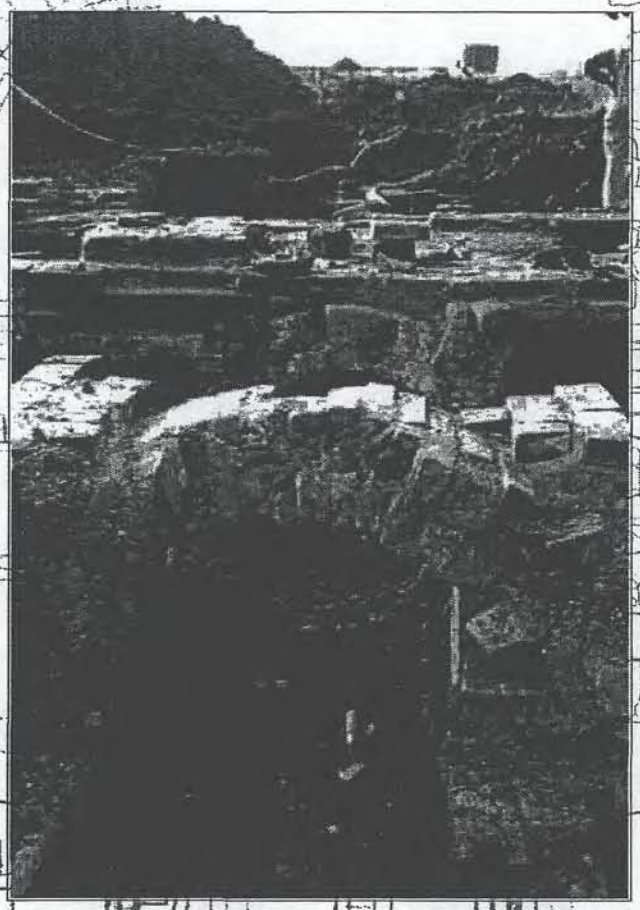
VIRGINIA GLASS COMPANY

BOTTLE FACTORY

SITE 44AX181



Phase I and Phase II/III Archeological Investigations

Alexandria, Virginia

DAMES & MOORE

A DAMES & MOORE GROUP COMPANY

Virginia Glass Company Bottle Factory Phase I and Phase II/III Archeological Investigations John Carlyle Square Site 44AX181 Alexandria, Virginia

Volume I: Text

Virginia Glass Company Bottle Factory
Phase I and Phase II/III Archeological Investigations
John Carlyle Square
Site 44AX181
Alexandria, Virginia

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TABLE OF CONTENTS

1.0 INTRODUCTION 1-1

1.1 PROJECT DESCRIPTION 1-1

1.2 HISTORIC PRESERVATION COMPLIANCE 1-4

1.3 AN OVERVIEW OF THE VIRGINIA GLASS COMPANY 1-4

2.0 ENVIRONMENTAL SETTING 2-1

2.1 GEOLOGY 2-1

2.2 CLIMATE 2-1

2.3 CURRENT CONDITIONS 2-2

3.0 RESEARCH QUESTIONS AND METHODOLOGY 3-1

3.1 RESEARCH QUESTIONS ADDRESSING SITE 44AX181 3-1

3.2 METHODOLOGY FOR HISTORIC RESEARCH 3-2

4.0 GENERAL HISTORIC BACKGROUND OF ALEXANDRIA, VIRGINIA 4-1

4.1 HISTORIC CONTEXT 4-1
4.1.1 Settlement Period (1749 - 1805) 4-1
4.1.2 Mercantile Expansionism (1805 - 1850s) 4-3
4.1.3 Civil War Period (1861 - 1865) 4-5
4.1.4 Post-War Industrialization (1865 - 1900) 4-6
4.1.5 Twentieth Century (1900-present) 4-6

4.2 PREVIOUS ARCHEOLOGICAL INVESTIGATIONS 4-7

5.0 HISTORIC BACKGROUND: WEST END AND PROJECT AREA 5-1

5.1 DEVELOPMENT OF ALEXANDRIA'S WEST END NEIGHBORHOOD 5-1
5.1.1 The Village of Cameron 5-1
5.1.2 The Village of West End 5-3
5.1.3 Changes Brought About by the Railroad 5-4
5.1.4 The Civil War in West End 5-4

5.2 LAND USE HISTORY OF THE PROJECT AREA 5-7

5.3 THE VIRGINIA GLASS COMPANY (BY: RICHARD O' CONNOR) 5-14
5.3.1 Melting Technology 5-14
5.3.2 Producer Gas 5-22
5.3.3 Making Bottles 5-28
5.3.4 Annealing Equipment 5-29
5.3.5 Demise of the Virginia Glass Company 5-30
5.3.6 Later Glass Factories in Alexandria 5-32

6.0 METHODOLOGY FOR ARCHEOLOGICAL STUDY 6-1

6.1 PHASE I INVESTIGATION 6-1
6.1.1 Research Objectives 6-1
6.1.2 Monitoring 6-1
6.1.3 Field Methods 6-3

6.2 PHASE II/III EXCAVATION AND DATA RECOVERY 6-4
6.2.1 Research Objectives 6-4
6.2.2 Field Methods 6-4

6.3 LABORATORY METHODS 6-5
6.3.1 Artifact Processing 6-6
6.3.2 Artifact Cataloging and Analysis 6-6
6.3.3 Analysis of Bottles 6-7

7.0 PHASE I ARCHEOLOGICAL FINDINGS 7-1

7.1 SOIL STRATIGRAPHY, GENERAL OVERVIEW 7-1

7.2 PHASE I TRENCHES 7-5
7.2.1 Trench 1 7-5
7.2.2 Trench 2 7-9
7.2.3 Trench 3 7-11
7.2.4 Trench 4 7-12
7.2.5 Trench 5 7-13
7.2.6 Trench 6 7-14
7.2.7 Trench 7 7-15
7.2.8 Trench 8 7-16
7.2.9 Trench 9 7-17

7.3 EXCAVATION BLOCKSB 7-19
7.3.1 Block 1 7-19
7.3.2 Block 2 7-19
7.3.3 Block 3 7-20
7.3.4 Block 4 7-20

7.4 SUMMARY OF THE PHASE I INVESTIGATIONS 7-21

8.0 PHASE II/III EXCAVATIONS AND DATA RECOVERY 8-1

8.1 PHASE II/III TEST UNITS 8-1
8.1.1 Test Unit 1 8-2
8.1.2 Test Unit 2 8-3
8.1.3 Test Unit 3 8-4

8.2 APPROACH TO SCRAPE 1 AND 2 8-5

8.3 SCRAPE 1 AND SCRAPE 2 INTERPRETATION 8-6
8.3.1 Step One: Mixing of Raw Materials 8-6
8.3.2 Step Two: Preparing the Melting Pot for the Furnace 8-8
8.3.3 Step Three: Heating the Furnace 8-9
8.3.4 Step Four: Melting the Batch 8-15
8.3.5 Step Five: Forming the Bottles in Molds 8-21
8.3.6 Step Six: Annealing the Bottles 8-23

9.0 ARTIFACT ANALYSIS 9-1

9.1 GENERAL ARTIFACT DISCUSSION 9-1
9.1.1 Collection Strategy 9-1
9.1.2 Artifact Context 9-1
9.1.3 Overview of Artifacts Found 9-2

9.2 METHOD OF BOTTLE MANUFACTURE BASED ON FACTORY ARTIFACTS ... 9-4

9.3 BOTTLE TYPOLOGY 9-11
9.3.1 Method of Defining the Bottle Typology 9-12
9.3.2 Typology Biases 9-14
9.3.3 Whole Bottles Produced at the Virginia Glass Company Factory 9-14

9.4 DIAGNOSTIC FACTORY BOTTLE FRAGMENTS 9-23
9.4.1 Lip/Necks 9-23
9.4.2 Base Fragments 9-29
9.4.3 Diagnostic Body Fragments 9-30
9.4.4 Conclusion: Bottle Fragments 9-32

9.5 COLOR 9-32

9.6 STOPPERS, CLOSURES, TUBES, DECORATIVE CANES AND PREFORMS 9-33

9.7 GLASS MAKING TOOLS AND OTHER IMPLEMENTS 9-38

9.8 OTHER GLASS ARTIFACTS 9-41
9.8.1 Contemporaneous Bottles and Jars Not Made at the Factory 9-41
9.8.2 Later Bottles and Jars 9-42
9.8.3 Drinking Glasses and Glass Bowls 9-44
9.8.4 Marbles 9-45
9.8.5 Window glass 9-46

9.9 HISTORIC CERAMICS 9-46

9.10 FIREBRICKS 9-49

9.11 FAUNAL REMAINS 9-50

9.12 ELECTRICAL ARTIFACTS 9-51

9.13 SUMMARY AND CONCLUSIONS 9-51

10.0 SUMMARY AND RECOMMENDATIONS 10-1

10.1 SUMMARY OF RESEARCH QUESTIONS 10-1

10.2 RECOMMENDATION OF SIGNIFICANCE 10-8

11.0 BIBLIOGRAPHY 11-1

APPENDICES

APPENDIX A: SCOPE OF WORK
APPENDIX B: CONTEXT NUMBERS, TRENCH REGISTRY, FEATURE REGISTRY AND UNIT REGISTRY
APPENDIX C: ARTIFACT CATALOG
APPENDIX D: GLOSSARY OF ARCHEOLOGICAL AND GLASS-MAKING TERMS
APPENDIX E: BOTTLE TYPES
APPENDIX F: LIP/NECK TYPES
APPENDIX G: CHAIN OF TITLE
APPENDIX H: SITE FORM
APPENDIX I: PHOTOGRAPHS OF GLASS FACTORY EXCAVATIONS
APPENDIX J: FIELD DOCUMENTATION
APPENDIX K: RESUMES OF KEY PERSONNEL

LIST OF FIGURES

Figure 1-1. U.S.G.S. Alexandria Quad, Showing Project Location 1-2
Figure 1-2. Lot 608 and the Current Site Plan 1-3
Figure 1-3. 1912 Sanborn Fire Insurance Map 1-6

Figure 2-1. The Station Shops 2-3

Figure 5-1. 1798 Map of Alexandria, Published by I.V. Thomas 5-2
Figure 5-2. 1878 Detailed Hopkins Atlas 5-5
Figure 5-3. 1864 Barnard Map of the Environs of Washington 5-9
Figure 5-4. 1894 Hopkins Atlas 5-10
Figure 5-5. 1907 Sanborn Fire Insurance Map 5-12
Figure 5-6. 1912 Sanborn Fire Insurance Map 5-13
Figure 5-7. Model of a Pot Furnace 5-16
Figure 5-8. Model of a Continuous Tank Furnace with Attached Producer Gas Plant 5-19
Figure 5-9. Photograph of End-Port Furnace, with Regenerator Chambers below Ports 5-20
Figure 5-10. Drawing of Glass Furnace Illustrating Different Brick Types Used in Regenerators and Tank Area 5-21
Figure 5-11. Illustration of Refractories Used in Tank Furnace Construction 5-23
Figure 5-12. Illustration of Refractories Used in Tank Furnace Construction 5-24
Figure 5-13. Illustration of Refractories Used in Tank Furnace Construction 5-25
Figure 5-14. Siemens Reversing Valve, Used to Reverse Flow of Air and Gas Between Regenerators. 5-27
Figure 5-15. Details of Mushroom Saucer Valve Cover. 5-27
Figure 5-16. Cut-away Section of Endless Conveyor Lehr 5-30

Figure 6-1. 1907 Sanborn Fire Insurance Map Showing Phase I Trenches 6-2
Figure 6-2. Parts of a Bottle 6-11

Figure 7-1. Lot 608 and the Current Site Plan, Showing Locations of all the Trenches and Blocks 7-6
Figure 7-2. Profiles of Trench 1 7-8
Figure 7-3. Profile of Trench 2, South Wall 7-10
Figure 7-4. Profile of Trench3, South Wall 7-12
Figure 7-5. Profile of Trench 4, East Wall 7-13
Figure 7-6. Profile of Trench 5, North Wall 7-14
Figure 7-7. Profile of Trench 6, East Wall, Showing Part of the Small Oven 7-14
Figure 7-8. Profile of Trench 7, South Wall 7-15
Figure 7-9. Profile of Trench 8, East Wall 7-17
Figure 7-10. Profile of Trench 9, South Wall 7-18

Figure 8-1. Profile of Test Unit 1, South Wall 8-3
Figure 8-2. Profile of Test Unit 2, South Wall 8-4

Figure 8-3. Plan View of the Factory Remains 8-7
Figure 8-4. The Small Oven, View to the Northeast 8-9
Figure 8-5. Factory Remains South of Furnace 1, Showing Ventilation System, Ramp, Walkway Between Furnaces, and Gas Producer Remains 8-11
Figure 8-6. Architectural Remains of Furnace 1 8-16
Figure 8-7 The Chambers of Furnace 1 8-19
Figure 8-8. Photograph of Ventilation Interior, Showing Internal Flues, Photo Taken from Gas Access Flue, View to South 8-20
Figure 8-9. Structural Remains of Furnace 2 8-22
Figure 8-10. Lehr 1 Remains 8-24
Figure 8-11. Brick Floor Adjacent to Lehr 2 8-25

Figure 9-1. Type 9 Bottle Made by Lampworking 9-8
Figure 9-2. Snap Case (Peligot 1877: Fig. 48) 9-9
Figure 9-3. Finishing Tool (Jones and Sullivan 1985:42) 9-9
Figure 9-4. Bottle Types 9-15
Figure 9-5. Robert Portner Tivoli Beer Bottles 9-18
Figure 9-6. Small Medicine Bottles 9-20
Figure 9-7. Type 15 Medicine Bottles 9-22
Figure 9-8. Lip/Neck Types 9-25
Figure 9-9. Type C Crown Finish 9-26
Figure 9-10. Type J Perry Davis Finish 9-26
Figure 9-11. Type V Blob Top Finish 9-26
Figure 9-12. Type I Lip/Neck Fragments 9-26
Figure 9-13. Type E Lip/Neck Fragment 9-27
Figure 9-14. Representative Examples of Canes Produced by the Virginia Glass Factory 9-34
Figure 9-15. Possible Stopper, Catalog #254 9-35
Figure 9-16. Possible Stopper Preform, Catalog #491 9-36
Figure 9-17. Hutchinson Spring Stopper 9-37
Figure 9-18. Lightning-Type Stopper, (Cat. 256) 9-37
Figure 9-19. Remains of a Clock Found During Excavation 9-39
Figure 9-20. Possible Latch 9-40

LIST OF TABLES

Table 6-1. Artifact Categories and Types 6-8
Table 7-1. Soil Descriptions of Trench Profiles 7-7
Table 9-1. Artifact Summary 9-3
Table 9-2. Comparison of Lip/Neck Fragments with Whole Bottles 9-28
Table 9-3. Lettered Bottle Body Fragments 9-31
Table 9-4. Ceramic Summary 9-47

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PUBLIC REPORT SUMMARY

Dames & Moore of Bethesda, Maryland, conducted Phase I and II archeological investigations and Phase III data recovery of the Virginia Glass Company Site (44AX181) in Alexandria, Virginia, during November and December 1997. The Norfolk Southern Corporation funded the archeological investigations on their property to comply with regulations set forth in Alexandria Zoning Ordinance Section 1-100 subsection 1-102 (G), Section 2-100 subsection 2-151, Section 11-400 subsection 11-403 (D) and subsection 1-411. *Alexandria Archaeology*, an agency of the city of Alexandria, served as the regulatory agency.

In the early 1990s, the Norfolk Southern Company initiated redevelopment of a 76-acre parcel of land and consolidated several tracts to form ACarlyle". The project area, located at 1820-1828 Duke Street in West End, is part of Block D of the Carlyle Development Project. Extensive archeological investigations were conducted in the Carlyle Project area by Tellus Consultants, Inc., from 1990 to 1993, and by Engineering Science, Inc., in 1993 and 1994. This area of Block D was not investigated at that time because the Station Shops building, constructed in 1961, covered most of the project area. In 1993, an agreement was reached between Norfolk Southern Corporation and the City of Alexandria. Under that agreement, an archeological investigation would be conducted after portions of the Station Shops were demolished.

Historic and documentary research indicated that the project area could contain archeological remains from the Virginia Glass Company bottle factory that occupied the site from 1893 to 1916. The Virginia Glass Company had played a significant role in the development of the glass industry in Alexandria. The success of this company was part of the industrial revitalization of Alexandria at the end of the nineteenth and early-twentieth centuries. Virginia Glass Company was a fixture in the West End Corridor for over twenty years. Glassblowers and company managers of the Virginia Glass Company were sought after and eventually hired by larger twentieth-century companies, such as the Bel Pre Glassworks. The Virginia Glass Company set standards within the glass-making community by this transfer of skills to other companies.

The Virginia Glass Company of Alexandria, Virginia, was a small glass factory that produced bottles for beverages, medicines and general food packaging. It was the first glass firm in Alexandria and the only bottle-making company in Virginia in the 1890s. It was founded by glass workers from Royersford, Pennsylvania, the site of a large glass factory. The Virginia Glass Company initially operated as a hand-production plant, but may have experimented later with mechanized semi-automatic bottle molds. The company periodically renovated its melting technology, successively utilizing increasingly sophisticated furnaces and shifting from direct coal-firing to produced gas. Although the company survived one fire in 1895, a second major fire in 1916 closed the plant permanently. The factory employed glassblowers of the traditional style. While other urban factories were making the shift to mechanical bottle glass production, Virginia Glass never became fully mechanized. However, the Virginia Glass Company benefited greatly from advances that were made in glass melting technology during the industrial revolution.

Dames & Moore archeologists began the Phase I archeological investigation on November 11, 1997. The objective of the Phase I investigation was to identify any structural remains or artifacts associated with the occupation of the site by the Virginia Glass Company.

The Phase I testing plan involved the mechanical excavation of nine trenches and four 100-square-foot blocks. It was apparent from trench results that some of the architectural remains of the factory, such as foundations, furnaces and lehrs, were intact.

Phase II/III evaluation and data recovery was initiated in December 1997 to document the extensive factory remains and to recover an assemblage of artifacts that would contribute to the continuing study of manufacturing in Alexandria. Specific research questions were developed prior to data recovery to maximize the short time available for Phase II/III investigation and to enhance the archeologists' overall understanding of the glass factory operations. Testing methods included hand excavating test units and mechanically scraping with a grade-all and front-loader over most of the site. Numerous architectural features relating to the operation of

the Virginia Glass Company were exposed. The brick ventilation system of the factory was in excellent condition; the tank furnaces and lehrs were documented. The artifact assemblage consisted of Virginia Glass Company bottles in various stages of production, some glass specialty items and glass-making tools.

At the conclusion of Phase II/III data recovery the site was carefully back-filled based on specifications required by *Alexandria Archaeology*. Norfolk Southern Company has no immediate construction plan for the project area. The Virginia Glass Company site (44AX181) is being nominated to the National Register of Historic Places under Criteria A, C, and D because of its contribution to the understanding of nineteenth-century industry in an urban setting.

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Dames & Moore of Bethesda, Maryland, conducted Phase I and II archeological investigations and Phase III data recovery of the Virginia Glass Company Site in November and December 1997. The investigations were required to comply with Alexandria Zoning Ordinance sections. *Alexandria Archaeology,* an agency of the city of Alexandria, Virginia, served as the regulatory agency. Norfolk Southern Corporation funded the archeological investigations on their property to comply with the Alexandria ordinance. The Scope of Work for the archeological investigations is in Appendix A of this report.

The project area is situated within the city of Alexandria, Virginia, approximately 5 miles from Washington D.C. (Figure 1-1). The project area is part of Block D, Lot 608 of the Carlyle Development Project, located at 1820-1822 Duke Street. The Virginia Glass Company remains (Site 44AX181) are contained within the southern section of Lot 608, south of Duke Street (Figure 1-2). This parcel was the site of a section of the Station Shops commercial building that was constructed in the early 1960s and razed just before the archeological investigation was initiated. The eastern section of the Station Shops building was razed during an earlier phase of the Carlyle Development Project; the western section of the commercial complex was still standing immediately prior to the archeological investigation.

