,889

H. Removal of existing concrete curb, assumed length
(75ft) x ($4.50/ft) = $338

I. Place granite curb, assumed length
(75ft) x ($50.00/ft) = $3,750

Subtotal	= $65,438
Add 35% for construction incidentals	+ $22,903
Add 30% for Planning, Administration, and Construction Supervision	+ $19,631
Total	= $107,972

Estimated Cost = $110,000

COST ESTIMATE

ROUTE 400 - BAXTER AVENUE

A. Removal of asphalt pavement
(28,500sf) x (1sy/9sf) x ($3.50/sy) = $11,083

B. Regrade base
(28,500sf) x (1sy/9sf) x ($5.00/sy) = $15,833

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(28,500sf) x (4" depth) x (1ft/12") = 9,500cf
(9,500cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $35,625

D. Pavement markings
(3,300lf) x ($0.45/lf) = $1,485

E. Removal of existing chain link fence, assumed length
(700ft) x ($3.00/ft) = $2,100

F. Cast iron fence
(700ft) x ($30.00ft) = $21,000

Subtotal	=	$87,126
Add 35% for construction incidentals	+	$30,494
Add 30% for Planning, Administration, and Construction Supervision	+	$26,138
Total	=	$143,758

Estimated Cost = $140,000

COST ESTIMATE

ROUTE 401 - SERVICE DRIVE

A. Removal of asphalt pavement
(10,400sf) x (1sy/9sf) x ($3.50/sy) = $4,044

B. Pavement, 4" hot asphaltic concrete pavement (HACP)
(10,400sf) x (4" depth) x (1ft/12") = 3,467cf
(3,467cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $13,000

C. Pavement markings
(2,700lf) x ($0.45/lf) = $1,215

D. Drainage
(1 inlet) x ($1,600.00/inlet) = $1,600

E. Remove and reconstruct concrete drainage ditch, assumed area
(150sf) x (1sy/9sf) x ($50.00/sy) = $833

Subtotal = $20,692
Add 35% for construction incidentals + $7,242
Add 30% for Planning, Administration,
and Construction Supervision + $6,208

Total = $34,142

Estimated Cost = $34,000

COST ESTIMATE

ROUTE 402 - SERVICE LOOP

A. Pavement, 2" hot asphaltic concrete pavement (HACP) overlay
(5,800sf) x (2" depth) x (1ft/12") = 967cf
(967cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $3,625

B. Milling, 0" to 2" variable milling
(1,500sf) x (1sy/9sf) x ($2.00/sy) = $333

Subtotal	= $3,958
Add 35% for construction incidentals	+ $1,385
Add 30% for Planning, Administration, and Construction Supervision	+ $1,187
Total	= $6,530

Estimated Cost = $7,000

COST ESTIMATE

ROUTE 403 - PIER 2 (SOUTH)

A. Removal of asphalt pavement
(30,000sf) x (1sy/9sf) x ($3.50/sy) = $11,667

B. Regrade base
(30,000sf) x (1sy/9sf) x ($5.00/sy) = $16,667

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(30,000sf) x (4" depth) x (1ft/12") = 10,000cf
(10,000cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $37,500

Subtotal	=	$65,834
Add 35% for construction incidentals	+	$23,042
Add 30% for Planning, Administration, and Construction Supervision	+	$19,750
Total	=	$108,626

Estimated Cost = $110,000

COST ESTIMATE

ROUTE 404 - PIER 2 (NORTH)

A. Removal of asphalt pavement
(24,700sf) x (1sy/9sf) x ($3.50/sy) = $9,606

B. Regrade base
(24,700sf) x (1sy/9sf) x ($5.00/sy) = $13,722

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(16,700sf) x (4" depth) x (1ft/12") = 5,567cf
(5,567cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $20,876

D. Removal of existing concrete pavement structure
(20ft x 400ft) x (1sy/9sf) x ($6.50/sy) = $5,778

E. Concrete pavement between crane rails
(20ft x 400ft) x (1sy/9sf) x ($40.00/sy) = $35,556

F. Crane rails safety adjustment, concrete
(800ft) x ($17.50/ft) = $13,800

G. Crane rails safety adjustment, wood
(1,600ft) x (12"/ft) x (3"x2") = 115,200 in^3
(115,200in^3) x (1 board ft/144 in^3) = 800bf
(800bf) x (1 mfbm/1,000bf) x ($1,400/mfbm) = $1,120