The West End neighborhood of Alexandria developed along the Duke Street corridor as a working class extension of the city. Duke Street, called the Little River Turnpike in the eighteenth and nineteenth centuries, was a primary access road to Old Town from points west. With the advent of the railroad and the de-emphasis of maritime transportation, West End became the railroad center for Alexandria. The railways were enhanced during the Civil War when a round house and rail extensions were constructed for the United States Military Railroad System. Although the economy went into a depression during Reconstruction and the late-

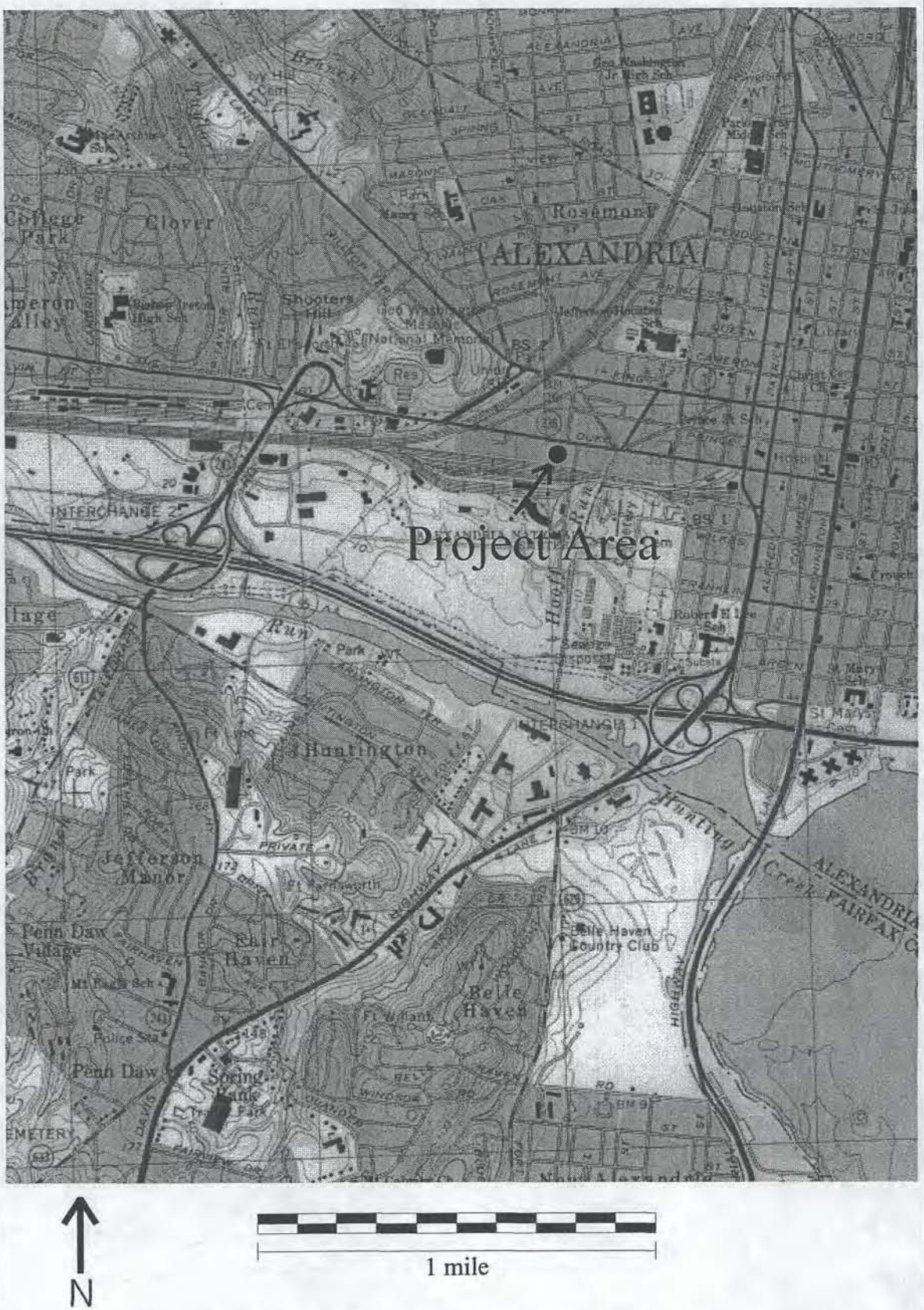


Figure 1-1. U.S.G.S. Alexandria Quad, Showing Project Location

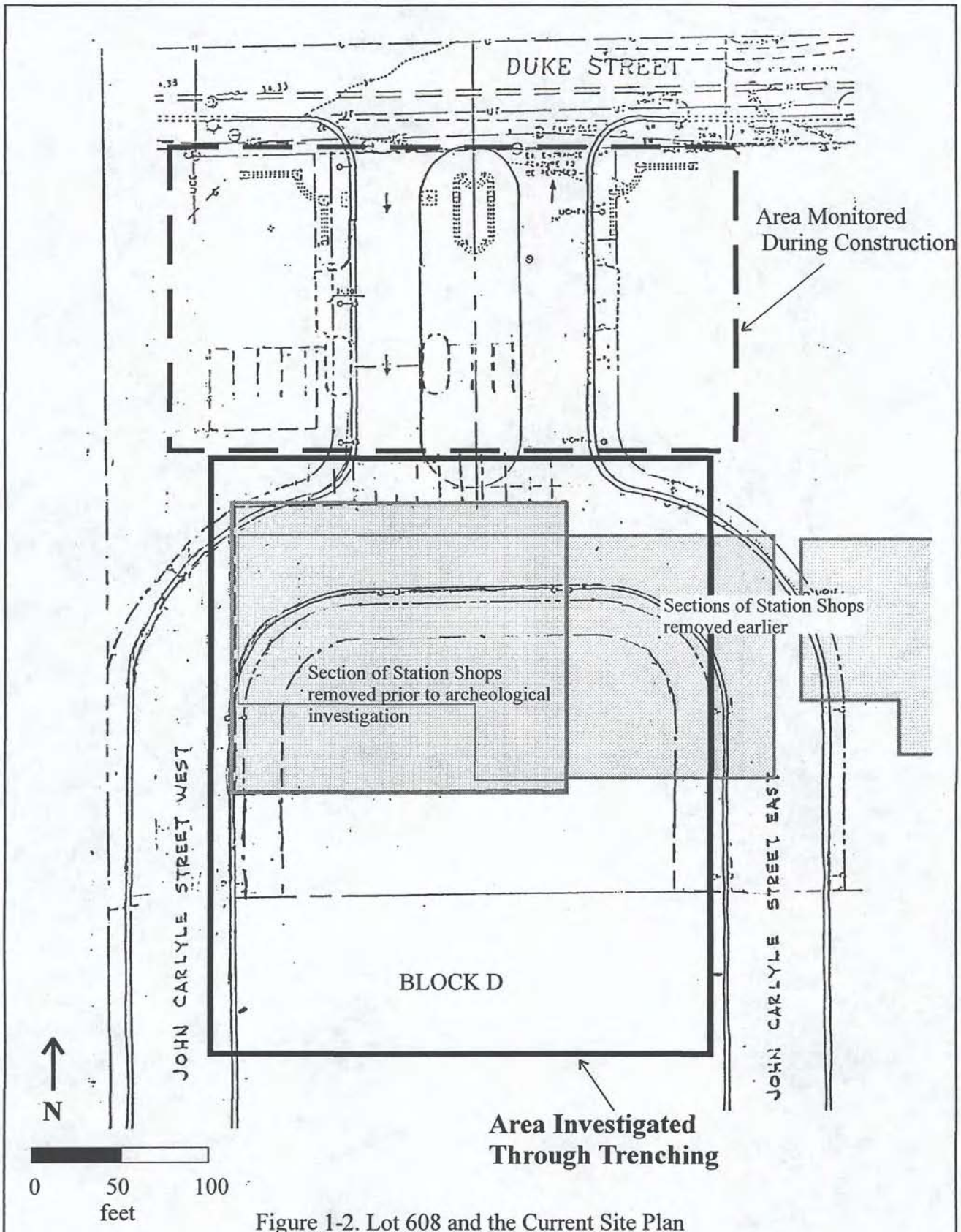


Figure 1-2. Lot 608 and the Current Site Plan

nineteenth century, the West End retained its merchant character. The Virginia Glass Company was established in West End at the end of the nineteenth century when the economy of Alexandria was gradually improving.

The Scope of Work and Research Design for the Virginia Glass Company site were developed in conjunction with the staff archeologists at *Alexandria Archaeology*. The purpose of the Phase I archeological investigation was to determine if remains of the Virginia Glass Company were located within the project area. The Phase II/III investigation and data recovery was implemented to document the extensive factory remains (Appendix B) and to recover an assemblage of artifacts (Appendix C) that would contribute to continuing study of manufacturing in Alexandria.

Dames & Moore conducted the Phase I investigation in November 1997. The Phase II/III investigation and data recovery continued into December. Janet Friedman served as the Principal Investigator, Cynthia Pfanstiehl acted as Field Director, and Heather Crowl was crew chief. The field crew included Lolly Vann, Rachel Grant, George Germaine, Paula Miller, Allysa Loney, William Ganzer and Brinton Ramsey.

1.2 HISTORIC PRESERVATION COMPLIANCE

The Norfolk Southern Corporation funded the archeological investigations on their property to comply with regulations set forth in Alexandria Zoning Ordinance Section 1-100 subsection 1-102 (G), Section 2-100 subsection 2-151, Section 11-400 subsection 11-403 (D) and subsection 1-411. The city regulations require developers to consider the effects of their activities on prehistoric and historic properties, and to mitigate adverse project impacts.

1.3 AN OVERVIEW OF THE VIRGINIA GLASS COMPANY

The Virginia Glass Company was built in 1893; by 1896, it employed over eighty men. The factory remained in operation until it burned down in 1916. A Sanborn Fire Insurance map

of 1912 and archeological investigations show the configuration of the factory south of Duke Street (Figure 1-3). The factory building measured approximately 162 feet by 75 feet, with two melting furnaces in the southern section of the factory structure. Two annealing lehrs, one large and one small, were situated north of the furnaces. The front (or northern extent) of the factory faced Factory Lane, which ran parallel to Duke Street. This was the packing area of the factory where finished bottles were boxed for shipment. The factory plan shows that boxes of bottles could be loaded directly onto Washington Southern Railway cars. The tracks were located approximately fifteen to twenty feet south of the factory.

The major structural components of the factory that relate to glass production include the melting furnaces, pot arches, gas producers and lehrs (defined below).

Melting Furnaces. Two melting furnaces were identified at the Virginia Glass Company site. They were located in the southern section of the factory and were constructed primarily of brick. During the early years of factory operation, traditional pot furnaces were used to melt glass. Several years later, glass-melting technology improved at the factory when tank furnaces were constructed. The major difference between the pot and tank furnace technology was that glass was melted in large brick tanks rather than pots. Tanks required extreme heat, which was provided by coal-fueled gas producers. Tank furnace technology greatly increased the daily output of bottles from the factory.

Pot Arches. Located at the working (northern) end of the furnace, the brick pot arches held the clay melting pots that were used for bottle manufacture. In traditional bottle-making, glass workers would gather glass from the pots and blow air though a blowing iron into iron molds to form bottles. The necks and lips of bottles were finished using hand tools.

Gas Producers. Gas producers, used in association with the tank furnace, were located in the southwestern section of the factory property. They consisted of large steel tanks that were lined with firebricks. The combustion of coal in the tank produced a gas that entered the tank

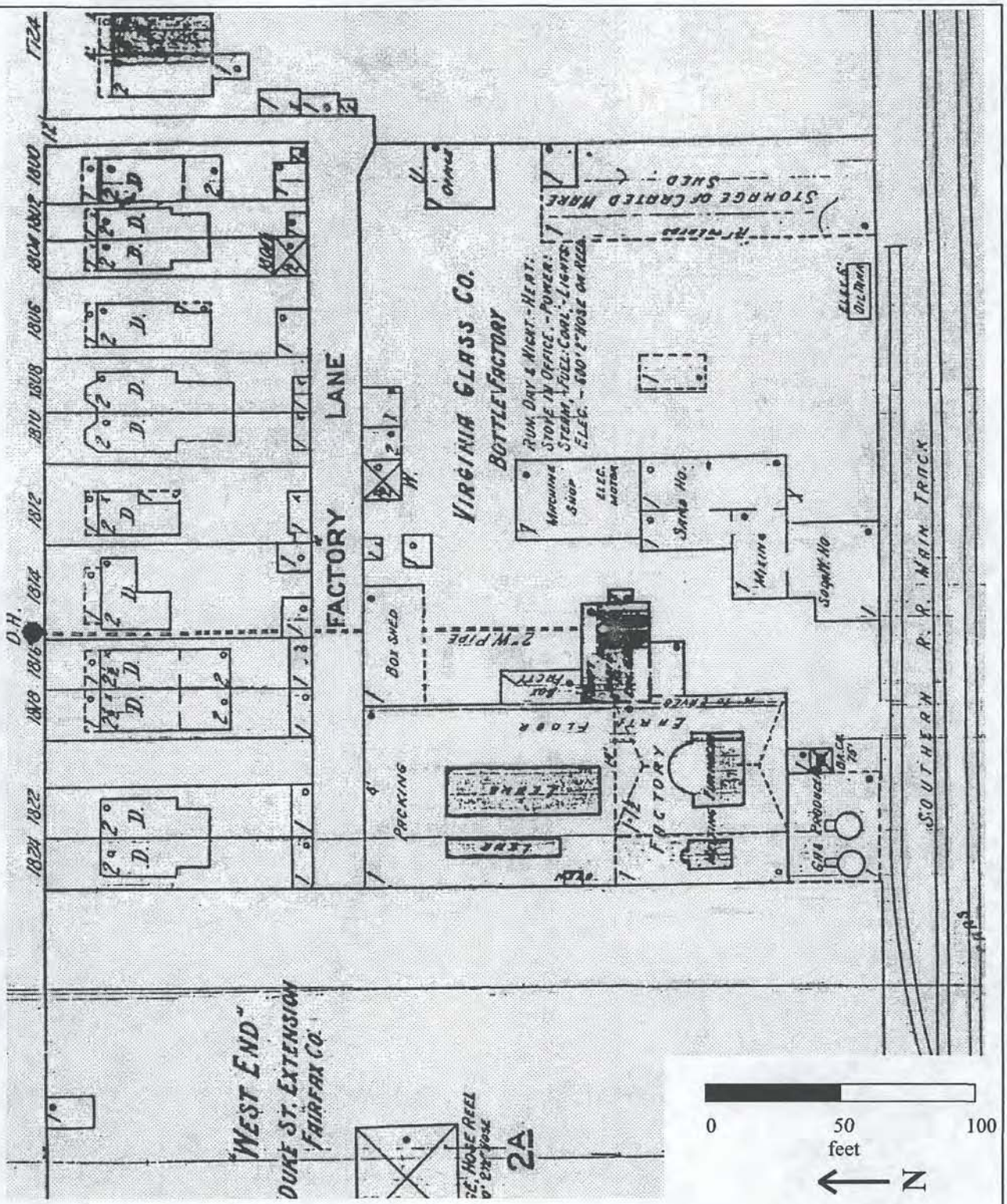


Figure 1-3. 1912 Sanborn Fire Insurance Map

furnace through a complex system of air flues or ventilation tunnels. The gas fuel created extremely high temperatures within the furnace.

Lehrs. Lehrs were rectangular brick tunnels located in a separate workspace in the factory. At the Virginia Glass Company, the two lehrs were located 15 to 20 feet north of the furnaces. Lehrs were used for annealing the bottles once they were molded. Annealing is a glass-strengthening process that reduces the internal stresses in the bottles, making them less likely to shatter. Trays of bottles entered the lehrs and were pulled by a conveyor through the heated brick tunnels. Extreme heat was required at the entrance of the lehr to partially re-melt the bottles. The heating and eventual cooling of the bottles within the lehr were carefully timed. Bottles exited the lehr ready to be packaged.

2.0 ENVIRONMENTAL SETTING

2.1 GEOLOGY

The project area is contained within the Atlantic Coastal Plain physiographic province and lies east of the fall line. The geology of Alexandria, Virginia, is part of the Potomac Formation, containing a series of unconsolidated deposits of gravel, sand, silt and clay from the early Cretaceous period. Secondary deposits of cobbles and gravel are commonly exposed in streambeds and river channels and on old marine and river terraces. Soils in the vicinity of the site have low permeability and groundwater is abundant because of the low relief (Obermeier and Langer 1986). Hooff's Run is less than a mile east of the project area and drains into Hunting Creek. Cameron Run is south of the project area and is a 0-4th order watershed that also drains into Hunting Creek. Historically, elevations in the project area ranged from 40 to 60 feet above sea level according to Civil War period maps (Barnard 1865). Due to nineteenth and twentieth-century site modifications, current elevations range between 34 to 35 feet above sea level.

Soils within the project area are classified as urban land. Naturally-occurring topsoil is absent in the project area. Terrace alluvium is the natural soil type for the areas to the immediate south and east of the project area on terraces above the Hooff's Run floodplain. Terrace alluvium consists of sand, gravel, silt and clay deposited by water; terrace alluvium is found along existing stream terraces (Obermeier and Langer 1986).

2.2 CLIMATE

The climate in the vicinity of Alexandria is semi-continental and humid. Summer and fall are generally dominated by tropical air masses originating in the Gulf of Mexico and moving northward. The cold drier Canadian air produces the winter systems (Mack 1966). The average temperature range is from 48.2 degrees Fahrenheit to 66.3 degrees Fahrenheit.

2.3 CURRENT CONDITIONS

The project area is a construction lot that had been previously stripped of any natural vegetation. It measures approximately 24,000 square feet. The area had been recently occupied by a section of the Station Shops that were built in the early 1960s (Figure 2-1). The area was still being cleared of debris from the demolition of a portion of the Station Shops when archeological testing began. Large concrete chunks and cinder blocks of the foundation were being scraped off of the surface at the time. During site leveling, fill was exposed where the Station Shops foundation floor had been removed. In some areas, the foundations and pipes could be seen through the fill, clearly defining the outline of the Station Shops building. Modern fill was visible on both sides of the foundation walls, consisting of dark yellow to orange sand mixed with blue stone gravel, sometimes including clay. In some areas, leveling exposed areas of historic fill so that large amounts of red brick, glass wasters, bottle fragments, and bottles were visible. The area east of and outside the Station Shops foundation showed evidence of recent unconsolidated fill, probably deposited when John Carlyle Street and the office building were constructed. After the remaining concrete chunks had been removed by mechanical equipment, the site was nearly level, ranging from 34 to 35 feet above sea level.

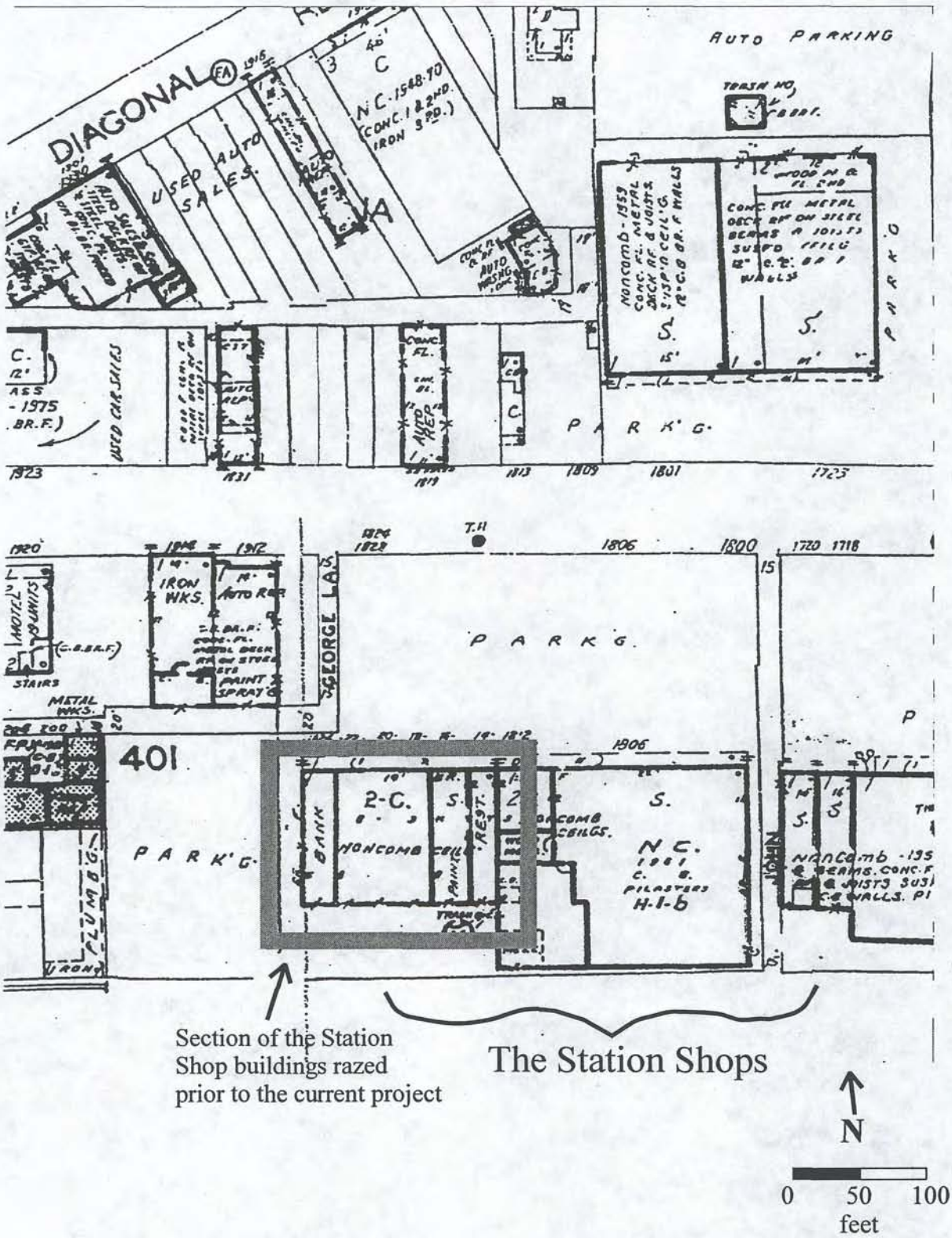


Figure 2-1. 1977 Sanborn Map Showing the Location of the Station Shops

3.0 RESEARCH QUESTIONS AND METHODOLOGY

3.1 RESEARCH QUESTIONS ADDRESSING SITE 44AX181

A series of questions was devised as part of the Phase II/III research strategy to recover as much information as possible about site 44AX181 and its historical significance to Alexandria. Each of these questions is addressed in specific sections of this report (section numbers appearing after each question provide the reference). A summary of the research questions appears in Section 9 (*Conclusions*) of the report. These questions include:

1. What historical information does the Virginia Glass Company provide about the rise, prosperity and end of glass manufacturing in Alexandria? (Section 5.3)

2. What can we learn about the growth of industrialization in the late-nineteenth century from studying this factory? (Section 5.3)

3. In what ways is the Virginia Glass Company similar to other bottle glass companies during this time of transitional technology? (Section 5.3)

4. What were the operations in the factory and the process of glass manufacture? (Section 5.3)

5. What light can be shed on the German community in Alexandria from the study of the Virginia Glass Company? (Section 5.1)

6. What was the trade sphere of materials produced at the Virginia Glass Company? (Section 5.4)

7. What were the sources for raw materials used for bottle production, and which companies did the Virginia Glass Company supply? (Sections 8.2)

8. What types of bottles were manufactured at the site? Were bottles from the Virginia Glass Company distinctive from those manufactured elsewhere? (Sections 5.3.1, 5.3.3., 8.2)

3.2 METHODOLOGY FOR HISTORIC RESEARCH

Historic research began at the onset of the Phase I archeological investigation. There were three objectives of this research: 1) prepare the historic context for Alexandria and West End; 2) provide a comprehensive background of the Virginia Glass Company; and 3) formulate and provide answers to the research questions.

Research began at *Alexandria Archaeology's* office with a review of previous West End archeological project reports. Pertinent land and tax records were reviewed at the Fairfax County Circuit Court and the Alexandria Land Records Office. Each deed for the project area was reviewed to compile a comprehensive chain of title. The Lloyd House Library in Alexandria provided articles from the *Alexandria Gazette*, as well as secondary sources. Many historic maps, newspapers and magazines were examined at the Virginia Room of the Fairfax County Library. Additional maps were acquired from the Library of Congress in Washington, D.C. Internet searches were particularly helpful in providing overviews of glass making. Specific entries in our glass glossary were derived from the *Corning Museum of Glass Glossary,* that was available on the Internet. Parks Canada's *Glass Glossary* (1985) provided information for the bottle analysis and glass glossary in this report (Appendix D).

Specific information regarding glass manufacturing and the Virginia Glass Company was acquired by examining nineteenth and twentieth-century glass factory business directories at the Library of Congress. Technical photographs and secondary sources were retrieved from the Corning Glass Museum of New York and the Baltimore Museum of Industry.

4.0 GENERAL HISTORIC BACKGROUND OF ALEXANDRIA, VIRGINIA

4.1 HISTORIC CONTEXT

This section focuses on the historic context for the site. Because the focus of this investigation was the historic glass factory, a prehistoric context was not relevant to the report and is not included.

4.1.1 Settlement Period (1749 - 1805)

European settlement in Virginia was preceded by Captain John Smith's visit to the Chesapeake Bay area around 1608. The notes from John Smith's travels include his map of Indian village sites along the major estuaries of Maryland and Virginia. Smith documented the activities, subsistence and customs of many groups, particularly the Algonquian-speaking Indians who occupied the banks and creeks of the Potomac River (Babour 1986). Fur trading was established in the early-seventeenth century between Anglo settlers and the Indians. The fur trade continued despite revolts by the Powhatan Indians against the English in 1622 (Carr 1988). In Northern Virginia, conflicts over territorial rights escalated to warfare again during the years 1675 to 1677, requiring the construction of fortifications along the rivers (Fausz 1988). Disease, warfare and starvation between the contact period and the eighteenth century resulted in the dramatic decline of Native American populations (Reinhart and Pogue 1993:28). These factors also contributed to the demise of the fur trade economy, which was gradually replaced by a tobacco production economy.

During the first half of the eighteenth century, Virginia trade was mostly confined to England, and the transport of goods was still limited to seagoing vessels. Soon, roadways were developed (generally in the locations of Indian paths) to facilitate travel of goods and mail from the piedmont areas to waterways.

English planters and indentured servants established settlements along the James River and Hampton Road. Soon after initial colonial settlement, the peninsula between the James and York Rivers was occupied (Rubin 1984). Additional European immigrants arrived in the Virginia piedmont during the second and third quarters of the seventeenth century. German and Scotch-Irish immigrants were among the first groups to move south from Pennsylvania and Maryland. Later, such individuals as Colonel Alexander Spotswood, John Stover and Adam Miller were instrumental in leading additional German and Swiss settlers into the valley areas of Virginia. Farming and milling settlements were common, but industrial communities were also formed during this time (Rubin 1984). Sheperdstown, Strasburg, Woodstock, Hamburg and Massanutten were all historic German settlements. Many religious backgrounds were represented, including Mennonites, Quakers, Tunkers and Lutherans (Wayland 1902).

Tobacco was an important cash crop in eighteenth-century Virginia and private tobacco warehouses emerged on the waterways. Historian Louis Rubin noted the importance of the Scottish merchants in the success of the tobacco industry at this time:

> The Act of Union in 1707 made it possible for Scottish merchants to find their way in the colonies. Establishing shops where tobacco was sold and shipped, they placed agents throughout the colony. Thrifty, good businessmen, they soon took over a goodly portion of the tobacco export trade and became very much a part of the Virginia scene [Rubin 1984:39].

Scotsmen organized tobacco exports from the first warehouse, which was located on Oronoco Bay on the south side of the Potomac River. The warehouse was constructed in 1732 and was one of the first centers of commerce in Alexandria (Harrison 1987:414). An act for erecting a town at the Hunting Creek Warehouse and the establishment of a Municipal Government of Alexandria was passed on May 11, 1749 (Harrison 1987:670). The plan of the city was laid out by John West Jr., the surveyor of Fairfax County. Philip Alexander, John Alexander and Hugh West owned the original 60-acre parcel that is now Old Town Alexandria.

The rugged paths and roads of Northern Virginia were essential for postal service and the transport of tobacco. One of the first roads connecting Alexandria with tobacco plantations to the west was the Colchester Road. The road began at the town of Occoquan, in Prince William County, and led to the Alexandria waterfront (Harrison 1987).

The Potomac River accommodated large seagoing vessels, enabling Alexandria to develop as a seaport. During the late-eighteenth century, Alexandria's waterfront property was reclaimed and wharves were constructed to increase the land surface. Alexandria's wharves really served two functions—to provide moorings for incoming or outgoing vessels and to expand the usable land of the waterfront. When construction included both fill and framework, wharves were substantial structures, large enough to accommodate shops and other buildings (Engineering Science 1993:96).

4.1.2 Mercantile Expansionism (1805 - 1850s)

The growth of Alexandria as a center of commerce was a paramount issue with local leaders. The depressed economy of the city had been a major concern of Alexandria's citizens during the early 1800s. In part, this economic depression was a result of trade embargoes established during the War of 1812 (Sharrer 1977).

Alexandria's ability to achieve economic success depended largely on transport of goods to and from points west and north of the city. The Potomac Company was chartered in 1785 with the goal of providing a canal system that would improve navigation on the Potomac River. The State of Virginia poured funds into the project that eventually opened its locks at Potomac's Great Falls. It was soon realized that the inadequate canal system operated by the Potomac Company was not sufficient to meet the needs of the growing merchant class (Shaw 1990).

The Alexandria Canal Company was established by charter on May 26, 1830. The plan of the canal company was to ultimately provide service to Virginia, Maryland, and the District. The first step of the process was for Alexandria to construct a bridge with an aqueduct on the

Potomac River. The aqueduct was completed and was regarded as an amazing engineering accomplishment for the time *(Alexandria Gazette* 7/29/1830*)*. By 1850, the canal systems were in operation but were difficult to maintain. The canals were recognized by local legislators to be an essential link in the economic success of Alexandria and the region. For this reason, the Alexandria Canal Company received assistance from the Virginia General Assembly for improvements and maintenance.

The Little River Turnpike Company was established in 1802 in an effort to improve local road transportation (Hills 1993). Initially, the costs of turnpike maintenance and improvements were difficult for the citizens of Alexandria to manage. But eventually the turnpike became a dependable route for transporting goods from northern and western Virginia into the city of Alexandria.

Interest in the Manassas Gap Railroad and the Alexandria and Orange Railroad began during the 1840s. Many local entrepreneurs made initial investments in these companies prior to 1850. Alexandria's reputation as a center of commerce was improving. This change in the economy during the 1850s increased city land values and led to the construction of churches, warehouses and industrial buildings (*Alexandria Gazette* 7/29/1830).

Modifications in the city government in the early 1800s included a new charter provided by Congress that divided the city into four wards and declared that a "common council" would be responsible for electing the mayor of the city (Sharrer 1977). It was not until 1843 that the charter was amended to allow the position of mayor to be determined for the first time by a voter election.

Prosperity and growth in Alexandria were evident in the large population increase between 1850 and 1860 and in the flourishing of local industry (Sharrer 1977). Small-scale processing industries and residences defined the working class character of the West End neighborhood of Alexandria. Mills, tanneries, butcher shops, taverns and hotels were built along the Little River Turnpike during this period of expansion (Hills 1993). The turnpike was a main

thoroughfare at this time because West End processing industries relied upon raw materials, such as grain and meat transported from the farmlands of Virginia, for their goods.

The slave trade was thriving in Alexandria just prior to the Civil War. During this period it was common for slaves to be crudely kept in local pens or holding facilities until the time of their sale. The Franklin and Armfield Slave Brokerage on 1315 Duke Street was one of the largest of these establishments in the area. Despite the large slave traffic, a free black community was already emerging. According to the 1820 Census, Alexandria's freed blacks, most of them industrial laborers, numbered 1,168 (Digilio 1978).

4.1.3 Civil War Period (1861 - 1865)

The military occupation of Alexandria during the Civil War period began with the arrival of Federal troops in May of 1861. General George McClellan, of the Army of the Potomac, was a major figure directing the defense of Washington from his headquarters at the Episcopal Theological Seminary in Alexandria (Hurd 1983). Largely because of its location and resources, Alexandria became a center of medical services for wounded soldiers. Many of these soldiers were from the Army of the Potomac and points west, such as Manassas, Virginia. Alexandria's general hospital filled to capacity rather quickly, so unit hospitals were built to augment existing facilities. The number of incoming wounded soldiers was so large that some Alexandria churches, homes, and military barracks were converted to hospitals. Residents of Alexandria sacrificed their time, homes and privacy during this difficult period and remained under martial law for the duration of the war. However, they accommodated the occupation with amazing effort.

Throughout the war, residents of Alexandria and West End neighborhood were engaged in providing the basic needs of military troops and of the large number of medical facilities in the city. The trains at Alexandria's four railroad stations and the roundhouse at Duke Street were in constant operation during the war. The four systems were merged to form the United States Military Railroads system. As part of this transformation, a track was laid to connect Alexandria

to Washington D.C. (Williams 1961). Free black workers were a major force in the construction of the Military Railroad. New neighborhoods in Western Alexandria, such as Sumnerville, were made up of free black laborers and their families during this period. The railroads were essential to the transport of military personnel and supplies, and they were heavily guarded and stockaded to prevent possible raids.

4.1.4 Post-War Industrialization (1865 - 1900)

The Civil War occupation of Alexandria substantially altered its economic base. Some businesses that had been thriving prior to and during the war closed down. The militia had been an unending source of trade for some businessmen. The loss of slave labor in the workforce made it costly and difficult to rebuild farms, commercial structures and railroads. The city sold railroad stock to pay off a massive municipal debt (Digilio 1978). Slow recovery was made even more difficult by the changed face of Old Town. Many historic structures had become tenements and the city had lost its elegance.

New small industries, such as the Virginia Glass Company, helped to revitalize Alexandria in the 1890s. Unlike neighboring cities such as Baltimore, Philadelphia, and Pittsburgh – where steel working was central to the economy – Alexandria's industries were more diversified, and not as extensive. The result of the new industrial base was an increase in the Alexandria workforce as well as a general population increase. The general growth trend in the 1890s was an indicator that Old Town and its peripheral neighborhoods could be revitalized.

4.1.5 Twentieth Century (1900-present)

Rubin indicates that the increase in manufacturing prior to 1920 was a boon to the economy of Virginia in general (1984). He states "the value of goods produced in the state rose six-fold and by 1920 more than half the state's population was no longer engaged in agriculture" (Rubin 1984:160). One of the large riverfront industries during the early 1900s was the Ford Motor Company Plant situated on Union Street. Workers were employed there until the plant

was shut down in 1933 (Engineering Science 1993). The torpedo factory, a munitions industry on Union Street, employed numerous citizens of Alexandria during this period.

After World War I, Alexandria's restoration was facilitated during the "New Deal" era, resulting in the flow of money into the city's economy. World War II provided economic opportunities for Alexandria through the placement of government military installations and industries of defense in the city (Rubin 1984). Cameron Station, built between 1941 and 1945, was a large war-period addition to the Western Alexandria landscape. The station functioned as a quartermaster depot during the war and upgraded and enhanced Alexandria's rail transportation.

In recent years, suburbanization has positively influenced the city's economy. Old Town Alexandria has the advantage of being close to Washington D.C. and has become a residential suburb of the capitol city. The Carlyle Project is one of many projects that is building mixed-use office and retail structures in the Duke and West Patrick Street corridors. This approach to development is facilitating growth in Alexandria's peripheral neighborhoods, changing both the workforce and the general population of Alexandria.

4.2 PREVIOUS ARCHEOLOGICAL INVESTIGATIONS

The West End area of Alexandria has been the focus of numerous archeological investigations. A large part of this work was due to the Carlyle Development Project that began in 1990; the remainder of the work was required by the general expansion of the Duke Street corridor. In 1990, the Norfolk Southern Corporation initiated the redevelopment of an area formerly called Cameron Yards. The original Carlyle Project encompassed approximately 76 acres of land, bounded by Duke Street on the north, Hooff's Run on the east, Eisenhower Avenue on the south and Mill Road on the west (Alexandria Archaeology 1994:1).

The Carlyle Project involved the construction of major high-rise commercial buildings, governmental and residential structures and the reconfiguration of small streets running north-

south off of Duke Street. Carlyle was re-subdivided into twenty lots in May of 1991 (Alexandria Land Records, Book 1332, Page 1542). One concern of the City of Alexandria prior to the onset of the Carlyle project was that these large-scale changes to the landscape would impact historic and prehistoric sites.

Prior to the initiation of the Carlyle Development Project, a Phase I archeological survey was performed by John Milner Associates in 1986 as part of an environmental assessment. The investigation was conducted on a 3,150 square-foot section of Duke Street, extending from the intersection of Duke and South Henry Streets to Elizabeth Street, to incorporate the proposed widening of Duke Street (Route 236). The authors of the report recommended additional archival research and further archeological investigation of the potentially impacted areas between 1100 and 1900 Duke Street (Cheek and Zatz 1986).

In 1986, Engineering Science conducted archeological investigations at 1315-1317 Duke Street (Artemel and Crowell 1987). Documentary research indicated that buildings at this address had served as a holding facility for slaves prior to the Civil War and as a prison during the Civil War. In 1878, Alexandria Hospital moved to this location for seven years. Residential use of these buildings resumed around 1885. Archeological investigation entailed test units placed in the yard and basement of 1315 Duke Street. These were the areas to be impacted during the proposed building and reconstruction. The site yielded a large number of features, occupation surfaces and artifacts, including a Civil War Period privy. The range of ceramic and glass artifacts recovered from the site was particularly interesting, characterizing the social stratification of the building's inhabitants over time.

Phase III excavations were performed at the Bontz Site (44AX103) and the United States Military Railroad Station (44AX105) by James Madison University Archaeological Research Center (Cromwell and Hills 1989). The sites are located on the south side of the 1700 block of Route 236 (Duke Street). Phase III investigations were performed to insure that widening Route 236, proposed by the Virginia Department of Transportation, would not impact any historic properties. The Phase III data recovery at the Bontz Site revealed subsurface architectural

remains associated with two nineteenth century residential/commercial structures. Sheet middens (layered deposits of historic refuse) to the rear of the structure provided valuable information about the butchers who occupied the site. Miller determined that there would be no negative impacts to the Bontz site and the United Stated Military Railroad Station site as a result of the Route 236 road widening. Miller recommended additional documentary and archeological studies of both historically-significant sites if construction were to impact the properties.

Engineering Science, Inc., conducted a preliminary historical and archeological assessment of the Cameron Mills Site 44AX112 (Knepper and Pappas 1990). They undertook archival research and prepared a history of the mills. Archeological testing included both mechanical and manual subsurface excavations. Structural features associated with the eighteenth-century mill and its nineteenth-century additions were found to be intact. Engineering Science, in conjunction with *Alexandria Archaeology,* recommended archeological monitoring of the mill remains during the process of filling the site. Because the site 44AX112 was not subject to direct impact at the time of the 1990 study, further work was not recommended for the mill remains. However, research questions were developed for additional archeological investigation of the site, should the property be modified in the future. Additional development, and therefore additional archeological investigation, is now pending for this site.