Subtotal	= $100,458
Add 35% for construction incidentals	+ $35,160
Add 30% for Planning, Administration, and Construction Supervision	+ $30,137
Total	= $165,755

Estimated Cost = $170,000

COST ESTIMATE

ROUTE 405 - CONNECTOR ROAD

A. Removal of asphalt pavement
(16,700sf) x (1sy/9sf) x ($3.50/sy) = $6,494

B. Regrade base
(16,700sf) x (1sy/9sf) x ($5.00/sy) = $9,278

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(16,700sf) x (4" depth) x (1ft/12") = 5,567cf
(5,567cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $20,875

Subtotal	=	$36,647
Add 35% for construction incidentals	+	$12,826
Add 30% for Planning, Administration, and Construction Supervision	+	$10,994
Total	=	$60,467

Estimated Cost = $61,000

COST ESTIMATE

ROUTE 406 - TERMINUS OF ROUTE 400

A. Removal of existing asphalt pavement
(10,700sf) x (1sy/9sf) x ($3.50/sy) = $4,161

B. Aggregate base, 8" depth
(10,700sf) x (8" depth) x (1ft/12") = 7,133cf
(7,133cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton) = $10,343

C. Pavement, 4" hot asphaltic concrete pavement (HACP)
(10,700sf) x (4" depth) x (1ft/12") = 3,567cf
(3,567cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton) = $13,375

Subtotal	=	$27,879
Add 35% for construction incidentals	+	$9,758
Add 30% for Planning, Administration, and Construction Supervision	+	$8,364
Total	=	$46,001

Estimated Cost = $46,000

Preferred Alternative Cost Estimate

COST ESTIMATE
FIRST AVENUE
Pave all of First Avenue with brick

A. Removal of asphalt pavment (43,800sf) x (1sy/9sf) x ($3.50/sy)	= $	17,033.00
B. Aggregate base, 8" depth (43,800sf) x (8" depth) x (1ft/12") =29,200cf (29,200cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton)	= $	42,340.00
C. Brick Pavement Structure (43,800sf) x (1yd/9sf) x ($40.00/sy)	= $	194,667.00
D. Pavement Markings (500lf) x ($0.45/lf)	= $	225.00
E. Removal of existing concrete curb, length assumed (100lf) x ($4.50/lf)	= $	450.00
F. Place granite curb, length assumed (100lf) x ($50.00/lf)	= $	5,000.00
G. Drainage (7 inlets) x ($1600.00/ inlet)	= $	11,200.00
H. Manhole Adjustment (4 inlets) x ($1,600.00/inlet)	= $	6,400.00
I. Signs (2 signs) x (4sf/sign) x ($27.00/sf)	= $	216.00
SUBTOTAL	= $	277,531.00
Add 35% for construction incidentals	+ $	66,054.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	56,618.00
TOTAL	= $	400,203.00

COST ESTIMATE
FIRST AVENUE
Pave First Avenue with brick from the Main Gate to Building 5

A. Removal of asphalt pavment (43,800sf) x (1sy/9sf) x ($3.50/sy)	= $	17,033.00
B. Aggregate base, 8" depth (43,800sf) x (8" depth) x (1ft/12") =29,200cf (29,200cf) x (145lb/cf) x (1ton/2000lb) x ($20.00/ton)	= $	42,340.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (27,800sf) x (4" depth) x (1 ft/12") = (9,267 cf) x (150 lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	34,750.00
D. Brick Pavement Structure (16,000sf) x (1yd/9sf) x ($40.00/sy)	= $	71,111.00
E. Removal of existing concrete curb, length assumed (100lf) x ($4.50/lf)	= $	450.00
F. Place granite curb, length assumed (100lf) x ($50.00/lf)	= $	5,000.00
G. Drainage (7 inlets) x ($1600.00/ inlet)	= $	11,200.00
H. Manhole Adjustment (4 inlets) x ($1,600.00/inlet)	= $	6,400.00
I. Signs (2 signs) x (4sf/sign) x ($27.00/sf)	= $	216.00
SUBTOTAL	= $	188,500.00
Add 35% for construction incidentals	+ $	66,054.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	56,618.00
TOTAL	= $	311,172.00