Tellus Consultants, Inc., prepared a cultural resource and documentary assessment for the Carlyle Project in 1991. This report established a predictive model for the proposed Carlyle development area that indicated a high potential for encountering historic properties (Miller and Westover 1991). A Phase II archeological investigation conducted by Tellus included some of the Carlyle Project's subdivided areas. Those were designated Area A, Area B, Block I, and the Alexandria African American Heritage Park. Trenching during the Phase II archeological investigation provided evidence that large sections of the project area were disturbed or contained contaminated fill from the twentieth century. Results from trenching indicated that significant resources might be located at the Shuter's Hill Brewery site (Area B) and the Federal Courthouse site (Block I). A report of the Phase II Report of the Carlyle project survey was prepared by *Alexandria Archaeology* in 1994. The report summarizes and maps the known

historic and prehistoric resources in Area A and Areas N, O and P of the Carlyle project area (*Alexandria Archaeology* 1994).

Engineering Science conducted the Phase I investigation at the Federal Courthouse Site (44AX164) in 1991. Based on the results of the preliminary assessment, both historic and prehistoric resources were present at the site (Pappas, Artemel and Crowell 1991). Engineering Science conducted Phase II and Phase III archeological studies at Site 44AX164 in 1994. Archeologists recovered artifacts dating from the prehistoric period and historic artifacts from the eighteenth and nineteenth centuries (Pappas *et al* 1993).

Further development of the Carlyle Property required Phase II investigations and Phase III data recovery of the Shuter's Hill Brewery site (44AX35). Engineering Science performed the investigation in 1996. Shuter's Hill Brewery was one of many industries of Alexandria's West End village. The brewery began operations around 1858 and later functioned as a saloon. It was a fixture in the village until a fire destroyed the building in 1893. During the 1996 excavation, the architectural features that remained—the basement and the lager beer cellar—were excavated. The artifactual remains date primarily to the use of the building as a saloon (Walker, Dennee and Crane 1996).

In 1992, *Alexandria Archaeology* and Tellus investigated the African American Heritage Park (Bromberg and Shephard 1992). The site (44AX136) is located east of Holland Lane, near Hooff's Run in Alexandria. The objective of the investigation was to determine whether the African American Cemetery was at this location and to provide a preservation strategy for any burial remains. Historic documents indicate that the African American Cemetery was purchased by the Baptist Cemetery Association in 1885 (Bromberg and Shephard 1992:3). It is one of the oldest African American cemeteries in Alexandria. *Alexandria Archaeology* made recommendations regarding the preservation of other cultural resources in the Heritage Park. The field methods involved mechanical trenching to uncover the burial remains; the investigation was successful in locating both graves and burial artifacts.

5.0 HISTORIC BACKGROUND: WEST END AND PROJECT AREA

5.1 DEVELOPMENT OF ALEXANDRIA'S WEST END NEIGHBORHOOD

5.1.1 The Village of Cameron

During the eighteenth century, a small village called Cameron arose near Hunting and Cameron Creeks. Cameron was a crossroads settlement that contained a few residences and two mills. The village became a small commercial center that could be approached by water or the Colchester Road (Schweigert 1994). Hugh West, and later John West, owned a large tract of land in the area and maintained a residence called "West's Grove" (Harrison 1987:139).

Until about 1760, northern Virginia was primarily a tobacco economy. However, during the late-eighteenth century, farmers realized the negative aspects of tobacco farming, such as the depletion of arable farmland. In European markets, the demand for wheat and refined flour products increased, and these products soon important among Alexandria's primary exports. Because of the perishable nature of produce, a dependable route into the city of Alexandria became essential. The Colchester Road, which had been the primary road for transport to Alexandria, was no longer adequate. By 1792, the Colchester Road was named Centre Street and connected with King Street rather than leading straight into Old Town (Cromwell and Hills 1989).

In 1795, the Company of the Fairfax and Loudoun Turnpike Road was established to build a dependable transportation route and to support commerce. Later, the road was named the Little River Turnpike; it was called Duke Street in the city of Alexandria (Hills 1993). The turnpike road was 50 feet wide and employed both scales and tollgates. When completed in 1812, the turnpike intersected the north/south Colchester Road (Williams 1977). Later, Colchester Road was shifted to the west (Figure 5-1).

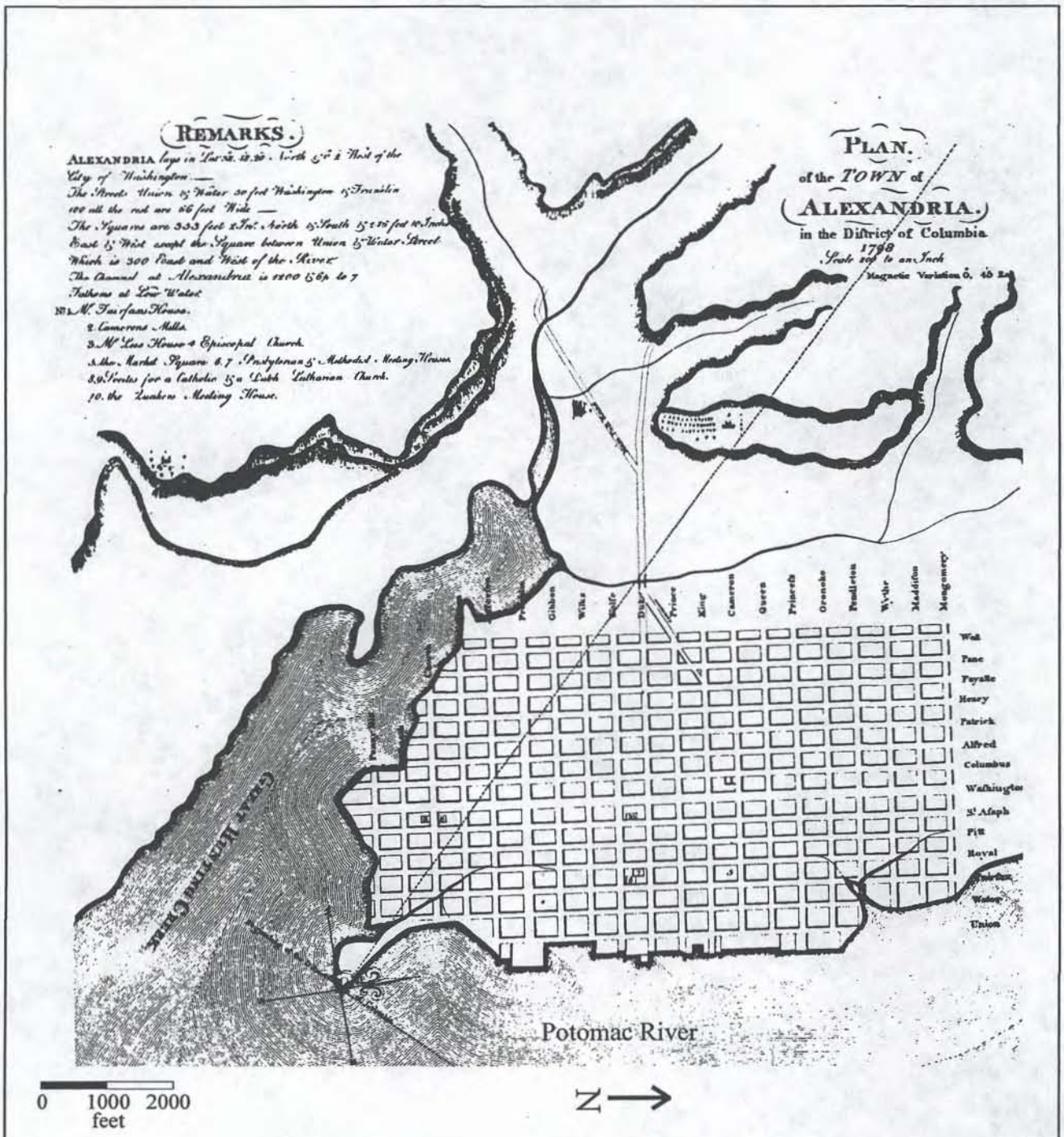


Figure 5-1. 1798 Map of Alexandria, Published by I.V. Thomas

5.1.2 The Village of West End

In the early 1800s, the first gate of the Little River Turnpike was constructed at the Colchester Road intersection. The turnpike gate changed Alexandria's incoming traffic pattern; travelers used the turnpike rather than King Street to enter the city (Hills 1993). The turnpike brought new traffic and eventually business to Duke Street. This was the birth of the West End Village (or Duke Street extension) of Alexandria. Small businesses rapidly cropped up in this area (T.M. Miller 1989). Bloxhams Board Yard, Simpsons Tavern, a soap factory and a tannery on Hooff's Creek were some of the early commercial ventures of this period that reaped benefits from their turnpike locations. Numerous structures were built along the turnpike, many of which were residential/commercial buildings. This new construction established the Little River Turnpike as the merchant corridor west of the city. During the first half of the nineteenth century, even in the wake of rapid commercial development, tenements and agriculture were still part of the West End landscape. Although businesses and residences fronted the turnpike, many backlots were still cultivated.

During the early-nineteenth century and throughout the Civil War, small-scale processing industries and commercial/residential structures characterized the West End village of Alexandria. This extension west of the city, defined primarily by the Little River Turnpike, was part of the Fairfax County jurisdiction. Although residents petitioned to incorporate West End as a township, it never happened. The neighborhood was distinct from the city of Alexandria in both social stratification and function. The gentry of Alexandria resided in Old Town proper or on large estates outside of town, as did the Dulanys of Shuters Hill. In contrast, the West End village housed craftsmen, owners of mills, tanneries, butcher shops, taverns, and hotels, a population that formed a significant stratum of working class individuals.

The population of West End's free black community of Alexandria increased during the early-nineteenth century, partly because of Alexandria's proximity to Washington. West End was on the periphery of Alexandria, which was exhibiting growth as a "secondary transport center" (Cressey and Stephens 1982:46). West End merchants benefited from Alexandria's

expansion during this period. Particular gains were made in the increased exposure to new industrial methods, patents, and technology.

5.1.3 Changes Brought About by the Railroad

The Alexandria and Fredericksburg Railroad brought increased business to West End. Originally chartered in 1848 as part of the Orange and Alexandria Railroad complex, the railroad laid tracks from Gordonsville to Alexandria (Williams 1977:53). The railroad and the local businesses--the Shuters Hill Brewery, a blacksmith shop, George Bontz's butcher shop, Drover's Hotel-- are shown in detail on the 1878 Hopkins Atlas (Figure 5-2). These establishments were accessible to the railroad, many of them within 350 feet of the tracks.

5.1.4 The Civil War in West End

Throughout the Civil War, the merchants of West End remained viable while meeting the increased demand for goods brought about by the military occupation of the city. The roundhouse located on the south side of Duke Street was a hub of activity for militia during the Civil War. It served as a depot for the United States Military, a staging area for troops, and a supply base for many of the battles that occurred within a 100-mile radius. It was also important for the transport of wounded soldiers to Alexandria hospitals (T.M. Miller 1989:280). Slough Hospital, transformed from military barracks, was one of the large Civil War Hospitals in West End, near Duke Street.

Neighborhoods of freed blacks grew in West End as a result of the enormous migration of black workers from the southern states to the Alexandria area during the Civil War. West End struggled economically during this period of depression. Although post-war recovery was difficult, commerce associated with the railways was still viable. According to Hurd: "The role of the railroads changed during the period between 1860 and 1880 from that of a supplier for the port of Alexandria, to being a transporting route between larger industrial cities" (Hurd 1983:9-

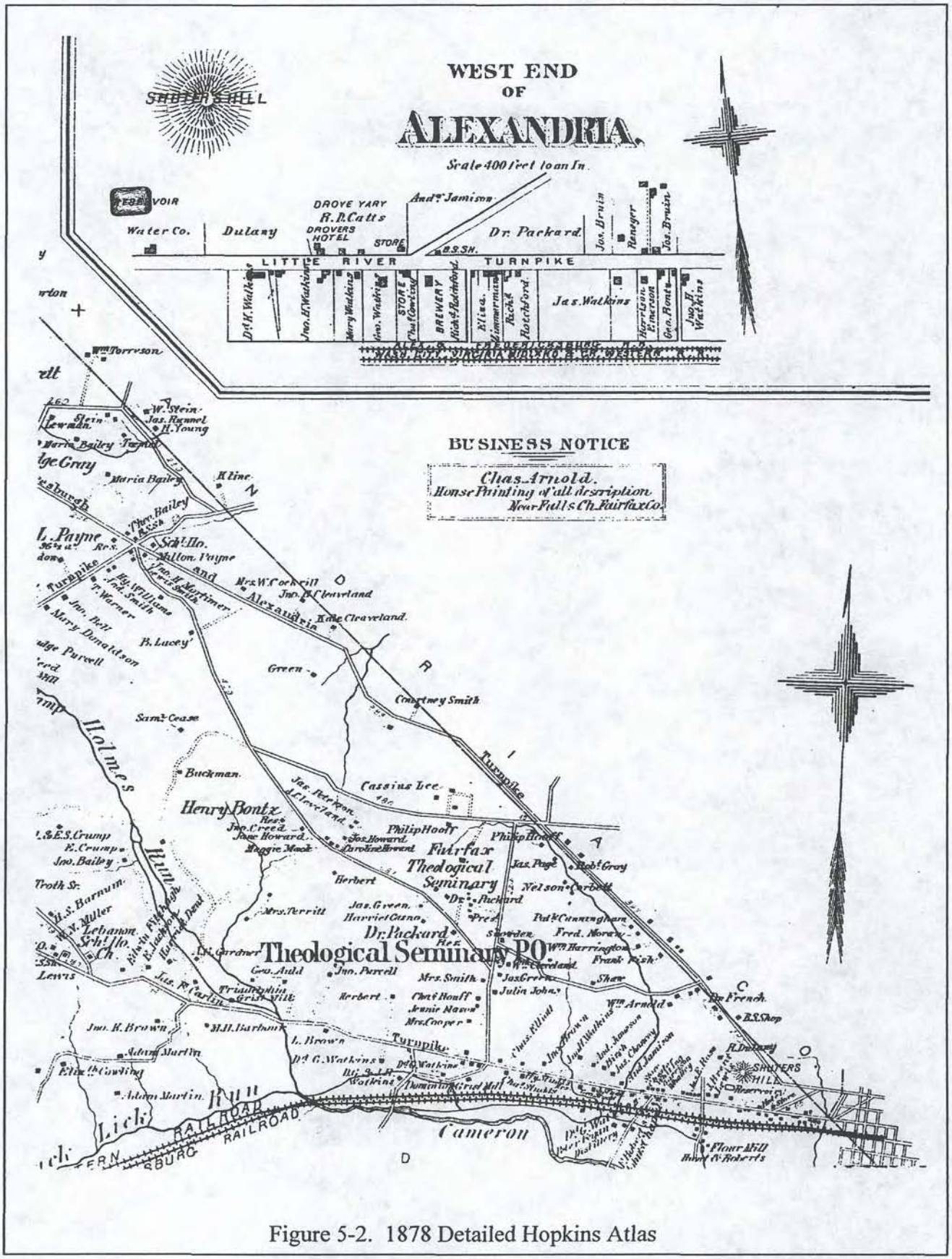


Figure 5-2. 1878 Detailed Hopkins Atlas

10). In West End, the Southern Railway extended its line toward the existing Orange and Alexandria Railroad complex, purchasing empty Duke Street lots for its expansion.

In general, the shift from commercialism to industrialism was realized later in Alexandria and West End than in larger Mid-Atlantic cities (Cressey and Stephens 1982). Evidence for this exists in the limited number of viable industries in Alexandria compared with other cities in the Northeast region during the 1870s and 1880s. Despite the lack of advanced manufacturing, West End appears to be commercially active, based on the 1878 Hopkins Map (see Figure 5-2).

The eventual advancement of industry in Alexandria during the 1890s was largely due to the introduction of electricity and gas power to the city in 1889 and mechanization brought about by the Industrial Revolution. New residential communities, such as Rosemont and Braddock Heights, were an outgrowth of economic change in Alexandria during the 1890s. Manufacturing and transport businesses clustered near the expanded railway system in West End.

The Virginia Glass Company was one of the new industries established in West End during this time. The company was established in 1893 by a cooperative group of six German glassblowers from Royersford, Pennsylvania. They joined an established enclave of immigrants of Germans descent who had migrated from Pennsylvania to Alexandria in the early-nineteenth century. They quickly became part of the fabric of the West End village. The glass-blowers were regarded highly within the Alexandria business community, and the demand for their products increased rapidly (*Alexandria Gazette* 1893:7:18).

Early-twentieth century residents of West End typically lived in rowhouses or low-rent tenements. The neighborhood grew based on the shift in the labor force from farming to manufacturing. In 1915, when Alexandria was annexed and enlarged, West End was incorporated into the city limits.

Currently, West End is characterized by commercial/retail areas. The proximity of West End to Interstate 95 has encouraged the growth of suburban housing. The Carlyle Development

Project has reconfigured the industrial area that used to be the Southern Railway Yards. The construction of high-rise buildings and facilities, such as King Street Station and the Federal Courthouse, have in many ways connected West End to Old Town.

5.2 LAND USE HISTORY OF THE PROJECT AREA

The project area passed through many owners during its long history. The chain of title is included as Appendix G of this report John West was one of the area's largest landholders in the village of West End. His sons, John and Thomas, inherited several large tracts of property when he died in 1777 (Fairfax County Will Book D: 4). This conveyance included a 313-acre parcel that was half of the original Carr & Simpson patent.

In 1796, John West, Jr. subdivided his "West End" tract into small lots and leased them. Some of the first homes in West End were on these lots. He farmlet a two-acre parcel to Richard Hewitt in the same year with the provisions that he:

> raise a house of brick, stone, or framed, on each half acre lot hereby leased (to wit Nos.3, 4, 13 and 14) each of the sixteen feet square at least with a brick chimney, two windows with twelve lights each and to complete the same by plastering and white washing in a workman-like manner together with everything else necessary to make it a comfortable and convenient dwelling house [Fairfax County Land Records Z-1:243].

Hewitt's parcel in the subdivision was situated within the Carlyle project area and included Lots 3, 4, 13, and 14. The four lots were roughly equivalent in size to a block in the West End village. The four lots formed a parcel that was bounded by the turnpike on the north, George Street on the east, Wolfe Street on the south and Catherine Street on the west.

Richard Hewitt conveyed 2/3 acre of the parcel back to John West in 1798 for a grain of corn annually (Fairfax County Land Records [FCLR] A-2: 438). Between 1806 and 1853, at least one tenement was built on the northwest corner lot of the two-acre parcel. Records indicate that there may have been several tenements. In addition to Hewitt, the Trydal family leased sections of the property.

The Lyles family acquired the parcel prior to 1853. Elizabeth Lyles' children, Josephine, David, George and Mary, inherited the parcel when she died. In 1854, Thomas Abbott and Mary Elizabeth Lyles sold the entire property to Thomas Javins (FCLR S-3: 298). The 1864 Barnard Map depicts a structure in the northeast corner of the two-acre parcel right on Duke Street (Figure 5-3). This map indicates a residence may have been standing at this time. Thomas Javins maintained the property for fifteen years and sold it for a price of $1,610 to Edward Javins in 1869 (FCLR K-4: 177).

Review of tax and land records for this time period did not provide information regarding the land-use of the two-acre parcel. Although other lots along Duke Street were developed by small commercial businesses prior to the 1860s, maps depict this two-acre parcel as a residential yard for a long period of time. The Alexandria and Fredericksburg Railroad Company purchased part of the southern section of the two-acre property during the early 1870s and later condemned approximately 3/4 acre of this land (FCLR N-5: 251).

In 1871, Edward T. Javins conveyed the property to Cassius Auger for the sum of $1,000 (FCLR M-4: 201). Javins conveyed the property to Wesley and Catherine Makely. It is probable that a structure was built on property under the Makely's ownership, for in the 1875 Deed of transfer from the Makelys to Ida Watkins, buildings valuing $1,750 are mentioned (FCLR U-4: 26). This is probably the estate that is mentioned in later deeds. The Watkins residence fronted Duke Street in the northeast corner of the two-acre parcel, as indicated on the 1878 Hopkins Atlas. The remainder of the two-acre property appears vacant, except for the railroad tracks at the rear of the parcel (see Figure 5-2; Figure 5-3 and Figure 5-4). Tax records for the Ida Watkins estate in 1876 show that the land value for the two-acre lot had increased to $1,100.

The deed for the 1892 property transfer from Ida Watkins to William Winston mentions a twenty-foot alley that began 120 feet south of Duke Street then paralleled Duke, running east to west across the entire block (FCLR N-5:251). The alley was maintained in the same location for

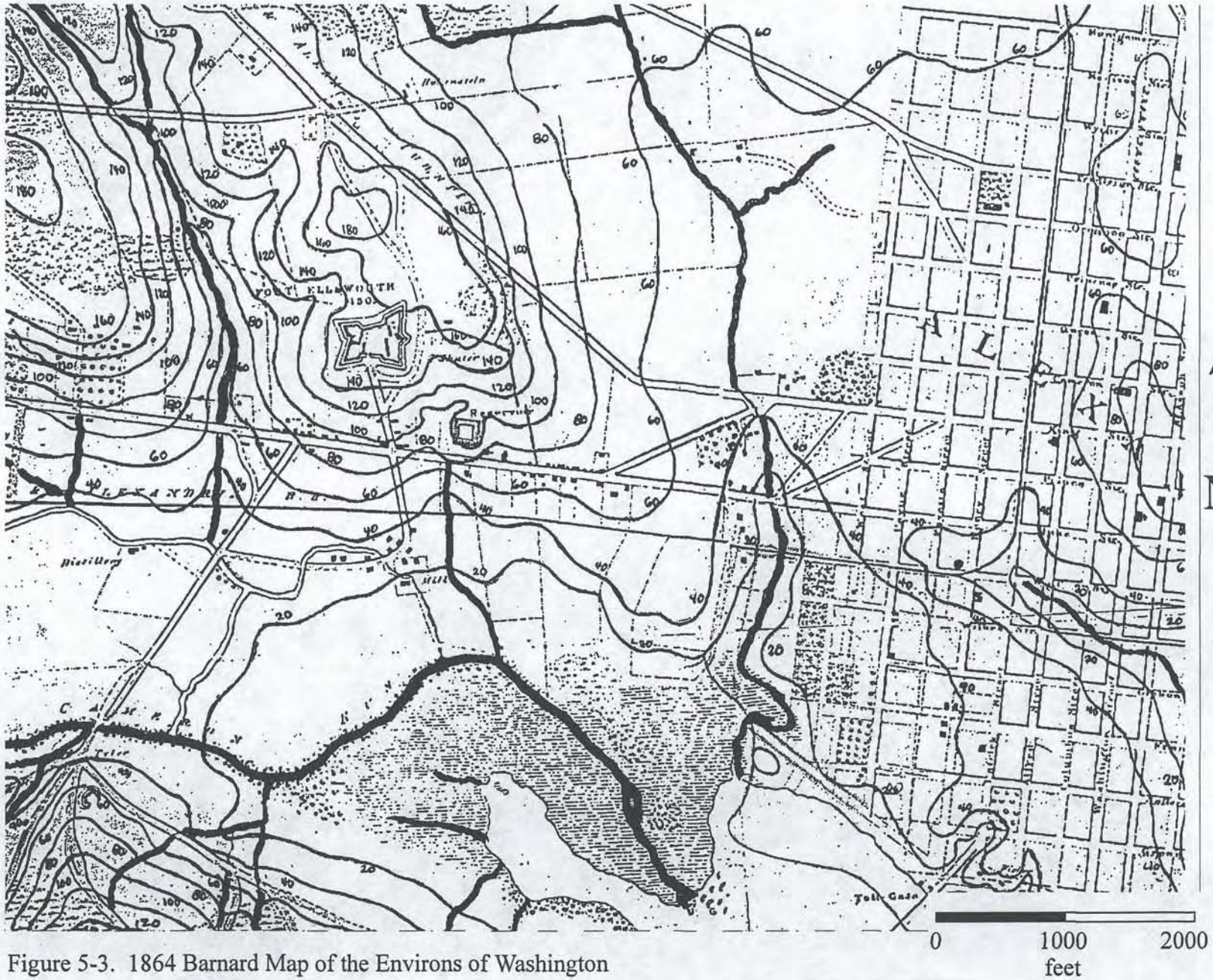


Figure 5-3. 1864 Barnard Map of the Environs of Washington

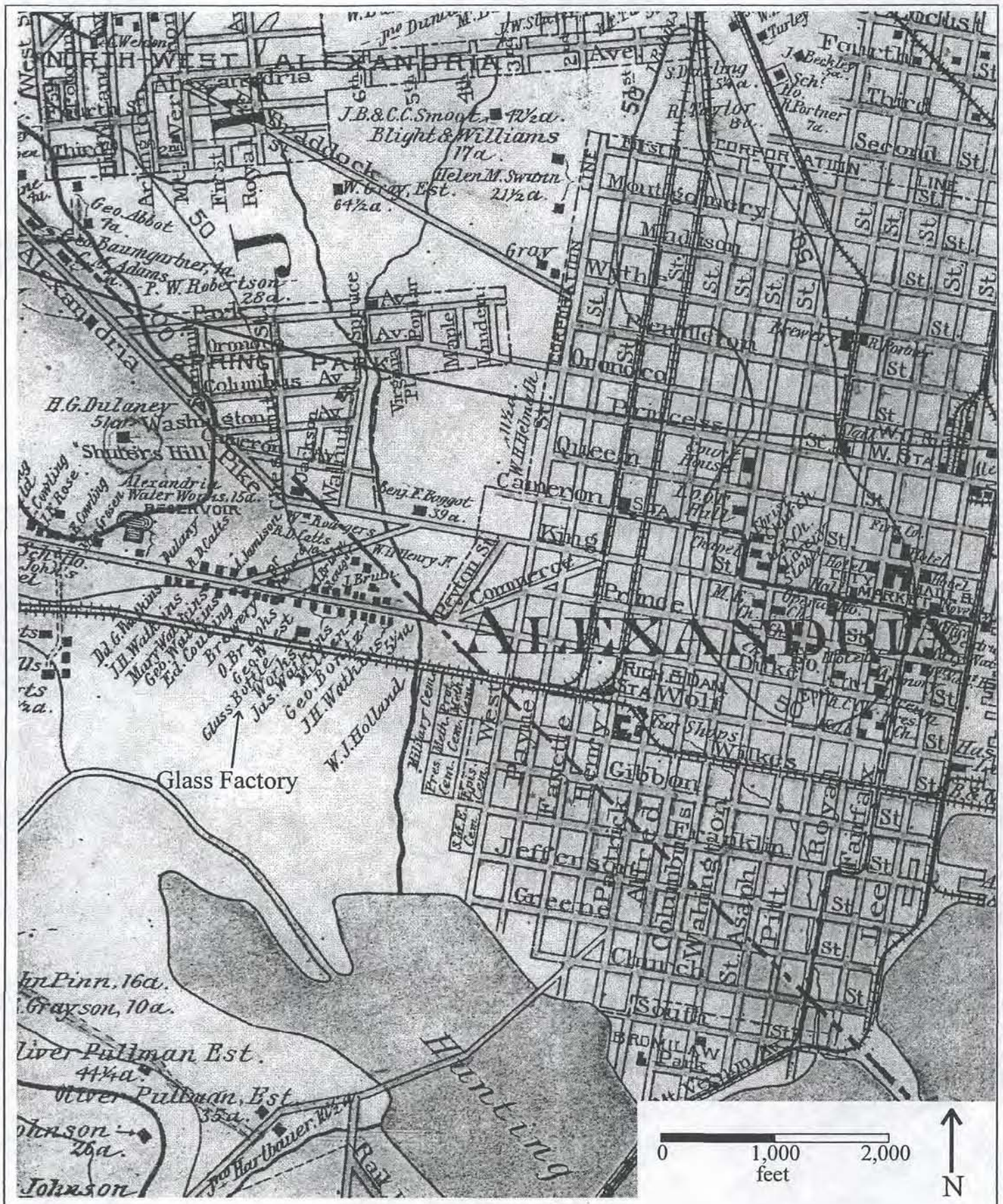


Figure 5-4. 1894 Hopkins Atlas

at least twenty years. Later in 1892, William Winston conveyed a northern section of his property to L.E. Winston (FCLR N-5:331). This was a 40-foot by 100-foot lot situated on 1822-1824 Duke Street and 60 feet west of Rochford's line. The deed contained an agreement that no building would be erected within 20 feet of the north property line. Two residences are shown on the 1907 Sanborn Fire Insurance Map (Figure 5-5).

In 1893, William Winston sold the southern portion of his property to Andrew J. Christie, Peter Astryke, John S. Bordman, Joseph H. Ramsey, Lorenzo Wolford, George H. Schwartzman, Henry Schnell and Edward Reese of Royersford, Pennsylvania (FCLR O-5:244). These gentlemen were the founders of the Virginia Glass Company.

The Glass Factory is depicted on the 1894 Hopkins Atlas (Figure 5-4). The glass factory parcel was situated south of the Watkins 20-foot alley, 185 feet to the Washington Southern Railway, 305 feet west across the block and back up to the alley. The alley was titled Factory Lane on the 1907 and 1912 Sanborn Fire Insurance Maps (Figures 5-5 and 5-6). It divides the parcel that belonged to the Virginia Glass Company from the Duke Street rowhouses or duplexes to the north. These structures were built in the late-nineteenth and early-twentieth centuries.

The Virginia Glass Factory occupied the project area until at least 1916. Improvements to the factory (such as additional furnaces, a packinghouse, a machine shop, and an office) occurred throughout its years of operation. These buildings apparently fit within the parcel originally purchased in 1893, for there are no records of any additional property acquisitions by the Virginia Glass Company at this location.

Twentieth-century maps do not show any structures in the project area from the 1920s until 1961. The Station Shops, commercial buildings housing both a bank and a restaurant, were constructed on the property between 1959 and 1961 (see Figure 2-1). A parking lot was located north of the building; it extended from the Station Shops building north to Duke Street. The western section of the shops occupied the property even after the Carlyle Development Project was initiated in 1991 (Alexandria Land Records [ALR] Book 1332, Page 1542). The properties,

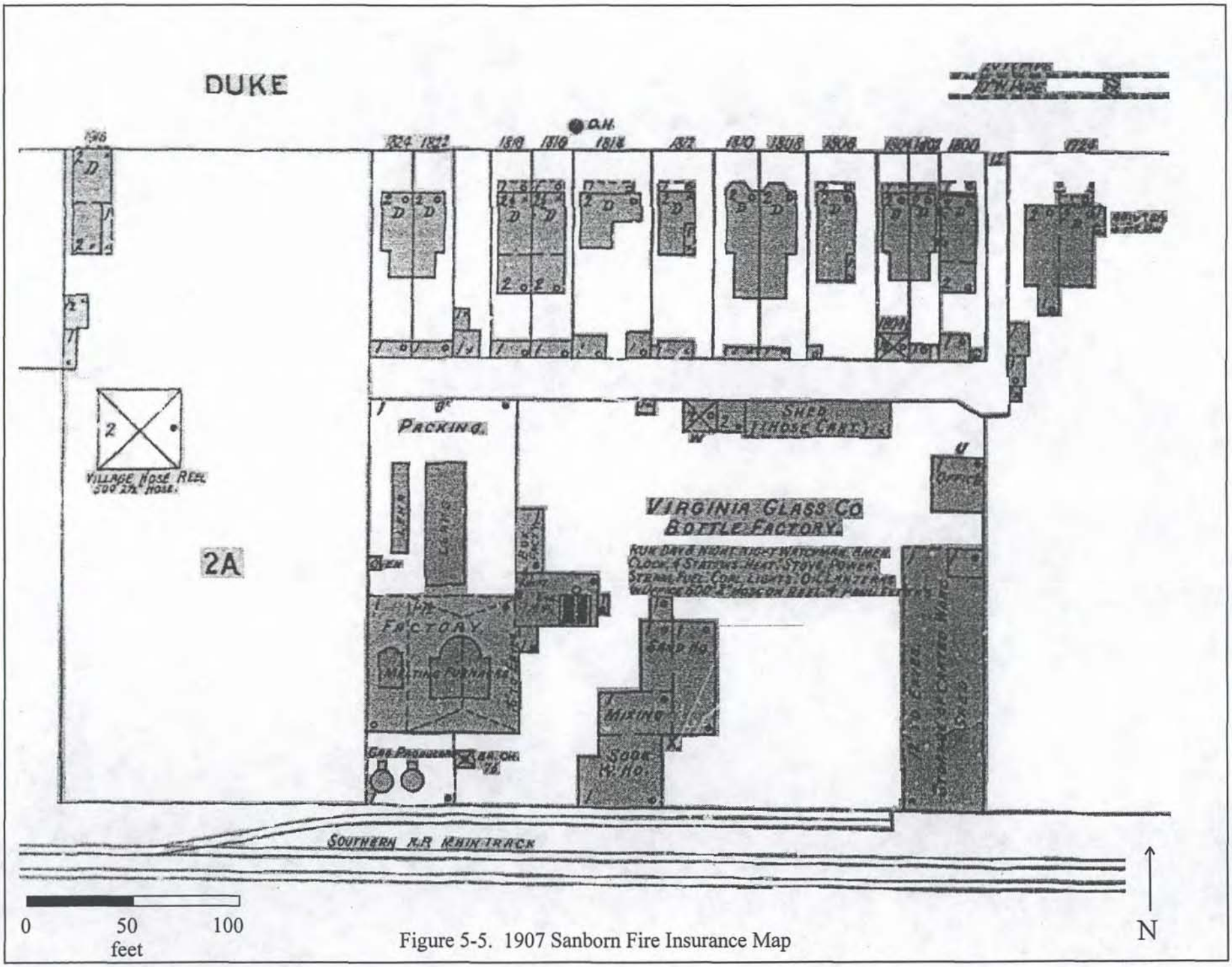


Figure 5-5. 1907 Sanborn Fire Insurance Map

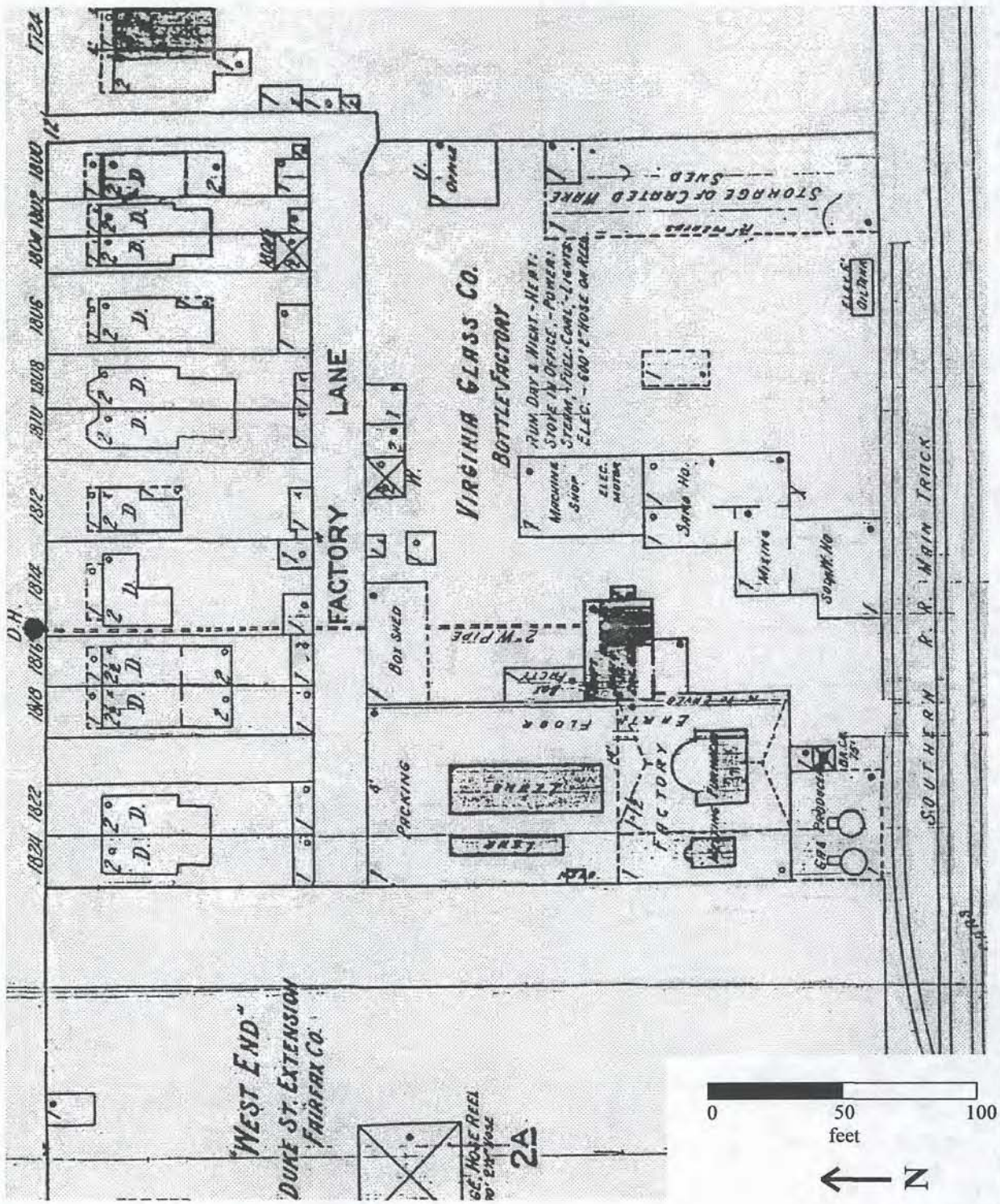


Figure 5-6. 1912 Sanborn Fire Insurance Map

belonging to Alexandria-Southern Properties, CNS Limited Partnership, Atlantic Investment Company, the City of Alexandria, and the United States of America, were consolidated in 1991, and the lots were subdivided into "Carlyle". In 1994, the lots were re-subdivided as part of Carlyle Development Corporation (ALR: 1510:0160). Sections of the Station Shops building were demolished as part of the Carlyle development project.

5.3 THE VIRGINIA GLASS COMPANY (BY: RICHARD O' CONNOR)

The Alexandria Glass Company (renamed the Virginia Glass Company in 1895) of Alexandria, Virginia (1894-1916) was a small glass factory that produced bottles for beverages, various medicinal remedies and general food packaging. It was the first glass firm in Alexandria, Virginia, and the only bottle-making company in Virginia in the 1890s. Founded by glass workers from Royersford, Pennsylvania (the site of a large bottle factory), the Virginia Glass Company operated as a hand-production plant throughout its brief existence. The company periodically renovated its melting technology, successively utilizing increasingly-sophisticated furnaces and shifting from direct coal-firing to producer gas. Although it survived one fire in 1895, a second major fire in 1916 closed the plant permanently.