COST ESTIMATE
ROUTE 11 - LINCOLN AVENUE/PIER 1

A. Removal of asphalt pavment (266,000sf) x (1sy/9sf) x ($3.50/sy)	= $	103,444.00
B. Removal of concrete pavement between crane rails (1,000sf) x (20 ft) x (1sy/9sf) x ($6.50/sy)	= $	14,444.00
C. Regrade base (266,000sf) x (1 sy/9sf) x ($5.00)	= $	147,778.00
D. Aggregate base, 8" depth (266,000sf) x (8" depth) x (1ft/12") = 177,333cf (177,333cf) x (145lb/cf) x (1 ton/2000lb) x ($20.00/ton)	= $	257,133.00
E. Pavement, 4" hot asphaltic concrete pavement (HACP) (246,000sf) x (4" depth) x (1ft/12") = 76,533cf (82,000cf) x (145lb/cf) x (1 ton/200lb) x ($50.00/ton)	= $	287,000.00
F. Brick Pavement Structure (15,000sf) x (1yd/sf) x ($40/sy)	= $	66,667.00
G. Granite Pavement Structure (1400sf) x (1yd/9sf) x ($90.00/sy)	= $	250,000.00
H. Concrete pavement between crane rails (1,000ft) x (20ft) x (1sy/9sf) x ($40.00/sy)	= $	88,889.00
I. Crane rails safety adjustment, concrete (2,000ft) x ($17.50/ft)	= $	35,000.00
J. Crane rails safety adjustment, wood (4,000ft) x (12"/ft) x (3'x2") = 288,000 inches cubed (288,000inches cubed) x (1 board ft/144 inches cubed) = 2,000 bf	= $	2,800.00
K. Pavement markings (2,700lf) x ($0.45/lf)	= $	1,215.00
L. Pavement Symbols (4 Handicap parking symbols) x ($25.00/ea)	= $	200.00
M. Reset granite curb, length assumed	= $	3,500.00
SUBTOTAL	= $	1,258,070.00
Add 35% for construction incidentals	+ $	357,725.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	306,621.00
TOTAL	= $	1,922,416.00

COST ESTIMATE
ROUTE 12 - SECOND AVENUE

A. Removal of asphalt pavment (40,000sf) x (1sy/9sf) x ($3.50/sy)	= $	15,556.00
B. Regrade base (40,000sf) x (1sy/9sf) x ($5.00/sy)	= $	22,222.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (40,000sf) x (4" depth) x (1ft/12") = 13,333cf (13,333cf) x (150lb/cf) x (1 ton/200lb) x ($50.00/ton)	= $	50,000.00
K. Pavement markings (1,600lf) x ($0.45/lf)	= $	720.00
SUBTOTAL	= $	88,498.00
Add 35% for construction incidentals	+ $	30,974.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	26,594.00
TOTAL	= $	146,066.00

COST ESTIMATE
ROUTE 12 - FOURTH STREET

A. Removal of asphalt pavment overlay (2 loader hours) x ($75.00/loader hour)	= $ 150.00
B. Removal of existing wood pavement structure, assumed area (1,350 sf) x ($3.00/sf)	= $ 4,050.00
C. Removal of existing brick pavement structure (3 loader hours) x ($75.00/loader hour)	= $ 225.00
D. Removal of existing concrete pavement structure	= $ 1,950.00
E. Removal of existing base (2,700sf) x (1 sy/sf) x ($1.50/sy)	= $ 450.00
F. Aggregate base, 8" depth (2,700sf) x (145lb/cf) x (1 ton/2000lb) x ($20.00/ton)	= $ 2,610.00
G. Reinforced concrete pavement (2,700sf) x (1sy/9sf) x ($40.00/sy)	= $12,000.00
H. Wood-on-end pavement structure (1,798cf) x (1,728 inches cubed/cf) x (1 board ft./144 inches cubed) = 21,576 (32.400bf) x (1mfbm/1000bf) x ($1,400.00/mfbm)	= $30,206.00
I. Brick Pavement Structure (902sf) x (1sf/sy) x (40sy)	= $ 4,009.00
SUBTOTAL	= $55,650.00
Add 35% for construction incidentals	+ $19,478.00
Add 30% for Planning, Administration, and Construction Supervision	+ $16,695.00
TOTAL	= $91,823.00