5.3.1 Melting Technology

At its founding, the Alexandria Glass Company melted glass in pots in a coal-fired furnace, the most traditional of techniques (Commoner & Glass Worker 1894). Pots were large, open-topped vessels built of clay "as pure as possible and very refractory, breaking with a clear, smooth, bright fracture, unctuous to the touch, free from lime and sulphide of calcium, the least iron possible being most desirable" (Biser 1899:70). Pot clay was mined in areas of large coal deposits, principally in Pennsylvania, New Jersey and Missouri, weathered to oxidize organic elements, dried, sorted and cleaned. Domestic clays were mixed with imported varieties, particularly German clays, and "leaners" (ground "potsherds" or burnt clay), to produce a composition with the desired qualities of plasticity, infusability and stability. After it was seived and mixed with water, clay was kneaded, either by tramping with bare feet (treading) or by

passing through a pug mill, to thoroughly bond materials and remove air bubbles that caused cracking during drying. Once clay was prepared, pots were built slowly, layer upon layer. They were allowed to dry for a prolonged period, from four to twelve months, depending on size and composition, before being tempered in a pot arch (a special furnace dedicated to pot tempering). Pots were made to resist three dangers: the weight of the glass, the intense heat of the furnace, and the corrosion of raw materials in the batch (Biser 1899:70-75; Weeks 1880:40-41).

Small by contemporary standards, the pot furnace of the Virginia Glass Company was very likely a direct coal-fired, reverberatory furnace of a type common in glass houses throughout the northeast and mid-west. It is possible that some of the bricks from the early reverbatory furnace were re-used in the construction of later tank furnaces, but there is no direct evidence of such re-use. Built of bricks or blocks (called refractories), these bottle furnaces were generally oblong in shape and consisted of a combustion chamber and a wind passage, commonly known as a cave. Separating the two was a grate that supported the fuel and a "siege" or bench that held the pots. A powerful draft drew air through the cave and through the coal piled on the grate, creating a fire of great intensity. The flames and heat reverberated off the "low, flattened arch" that formed the ceiling of the combustion chamber and played off the pots, heating the batch without touching the glass directly. Bottle furnaces provided an opening along the side for each pot, granting access for gathering the glass and charging the pot, at the same time creating an additional draft that drew the melting flame more directly around the pots (Figure 5-7).

The Virginia Glass Company contained only three melting pots (Commoner & Glass Worker 1894, 1895). It was one of the smallest furnaces listed in the glass factory directories, at a time when other glass factories generally held eight or ten pots. This small size suggests production for a small, local market (Weeks 1880:35-36; Biser 1899:59-61). Scoville notes that "by the period 1861-1880 the ten-pot furnace was quite common..." (1948:27).

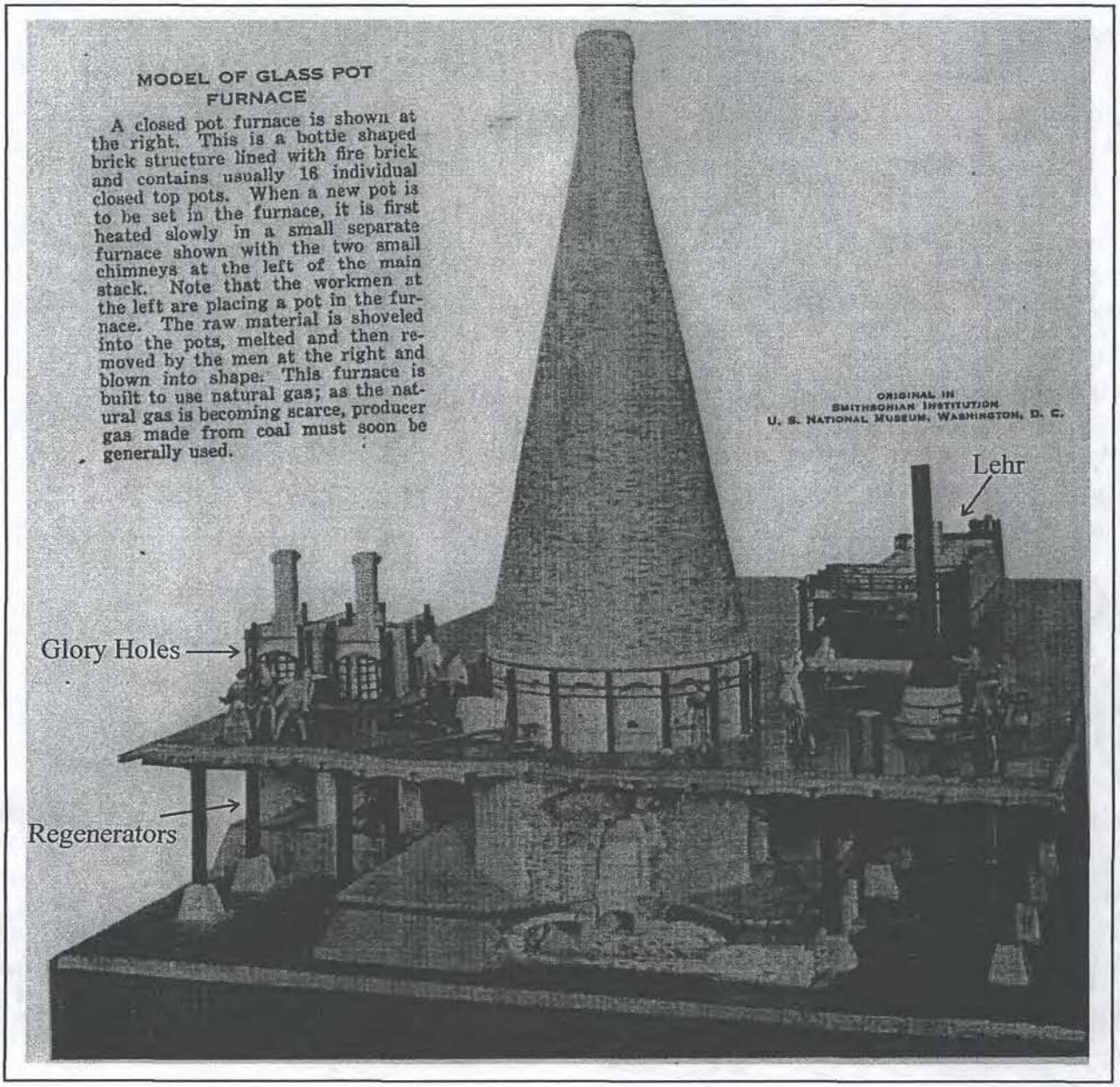


Figure 5-7. Model of a Pot Furnace. NOTE: this furnace contained closed pots and was used for melting flint glass. Pot furnaces for bottles did not use closed pots, and were oblong rather than round. This figure illustrates the cave area beneath the furnace (note regenerators), the glory holes where workers reheated glass (to left) and the lehr where glass was tempered (to right) of furnace. Source: Samuel S. Wyer, *The Smithsonian Institution's Study of Natural Resources applied to Pennsylvania's Resources* 1923, p. 88.

Within two years of its construction, the Virginia Glass Company completely abandoned pot furnace technology in favor of tank melting, with the corollary adoption of gas fuel. Tanks were not direct-fired by coal. Tanks had become very popular with glass makers in the United States in the 1890s as a result of the work of Frederick Siemens and others who developed tanks, gas melting and regeneration in the decades following 1860. The use of tanks freed glass workers from the vicissitudes of pot manufacture and the debilitating effects of pot breakage, permitted increased production, and facilitated greater uniformity in glass quality. Because direct firing did not work well with tanks, the adoption of tank melting was accompanied by the switch from coal to gas as a fuel. Gas was supplied either from natural deposits (in western Pennsylvania, Ohio, Indiana and West Virginia in this period) or by coal-fired gas-producers (in the case of the Virginia Glass Company). Indirect firing achieved its best results when gas and air were preheated, either in brick chambers called regenerators or, as at the Virginia Glass Company, through recuperation using heat exchangers, before achieving combustion in the tank itself.

In 1896, the Virginia Glass Company replaced its small three-pot furnace with a day tank melting the equivalent of eight pots per day (Commoner & Glass Worker 1896). Day tanks, also called periodic tanks, were charged at the end of the day and melted batch at night, preparing the "metal" for working during the next day. They melted relatively small quantities of glass, especially when compared to continuous tanks. Day tanks were oblong, allowing room within the melting chamber for melting and fining the batch. The working ends of day tanks in the bottle industry were generally semi-elliptical, a shape that tended to increase temperature uniformity. At each working hole, a ring, or gathering vessel, reached near the bottom of the tank to bring the most refined "metal" to the surface for gathering and working. Production at day tanks differed significantly from pot furnace practice, especially in output. Instead of individual pots each melting the equivalent of a day's worth of glass for a blowing shop, the day tank melted enough glass to supply several shops for a single day (Devilliers and Vaerewyck 1937:49-50; Biser 1899:61; Nagel 1909:102-108; Scoville 1948:28,76; Davis 1949:141-142).

The Virginia Glass Company worked with the day tank for only three years, its advantages over the pot furnace notwithstanding. In 1899, they replaced the day tank with an even more sophisticated technology, an eight-ring continuous tank (Commoner & Glass Worker 1899). The continuous tank was developed in England by Frederick Siemens and was widely employed throughout the glass producing countries of Europe in the later 1870s and 1880s. The continuous tank gained in popularity with American manufacturers in the 1890s. By the turn of the century, when the Virginia Glass Company installed its new, eight-ring tank, the Census of Manufactures noted that "(b)ottles of all kinds are being made from the continuous tank, and the bulk of the fruit jar and beer bottle production is made in this manner" (O'Connor 1991:9). Continuous melting had three principal advantages over the pot furnace and the day tank. Unlike both previous melting systems, where at least one-half the time was lost to cooling, settling, working, and reheating, the tank heated batch continuously. The new continuous tank resulted in improved glass quality due to the higher and more uniform temperatures and a constant level for gathering. Similarly, the elimination of fluctuating temperatures enhanced furnace durability. Because the tank was continuously charging, the number of men needed to charge and attend the melting operation was reduced. Probably its most significant advantage lay in the rationalization of the production process: by transforming a discrete process into a continuous process, the tank made glass production possible on a twenty-four hour basis for the first time (Figures 5-8, 5-9, 5-10) (O'Connor 1991:9; Biser 1899:61-63; Nagel 1909:102-103; Stein 1958:185-200; Devilliers and Vaerewyck 1937:68-71).

All indirect-fired melting tanks preheated producer gas and air for combustion as measures of economy. Air and gas combust at the port, shooting flames across the tank above the glass bath (Figure 5-10). Waste gas exhausts from a tank furnace at approximately 2700 degrees Fahrenheit, carrying into the atmosphere potentially usable heat. Tank furnaces utilized one of two different methods of recapturing that heat: regeneration or recuperation. In regeneration, exiting exhaust gases preheated stacked brick regenerators located on the sides of the tank. Intake of fuel and air was alternated from one side of the tank to the other, preheating gas and air as they passed through the regenerators. Recuperation involved the simple transfer of heat between the exhaust flue and incoming air flue, preheating air to approximately 1100-1400

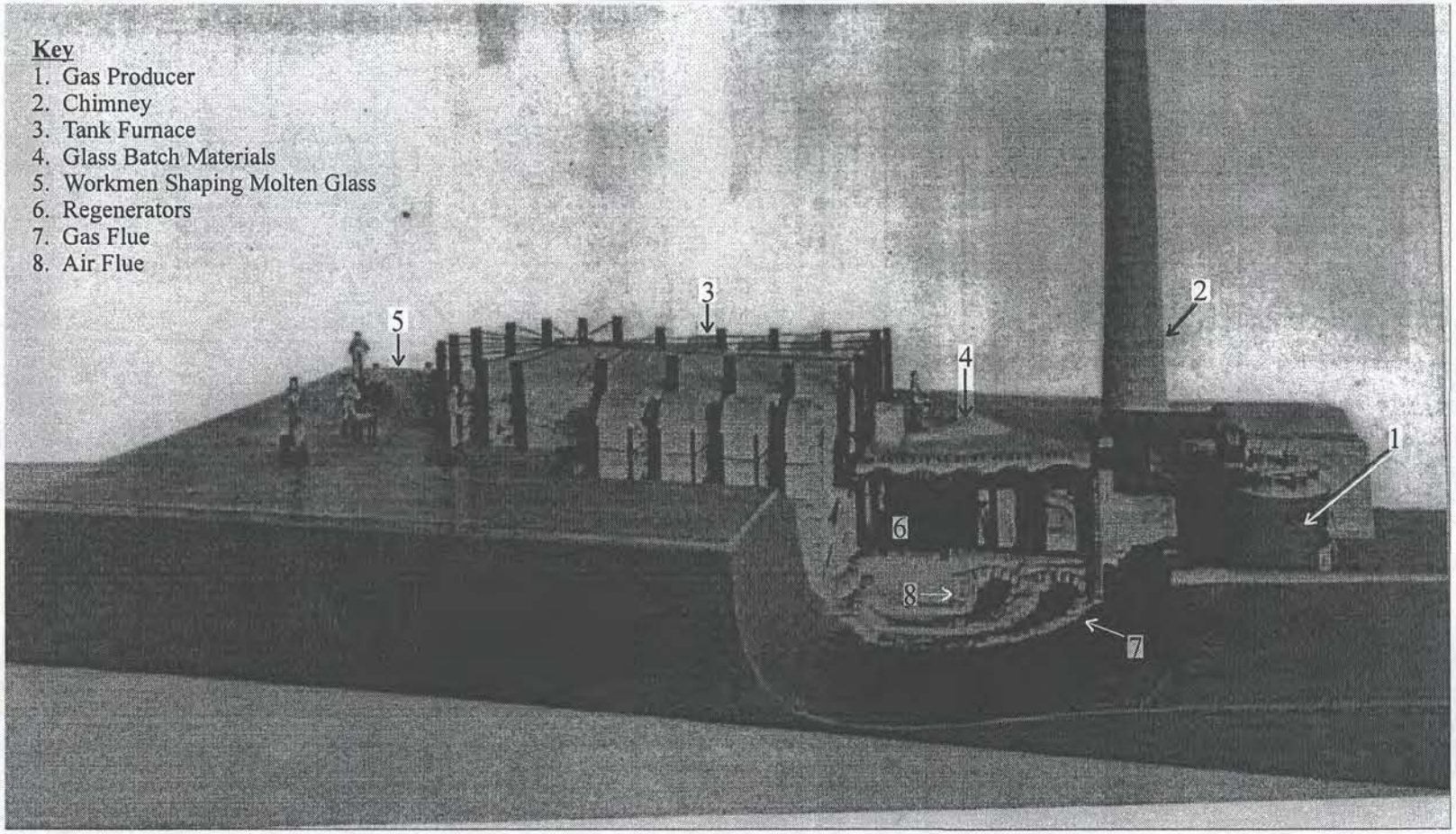


Figure 5-8. Model of a Continuous Tank Furnace with Attached Producer Gas Plant. This was probably modeled on a bottle glass furnace. It is a side-port furnace (where fuel and air enter from the side and flame plays across the batch) with brick regenerators below the side wings of the furnace and working area to the elliptical front. The other type of furnace (an end-port furnace where fuel and air enters from the end and flame plays lengthwise over the batch) is illustrated on the next figure. Note the gas flue coming from the gas producer and air flue from the chimney stack. Source: Samuel S. Wyer, *The Smithsonian Institution's Study of Natural Resources applied to Pennsylvania's Resources* 1923, p. 89.

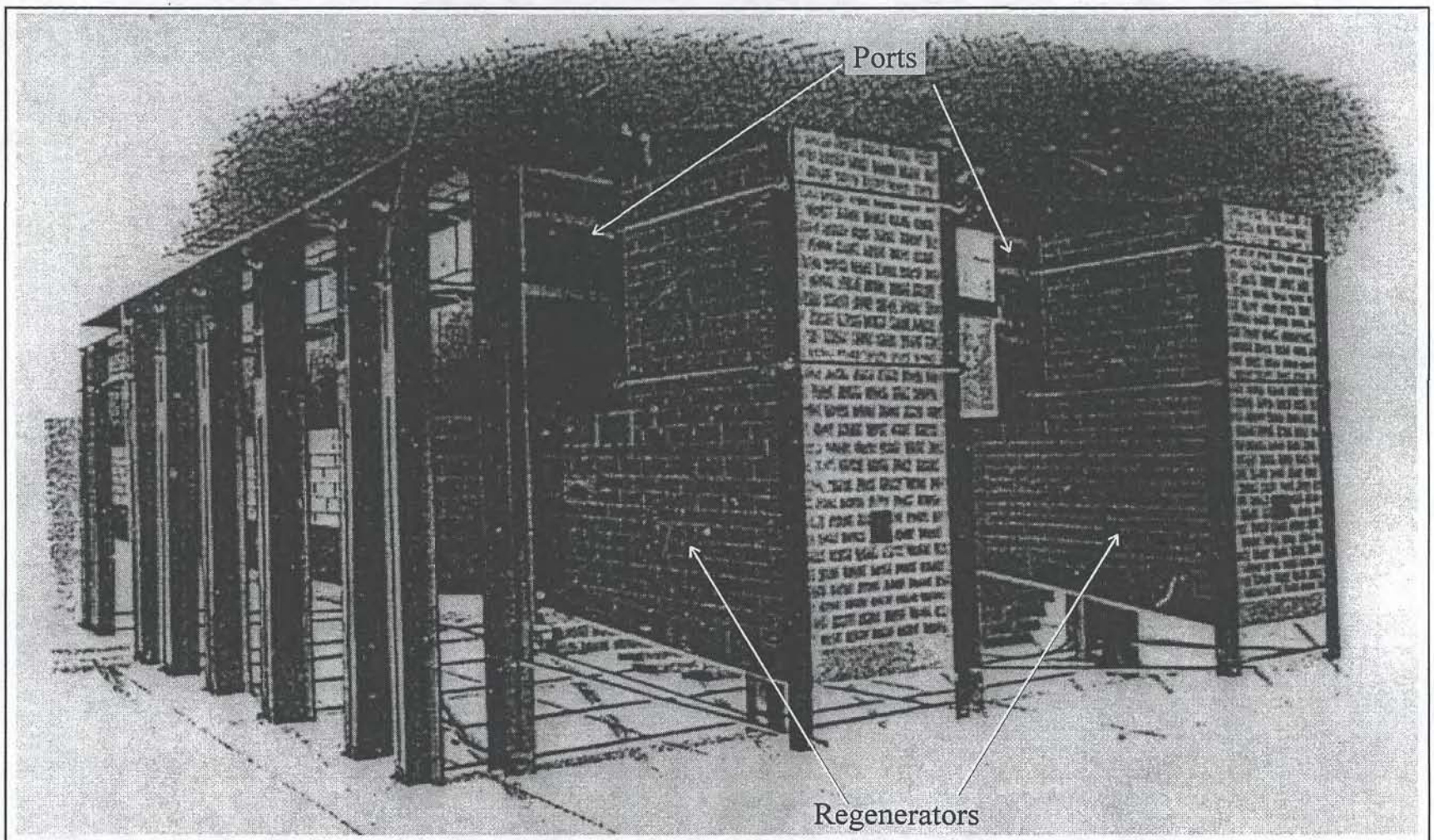


Figure 5-9. End-Port Furnace (where fuel and air entered from the end and flame played lengthwise over the batch), with Regenerator Chambers below Ports. Source: H.L. Dixon, *Everything for the Glass House*, 1908.