COST ESTIMATE
ROUTE 12 - THIRD STREET

A. Removal of asphalt patch (96sf) x (1sy/9sf) x ($3.50/sy)	= $	37.00
B. Removal of existing brick pavement structure (5 loader hours) x ($75.00/loader hour)	= $	375.00
C. Removal of existing concrete pavement structure (3,500sf) x (1sy/9sf) x ($6.50/sy)	= $	2,528.00
D. Removal of existing base (3,500sf) x (1 sy/sf) x ($1.50/sy)	= $	583.00
E. Aggregate base, 8" depth (3,500sf) x (8" depth) x (1ft/12") = 2,333cf (2,333cf) x (145lb/cf) x (1 ton/2000lb) x ($20.00/ton)	= $	3,383.00
F. Reinforced concrete pavement (3,500sf) x (1sy/9sf) x ($40.00/sy)	= $	15,555.00
G. Brick pavement structure (3,500sf) x (1sy/9sf) x ($100.00/sy)	= $	38,889.00
H. Removal of existing concrete curb, assumed length (75ft) x ($4.50/ft)	= $	338.00
I. Place granite curb, assumed length (75ft) x ($50.00/ft)	= $	3,750.00
SUBTOTAL	= $	65,438.00
Add 35% for construction incidentals	+ $	22,903.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	19,631.00
TOTAL	= $	107,972.00

COST ESTIMATE
ROUTE 400 - BAXTER AVENUE

A. Removal of asphalt pavment (28,500sf) x (1sy/9sf) x ($3.50/sy)	= $	11,083.00
B. Regrade base (28,500sf) x (4" depth) x (1ft/12") =9,500cf (9,500cf) x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	15,833.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (28,500sf) x (4" depth) x (1ft./12") = 9,500cf) (9,500cf) x (150lb/cf) x 1 ton/2000lb) x ($50.00/ton)	= $	35,625.00
D. Pavement markings (3,300lf) x ($0.45/lf)	= $	1,485.00
E. Removal of existing chainlink fence, length assumed (700lf) x ($3.00/lf)	= $	2,100.00
F. Cast iron fence (700lf) x ($30.00/lf)	= $	21,000.00
SUBTOTAL	= $	87,126.00
Add 35% for construction incidentals	+ $	30,494.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	26,138.00
TOTAL	= $	143,758.00

COST ESTIMATE
ROUTE 401 - SERVICE DRIVE

A. Removal of asphalt pavment (10,400sf) x (1sy/9sf) x ($3.50/sy)	= $	4,044.00
B. Pavement, 4" hot asphaltic concrete pavement (HACP) (10,400sf) x (4" depth) x (1ft/12") =3,467cf (3,467cf) x (150lb/cf) x (1ton/2000lb) x ($50.00/ton)	= $	13,000.00
C. Pavement markings (2700lf) x ($0.45/lf)	= $	1,215.00
D. Drainage (1 inlets) x ($1,600.00/ inlet)	= $	1,600.00
D. Remove and reconstruct concrete drainage ditch, assumed area (150lf) x (1sy/9sf) x ($50.00/sy)	= $	833.00
SUBTOTAL	= $	20,692.00
Add 35% for construction incidentals	+ $	7,242.00
Add 30% for Planning, Administration, and Construction Supervision	+ $	6,208.00
TOTAL	= $	34,142.00

COST ESTIMATE
ROUTE 402 - SERVICE DRIVE

A. Pavement, 2" hot asphaltic concrete pavement (HACP) overlay (5,800sf) x (2" depth) x (1ft/12") = 967cf (967cf x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	=	$	3,625.00
B. Milling, 0" to 2" variable milling (1,500sf) x (1sy/9sf) x ($2.00/sy)	=	$	333.00
SUBTOTAL	=		$3,958
Add 35% for construction incidentals	+	$	1,385.00
Add 30% for Planning, Administration, and Construction	+	$	1,187.00
TOTAL	=	$	6,530.00