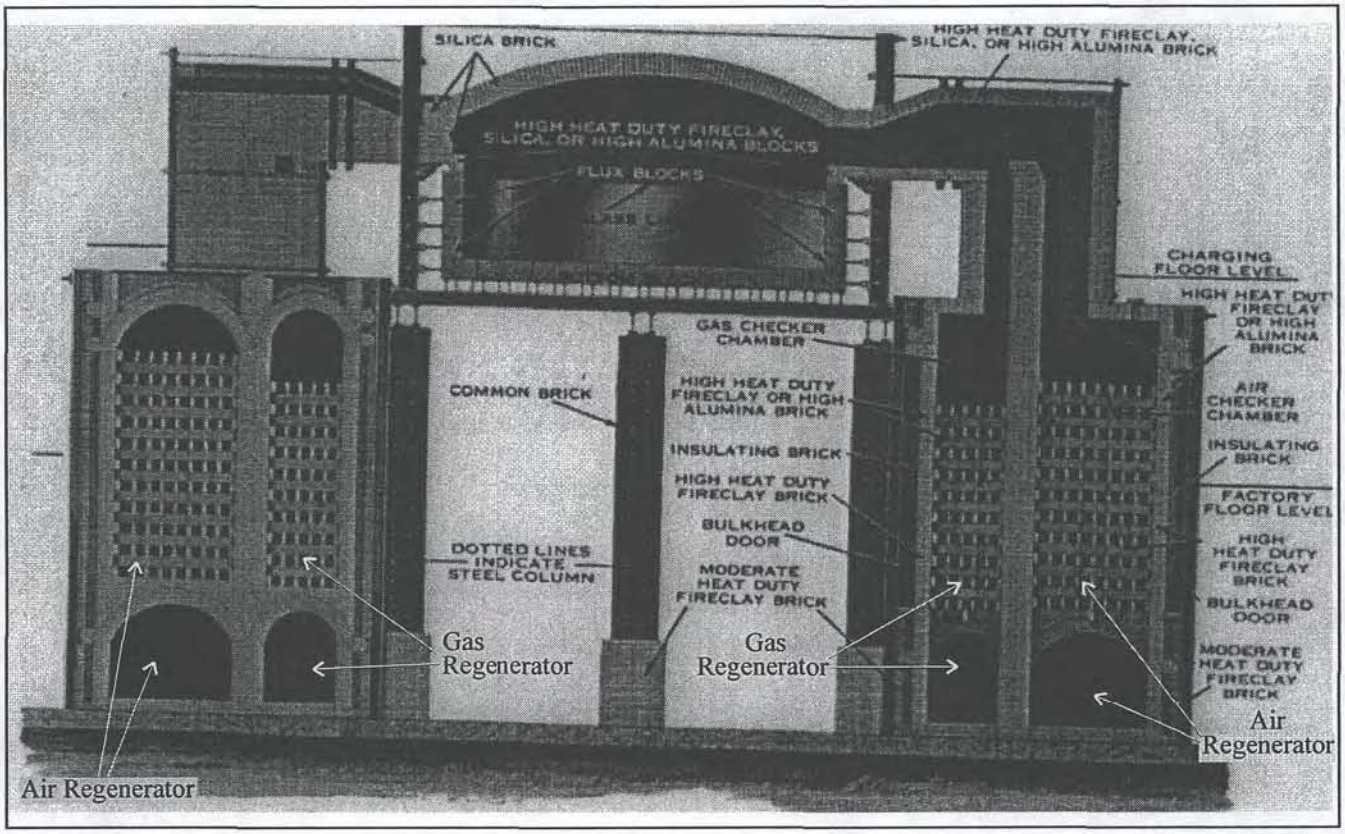


Figure 5-10. Drawing of Glass Furnace Illustrating Different Brick Types Used in Regenerators and Tank Area. This drawing also illustrates the configuration of air and gas regenerators in relationship to the furnace on a side-port furnace in which flames entered the furnace from the side walls. Source: Harbison-Walker Refractory Company, *Modern Refractory Practice*, 1937, p.128.

degrees Fahrenheit. The proximity of the gas producer to the furnace provided the furnace with heated gas laden with its full complement of tar for maximum illuminating heat. Although recuperators did not function as well for producer gas as they did for natural and by-product coke gas, they did not require the construction of regenerator chambers, a large expense for an operation the size of the Virginia Glass Company (Figures 5-11, 5-12, 5-13) (Gunther 1958:79-99). Archeological remains recently uncovered at the Virginia Glass Company did not indicate whether the tank was recuperative or regenerative in design. The location of air, producer gas and exhaust flues at approximately the level of the tank base suggests the possibility of recuperation as the method of heat recapture.

In 1914, the firm installed a second continuous tank. More than likely, this second tank, only half the size of the first (containing four rings instead of eight rings) was dedicated to specialty production. The Virginia Glass Company only operated two tanks in 1914, returning to one tank in 1915 before closing after a disastrous fire in 1916.

5.3.2 Producer Gas

The Virginia Glass Company's decision to switch melting technologies from pot furnace to day tank, and then to continuous tank carried with it the corollary requirement for a new fuel source because tanks could not be direct-fired by coal. Glass makers in the United States began switching from direct-fired coal to natural gas as their primary fuel after the discovery and application of natural gas in western Pennsylvania, Ohio, and Indiana in the 1880s and 1890s. They did considerable work on producer gas-fired furnaces in the latter decade. For melting glass, as well as in other metallurgical applications, gas was vastly superior to coal, improving glass quality by eliminating ash and smoke impurities, providing an easily regulated and more uniform temperature, and prolonging furnace life. Gas was also more economical: natural gas

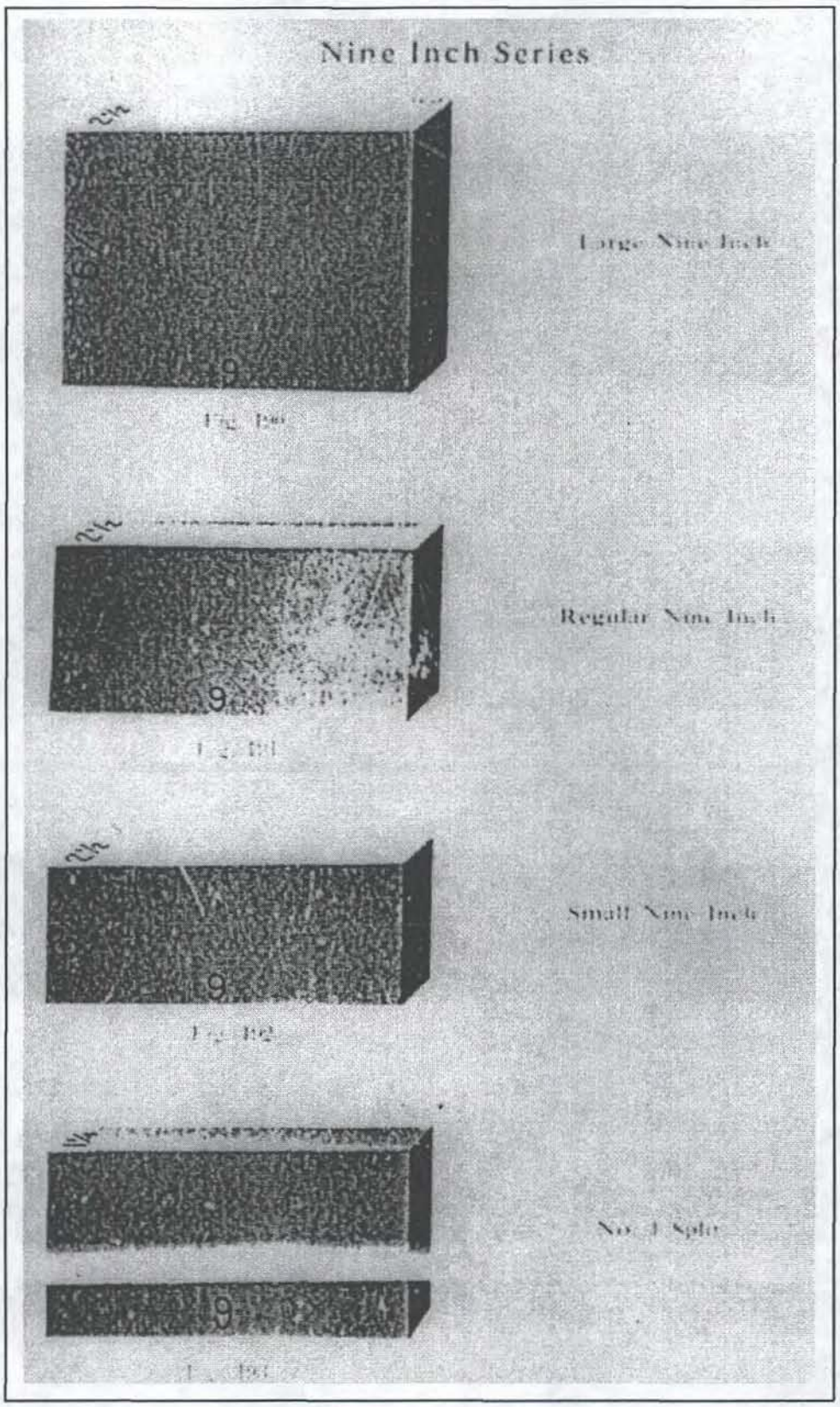


Figure 5-11. Illustration of Refractories Used in Tank Furnace Construction.
Source: H.L. Dixon, *Everything for the Glass House*, 1908.

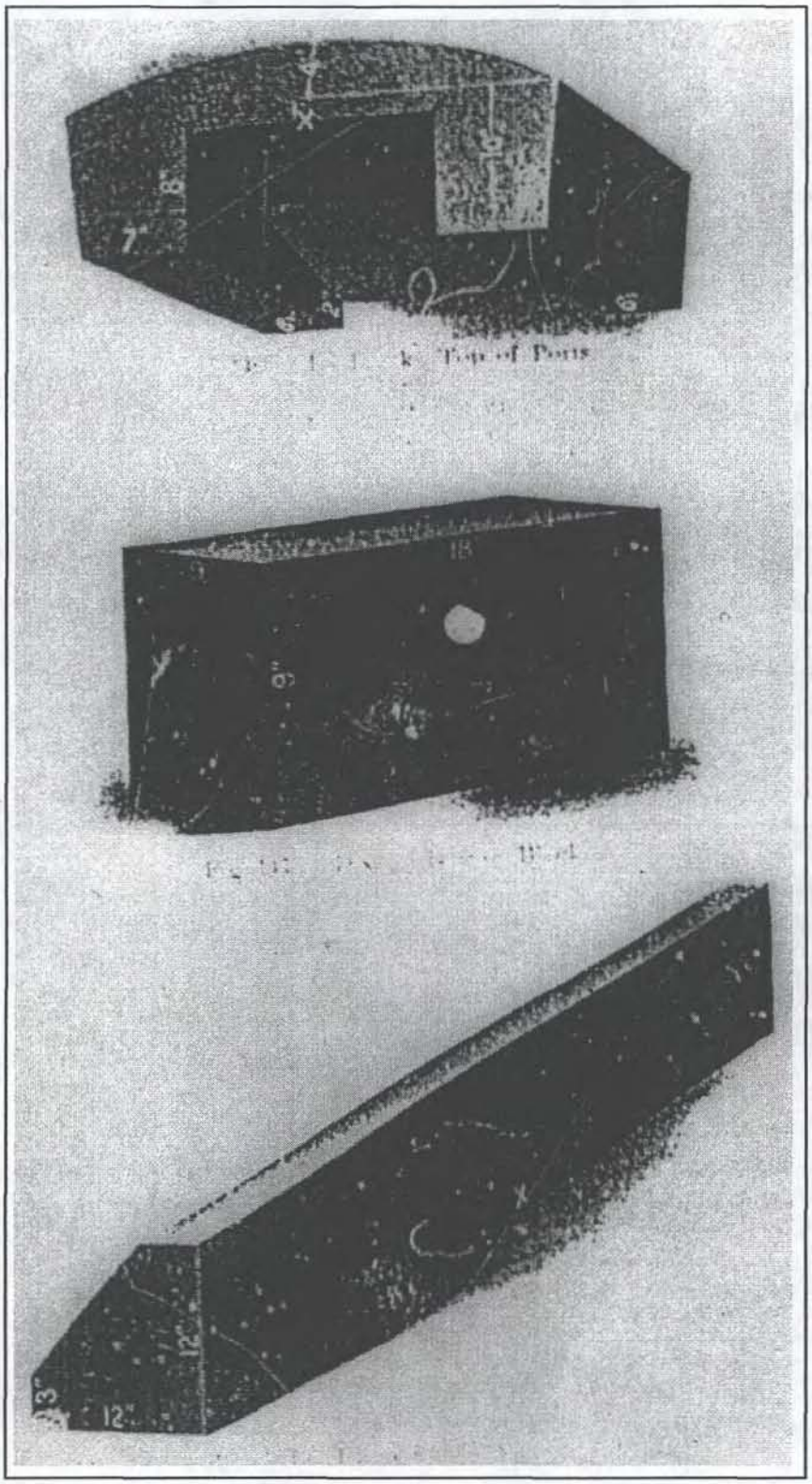


Figure 5-12. Illustration of Refractories Used in Tank Furnace Construction. Source: H.L. Dixon, *Everything for the Glass House*, 1908.

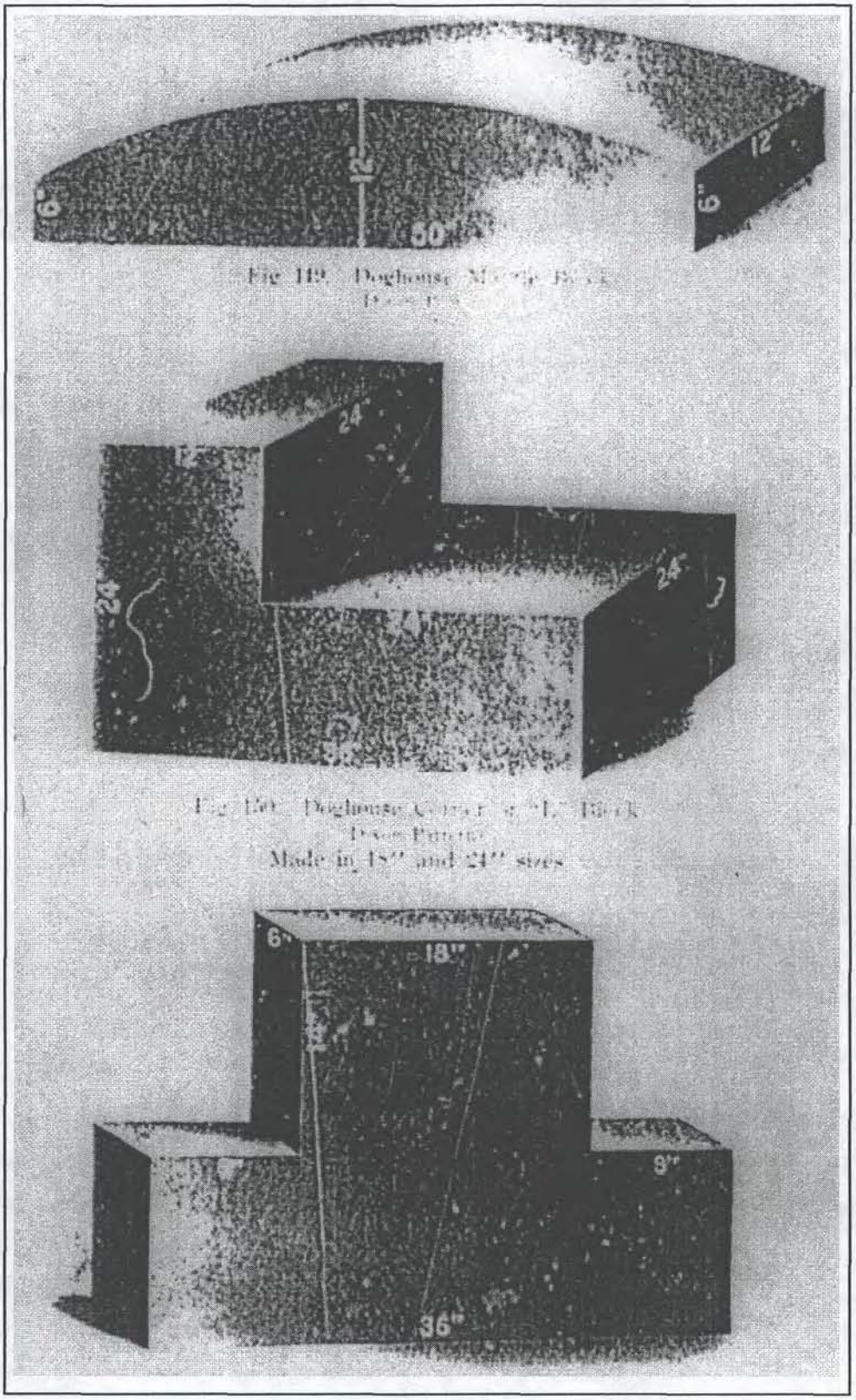
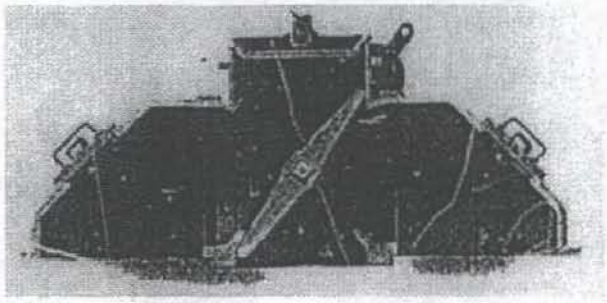


Figure 5-13. Illustration of Refractories Used in Tank Furnace Construction.
Source: H.L. Dixon, *Everything for the Glass House,* 1908.

was cheap (even free during the gas-belt booster period of the turn of the century), and gas producers could burn the cheapest coals (Weeks 1880:37; Scoville 1948:26-27).

Three primary types of producers were in use during this era: suction, pressure, and down draft. Although they differed significantly in detail, principles of operation were the same for all three. Air and steam passed continuously through a column of fuel, in this case bituminous coal. It gasified carbon, first to carbon dioxide and then to carbon monoxide, the essential component of producer gas, which was then passed to the glass furnace. Under normal operations with a good grade of coal, gas contained approximately 25% carbon monoxide. In addition, tarry vapors added heat value for gas used in glass furnace work. Ash was removed at the bottom (Wyer 1906:103; Fernald and Smith 1911:13-74; Nagel 1909:7-37; Damour 1906:86-121). The available archeological evidence--two pads supporting the remains of brick-lined metal shells--does not reveal the specific type of producer used at the Virginia Glass Company in the early twentieth century. The suction-producer appears to have been best suited to the small glass plant: it offered great fuel economy and required the least amount of labor and attention. Pressure and down draft plants were recommended for large units.

Producer gas was conveyed to furnaces through fire-clay brick tunnels like those uncovered at the Virginia Glass Company site. Fire-clay bricks and blocks are generally called "refractories" in the glass industry. Refractories for gas plants and conveyance tunnels were subject to highly corrosive and abrasive environments. Gas producers contained a constantly replenished and moving fuel charge that had a deteriorating effect on furnace walls, requiring refractory linings to be tough, dense and laid with tight-fitting joints bonded with an appropriate mortar. Hot blast mains and connections were lined with refractory brick backed by an insulating fire-clay brick to prevent radiant loss of heat and ensure gas temperatures high enough to deter formation of tar deposits in mains. Reversing valves redirected air and gas between alternate checker chambers in regenerative furnaces (Figures 5-14 and 5-15) (Harbison-Walker Refractory Company 1937:125-126; Dixon 1908).



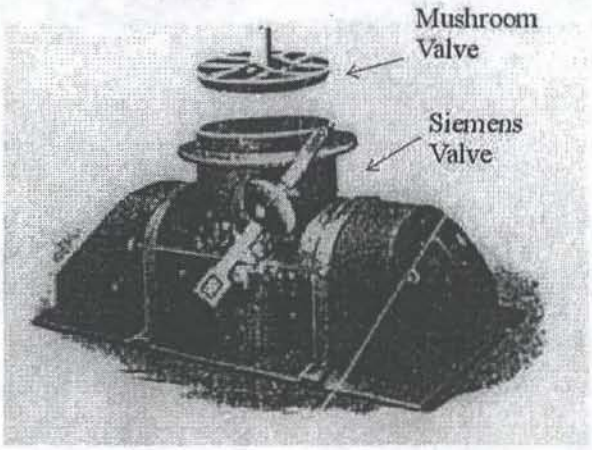
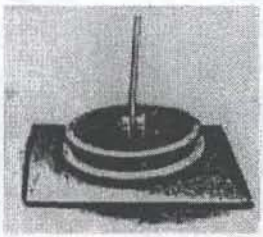


Figure 5-14. Siemens Reversing Valve, Used to Reverse Flow of Air and Gas Between Regenerators. Note mushroom saucer valve covering Siemens valve. Source: H.L. Dixon, *Everything for the Glass House*, 1908.