COST ESTIMATE
ROUTE 403 - PIER 2 (SOUTH)

A. Removal of asphalt pavement (30,000sf) x (1sy/9sf) x ($3.50/sy)	= $	11,667.00
B. Regrade base (30,000sf) x (1sy/9sf) x ($5.00/sy)	= $	16,667.00
C. Pavement, 4" hot asphaltic conrete pavement (HACP) (30,000sf) x (4" depth) x (1ft/12") = 10,000cf (10,000cf) x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	37,500.00
SUBTOTAL	= $	65,834.00
Add 35% for construction incidentals	+ $	23,042.00
Add 30% for Planning, Administration, and Construction	+ $	19,750.00
TOTAL	= $	108,626.00

COST ESTIMATE
ROUTE 404 - PIER 2 (NORTH)

A. Removal of asphalt pavement (24,700sf) x (1sy/9sf) x ($3.50/sy)	= $	9,606.00
B. Regrade base (24,700sf) x (1sy/9sf) x ($5.00/sy)	= $	13,722.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (16,700sf) x (4" depth) x (1ft/12") = 4,560cf (13,680cf) x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	17,100.00
D. Granite paving structure (258.4sf) x (1sy/9sf) x ($90.00/sf)	= $	25,870.00
E. Brick paving structure (433.25sf) x (1sy/'9sf) x ($40.00/sf)	= $	1,924.00
F. Removal of existing concrete pavement structure (20ft x 400ft) x (1sy/9sf) x ($6.50/sy)	= $	5,778.00
G. Concrete pavement between crane rails (20ft x 400ft) x (1sy/9sf) x ($40.00/sy)	= $	35,556.00
H. Crane rails safety adjustment, concrete (800ft) x ($17.50/ft)	= $	13,800.00
I. Crane rails safety adjustment, wood (1,600ft) x (12"/ft) x (3"x2") = 115,200 inches cubed (115,200 inches cubed) x (1 board ft/144 inches cubed) = 800bf (800bf) x (1 mfbm/1,000bf) x ($1,400/mfbm)	= $	1,120.00
SUBTOTAL	= $	124,476.00
Add 35% for construction incidentals	+ $	43,567.00
Add 30% for Planning, Administration, and Construction	+ $	37,343.00
TOTAL	= $	205,386.00

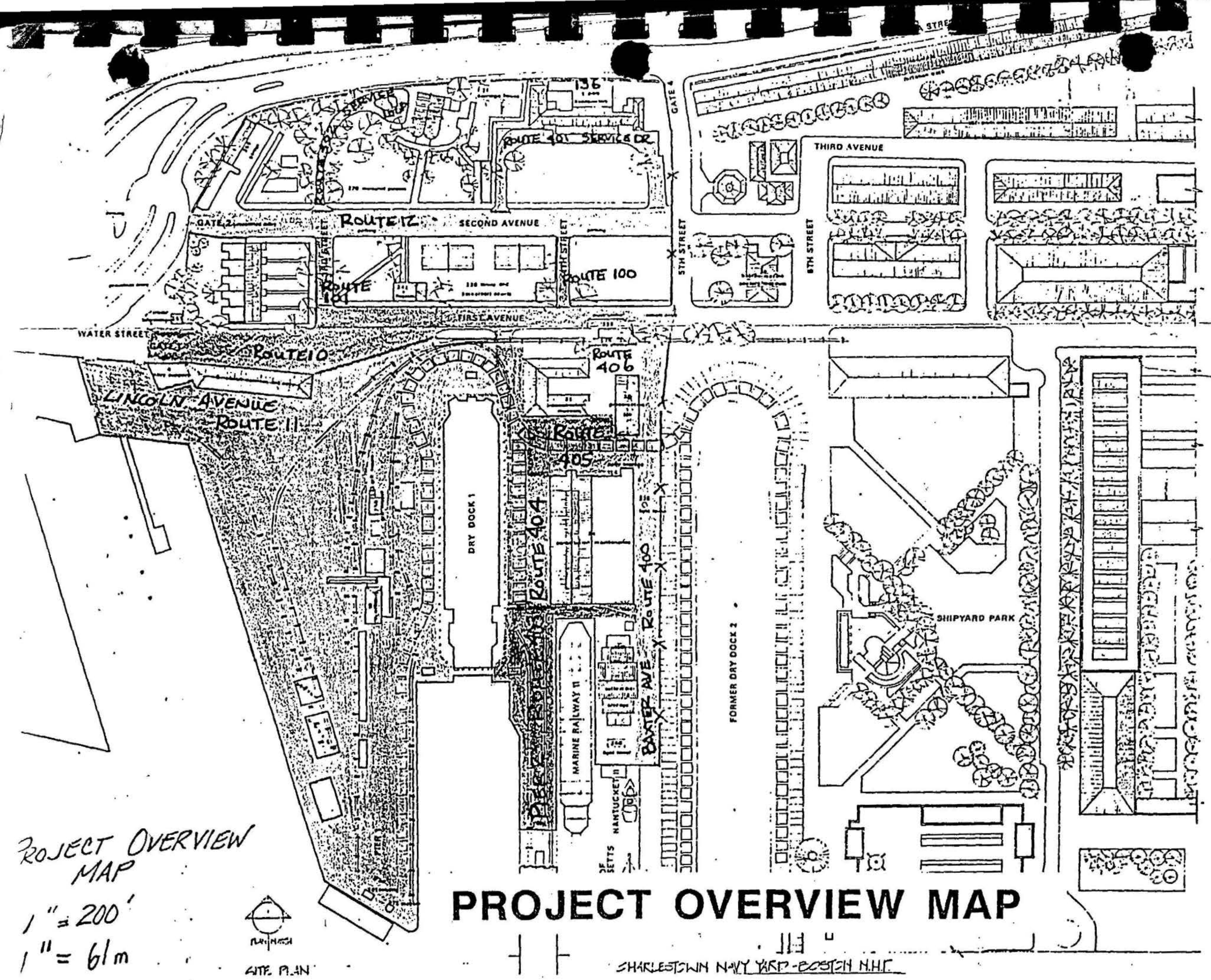
COST ESTIMATE
ROUTE 405 - CONNECTOR ROAD

A. Removal of asphalt pavement (16,700sf) x (1sy/9sf) x ($3.50/sy)	= $	6,494.00
B. Regrade base (16,700sf) x (1sy/9sf) x ($5.00/sy)	= $	9,278.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (10,316sf) x (4" depth) x (1ft/12") = 3,439cf (5,567cf) x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	12,896.00
D. Granite (3184sf) x (1sy/9sf) x ($90.00/sf)	= $	31,840.00
E. Brick paving structure (3200sf) x (1sy/'9sf) x ($40.00/sf)	= $	14,222.00
SUBTOTAL	=	$74,730
Add 35% for construction incidentals	+ $	26,156.00
Add 30% for Planning, Administration, and Construction	+ $	22,419.00
TOTAL	= $	123,305.00

COST ESTIMATE
ROUTE 406 - TERMINUS OF ROUTE 400

A. Removal of existing asphalt pavement (10,700sf) x (1sy/9sf) x ($3.50/sy)	= $	4,161.00
B. Aggregate base, 8" depth (10,700sf) x (8" depth) x (1ft/12") (7,133cf) x (145lb/cf) x 1 ton/2000lb) x ($20.00/ton)	= $	10,343.00
C. Pavement, 4" hot asphaltic concrete pavement (HACP) (10,700sf) x (4" depth) x (1ft/12") = 3,567cf (3,567cf) x (150lb/cf) x (1 ton/2000lb) x ($50.00/ton)	= $	13,375.00
SUBTOTAL	=	$27,879
Add 35% for construction incidentals	= $	9,758.00
Add 30% for Planning, Administration, and Construction	= $	8,364.00
TOTAL	= $	46,001.00

Map of Federal Highway Administration Zones for Cost Estimates



PROJECT OVERVIEW MAP

1" = 200'

1" = 61m

SITE PLAN

PROJECT OVERVIEW MAP

CHARLESTOWN NAVY YARD - BOSTON N.H.P.