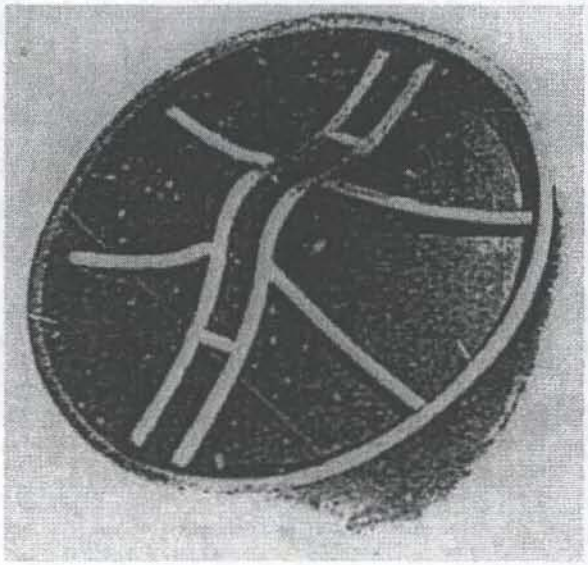


Figure 5-15. Details of Mushroom Saucer Valve Cap.
Source: H.L. Dixon, *Everything for the Glass House*, 1908.

5.3.3 Making Bottles

Historic records indicate that glass blowers were working at the Virginia Glass Company as late as 1907 (Alexandria City Directory 1907). This suggests that bottles and jars, the company's stock in trade, were made by skilled craftsmen using traditional glass-shaping techniques. From the 1870s, the standard production unit in non-machine bottle and jar factories was some variation on the seven-man shop. Two blowers gathered the glass and blew bottles, independent of each other, while a third skilled man finished the bottlenecks for both. Approximately equal in skill, the three rotated positions in twenty-minute turns. The remaining four shop members were boys, the *sine qua non* of glasshouse labor. The "mold boy" attended to the molds of the two blowers, opening and closing them as required. The "cleaning-off" or "knocking-off" boy cleaned the pipe after the bottle was removed. The "snapping-up" boy prepared the bottle for the finisher, and the "carrying-in" boy brought the bottles to the lehr. An efficient shop produced upwards of 275 to 300 dozen bottles per day, depending on size and style (Department of Commerce 1917:14).

The Department of Labor described the hand bottle-making process as follows:

> Standing in front of the working hole of the furnace, the blower dips his pipe into the white mass of molten glass and by skillful movements of his hand gathers on the end of the pipe the exact quantity of glass necessary for the size of the bottle to be made. This he quickly removes from the furnace and rolls and smoothes it on a flat piece of iron called the 'marver.' While thus marvering the glass the blower also gently blows into the free end of his pipe and by introducing a few puffs of air into the solid mass of glass forms the initial cavity in the prospective bottle. When the glass is marvered sufficiently, the worker, while continuing to blow into the pipe, swings it forward and backward a few times. As a result of these operations the bit of glass suspended at the end of the pipe assumes a pear-shaped form, with a small central air cavity inside.
>
> The mold boy now opens one of his two iron molds, the blower then closes the two halves of the mold. Continuing to blow into the pipe, the blower provides sufficient force to distend the glass to the exact shape patterned in the mold, after which the pressure of the blowing on the small amount of glass remaining above the mold causes it to distend to a mere film, which breaks readily and thus

> disconnects the pipe from the bottle in the mold. The film of glass above the mold, which is so thin and light that it actually floats in the air, is known as the 'blow-over.'
>
> While the bottle remains a short time in the mold until it solidifies sufficiently to be handled, the mold tender prepares the other mold for the second blower. Then he opens the first mold, takes out the bottle with a pair of pincers, and places it on a stand at his side. Frequently he also weighs the bottle on a small scale standing near by. At this stage of the process the bottle still needs to have its neck finished and the 'lip' on the top formed. The snapping-up boy picks it up with a pair of pincers and puts it in a heavy can-like receptacle with a long handle, known as the 'snap.' He then places the snap with the bottle in the reheating furnace, termed the 'glory hole', so that he may easily reach the snap and place it back in the fire when the bottle is finished. The work of the finisher consists of shaping with a special wooden tool usually improvised by himself.
>
> Next the snapping-up boy releases the finished bottle from the snap and places it on a stand for the carry-in boy, who picks up two or more bottles with a special iron fork and places them in the leer to be annealed [Department of Labor 1927:28-31].

In addition to the furnace and lehr, the 'glory hole' was an essential heating device in the plants that produced hand-made bottles. Usually a small, kiln-like structure heated with gas, the 'glory hole' provided heat to remelt the bottle top. When the top was plastic enough, it was given its final shape by the finisher who used a special tool to open the neck and create the outside lip (Department of Commerce 1917:73).

5.3.4 Annealing Equipment

After the bottles emerged from the glory hole, in which tops were fused to bodies, they were transported by carry-in boys, overhead conveyors or other belt mechanisms to annealing ovens or annealing lehrs in which jars and bottles were slowly cooled. Until the 1890s, annealing ovens had dominated the industry. Beginning in that decade, manufacturers rapidly adopted the gas-heated lehr, in which bottles and jars passed through a long, brick, heated chamber for a precise time period before they were removed. The Census claimed that "the new method lends itself more readily to scientific exactness in securing results and, being continuous in operation, makes it possible to handle the increased output of the factory in much less time

and at smaller cost" (Austin 1900). Lehr heat was approximately 1200 degrees Fahrenheit at the mouth, or beginning, and was maintained at a gradually decreasing temperature as bottles passed through various 'zones' before emerging fully annealed at the end. Bottles were placed on iron pans that were pulled through the lehr by a moving belt or endless chain, and were removed by packers who usually inspected the ware before packing it for shipping (Figure 5-16) (Austin 1900:972; Department of Commerce 1917:65-66). The presence of the lehr foundation at the Virginia Glass Company indicates that the bottles were treated to remove internal stresses imparted in the shaping process.

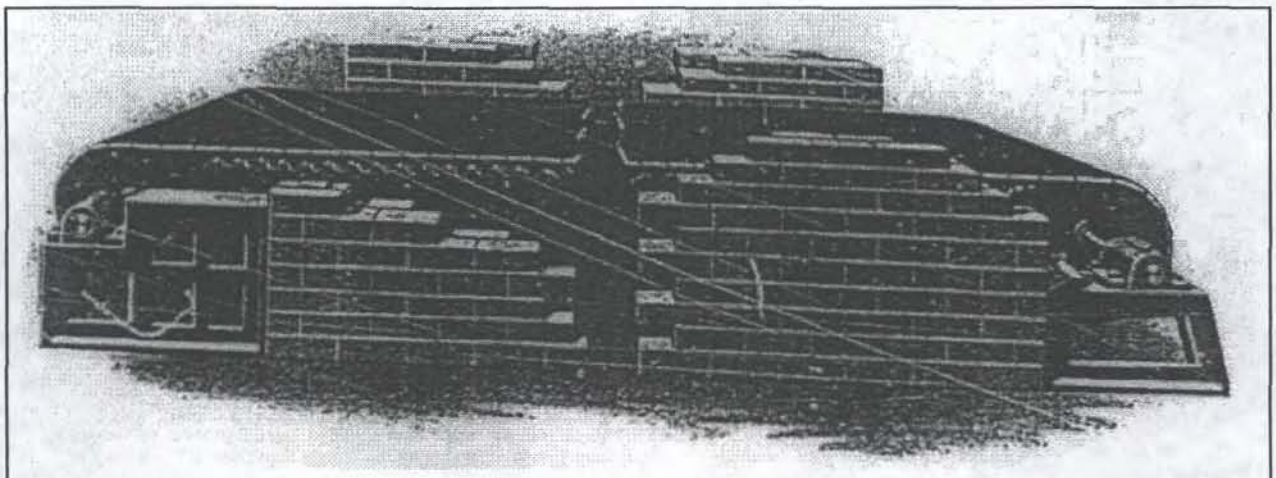


Figure 5-16. Cut-away Section of an Endless Conveyor Lehr. Source: H.L. Dixon, *Everything for the Glass House*, 1908.

5.3.5 Demise of the Virginia Glass Company

The Virginia Glass Company likely produced bottles by hand throughout its nearly two-decade existence, a period of rapid and profound changes in bottle making technology. Other companies automated while the Virginia Glass Company continued to use traditional techniques. The introduction of the Owens automatic machine in 1903 was followed by a variety of semiautomatic, one-, two- and three-man machines by other manufacturers. Steady improvements in machines increased their capacity and ability to manufacture almost any type of bottle necessary. By 1916, when used in combination with conveyor belts, the machine gathered its own glass and blew its own bottles without the aid of workmen. These advantages led to the

dominance of machine companies, to the gradual closing of hand manufacturing, to the centralization of the industry, and to a reduction in bottle styles. Although it was victimized by fire, the failure of the Virginia Glass Company can also be attributed to the pervasive influence of machine-made bottles that overtook its less efficient operations (Austin 1900:972).

Summary of operations, **Virginia Glass Company**, 1895-1916

Source: ***Commoner & Glass Worker***

March 10, 1894:	first appearance of **Alexandria Glass Company**, 1 furnace, 3 pots
February 23, 1895:	last appearance of **Alexandria Glass Company**, 1 furnace, 3 pots
March 2, 1895:	first appearance of **Virginia Glass Company**, 1 furnace, 3 pots
April 11, 1896:	1 day tank, 8 rings
July 1, 1899:	1 day tank, 8 rings, in operation
July 8-29, 1899:	1 day tank, 8 rings, NOT in operation
August 5, 1899:	1 continuous tank, 8 rings, NOT in operation
September 16, 1899:	1 continuous tank, 8 rings, in operation
February 3, 1900:	1 continuous tank, 8 rings, in operation, green and amber ware; beers & sodas, minerals, wine & brandies; packers & preservers ware; flasks & prop. medicine goods

Source: ***Glass Factory Directories***

1902: 1 continuous tank, 8 rings; flasks & prop. medicine goods, beers & sodas, minerals, wine & brandies, druggists ware, general prescription ware and druggists sundries.

1903: 1 continuous tank, 8 rings; green and amber ware, beers & sodas, minerals, wine & brandies, packers & preservers ware, flasks & prop. medicine goods.

1905: 1 continuous tank, 8 rings, green and amber ware, beers & sodas, minerals, wine & brandies, packers & preservers ware, flasks & prop. medicine goods. J.S. Borden, General Manager, Peter Astryke, Manager

1906: 1 continuous tank, 8 rings. green and amber ware, beers & sodas, minerals, wine & brandies, packers & preservers ware, flasks & prop. medicine goods. J.S. Borden, Manager

1907: 1 continuous tank, 8 rings. green and amber ware, beers & sodas, minerals, wine & brandies, flasks & prop. medicine goods, packers & preservers ware. (note change in order), J.S. Borden, Manager

1908: 1 continuous tank, 8 rings; green and amber ware, beers & sodas, minerals, wine & brandies, packers & preservers ware, flasks & prop. medicine goods.

1914: 2 continuous tanks, 12 rings; flint glass, prescription druggists ware, flasks or proprietary medicine goods, mold shop, inks, etc. W.G. Gardiner, Pres.; Guy S. Whiteford, sec/treas; T.V. Ale, Manager

1915: 1 continuous tank, 8 rings; flint glass, prescription druggists ware, flasks or proprietary medicine goods, mold shop, inks, etc. W.G. Gardiner, Pres.; Guy S. Whiteford, sec/treas; John Fody, Manager

1916: same as 1915

1917: not listed in directories for this year and after

Note: Entries indicate first appearance of change in factory listing.

5.3.6 Later Glass Factories in Alexandria

The early operations at the Virginia Glass Company were small and traditional, compared to other bottle glass factories in the northeastern United States. Because of the successful business development skills of the core group of company founders in the early years, the glass factory was able to sustain itself and eventually expand. The factory became a center of training for young glass apprentices who learned their trade on site at the factory. The Virginia Glass Company was employing 80 glass workers by 1896, only three years after the factory was built (*Alexandria Gazette*: 1/2/1896).

The Virginia Glass Company set the standard for the glass factories that were built later in Alexandria: Alexandria Glass Factory, the Belle Pre Bottle Company, and the Old Dominion Glass Company. The 1910 census for Alexandria lists the glass workers and the companies that employed them. Several of the core founders of the Virginia Glass Company had been hired to

manage operations at the Old Dominion Glass Company or the Belle Pre Glass Company by 1910.

Of the four glass factories in Alexandria, the Alexandria Glass Company was in operation for the shortest period of time. The factory, located on Henry and Montgomery Streets, opened for business in 1900. The factory contained one large tank furnace, two lehrs, and two gas producers. The company mainly produced beverage bottles for the Mid-Atlantic region. The factory was destroyed by a fire in 1916 and was not rebuilt (*Alexandria Gazette*: 2/8/1917).

On Henry Street in Alexandria, the Belle Pre Bottle Company opened for business in 1902. Joseph H. Ramsey and Edward S. Reeve directed operations in the factory. Both men were core founders of the Virginia Glass Company (*Alexandria Gazette*: 4/19/1902). The Belle Pre Bottle Company managed a large operation with one large continuous tank furnace fueled by three gas producers, and three lehrs. Milk bottles were one of the specialty products of the company and the trade sphere of the Belle Pre Bottle Company went well beyond the Mid-Atlantic region.

George Schwarzmann and Lorenzo Wolford, of the Old Dominion Glass Company, purchased the Belle Pre Bottle Company in 1913, when the business was failing (*Alexandria Gazette* 10/18/1913). The Belle Pre plant was reopened in 1916 and continued under the direction of Old Dominion Glass until a factory fire destroyed the plant in October 1921 (*Alexandria Gazette* 10/24/1921).

Old Dominion Glass Company began its operations in 1902 on North Fairfax Street. The company was directed by two of the founding members of the Virginia Glass Company, Lorenzo Wolford, and George H. Schwarzmann. The physical plant was laid out in a similar configuration to the Virginia Glass Factory. The factory housed one large tank furnace and two lehrs. Old Dominion had numerous contracts in the mid-Atlantic region and stayed in operation until 1925 (*Alexandria Gazette*: 11/11/1926). By this time the glass-making boom in Alexandria was ending. The Old Dominion Glass Company was the last of the four factories to close.

6.0 METHODOLOGY FOR ARCHEOLOGICAL STUDY

6.1 PHASE I INVESTIGATION

6.1.1 Research Objectives

The primary objective of Phase I investigations was to locate and identify features associated with the occupation of the site by the Virginia Glass Factory. Phase I fieldwork consisted of mechanical excavation of nine trenches using a backhoe and front-loader. The placement of trenches throughout the project area was determined prior to fieldwork by staff from *Alexandria Archaeology* and the Principal Investigator at Dames & Moore. The 1907 Sanborn Fire Insurance Map of the glass factory (Figure 6-1) provided the basis for the location of test trenches. The Carlyle Project area map was overlain by the Sanborn Map to show the parameters of the Virginia Glass Company buildings within the project area. Trenches 1 through 5 were placed in areas where the overlay map indicated that structural features from the glass factory would be intercepted. The overall Phase I work plan included four additional trenches to be placed judgmentally throughout the site after the first five were excavated.

6.1.2 Monitoring

During the Phase I investigation of the southern part of the project area that was expected to contain remains of the glass factory, Carlyle Development began construction of a road and traffic island in the northern section of the project area, fronting Duke Street. According to the 1912 Sanborn map, a packing-house of the glass factory and an alley had been located in this area. Archeologists periodically monitored the mechanical grading of this area to ensure that construction did not impact any cultural features that were exposed. When structural features associated with the glass factory were encountered, construction was stopped long enough for archeologists to document the features. These features are described in Section 7-2.

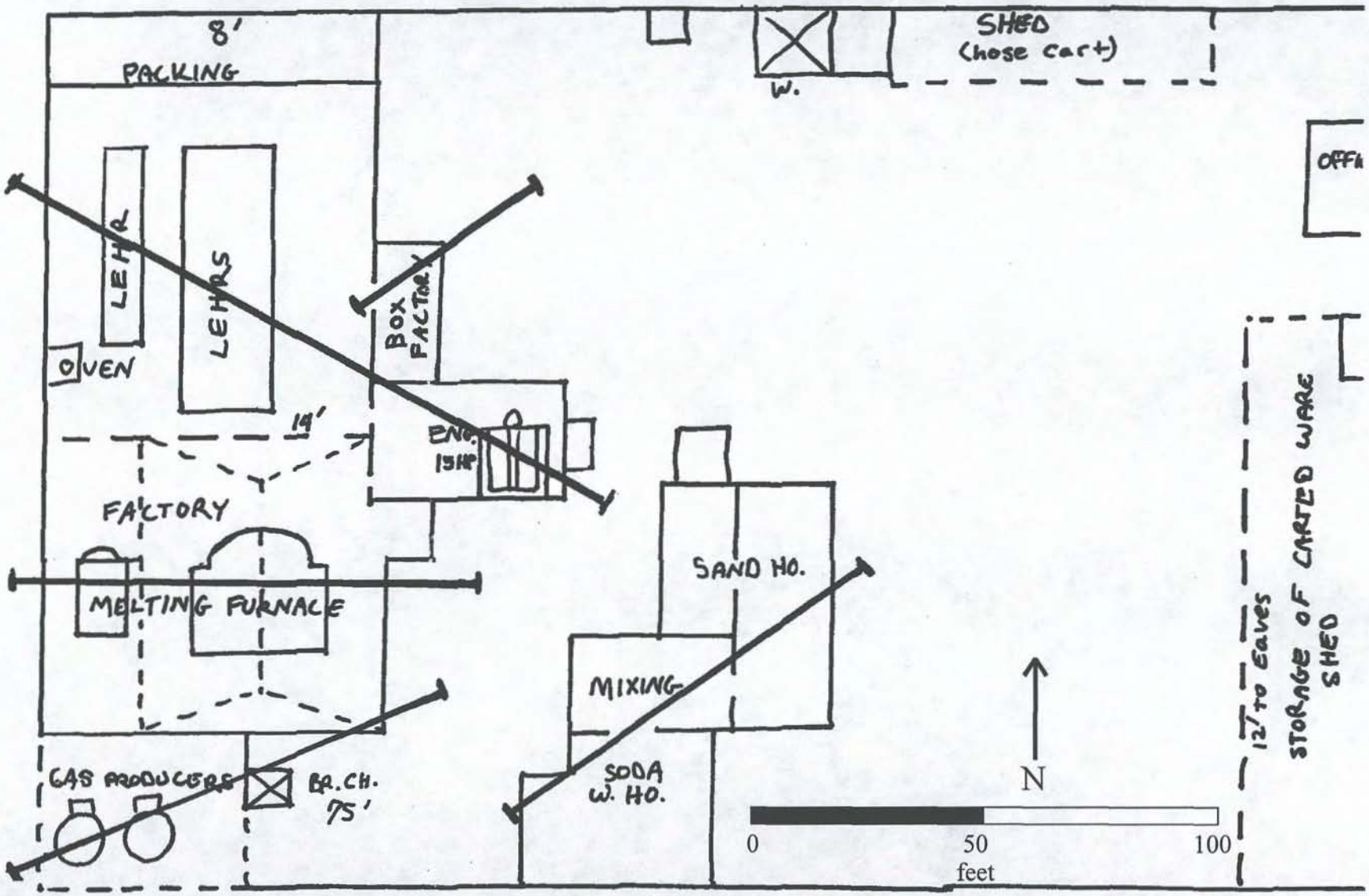


Figure 6-1. 1907 Sanborn Fire Insurance Map Showing Phase I Trenches

6.1.3 Field Methods

Trenches 1 through 5 were sighted in by surveyors and ground surface elevations were taken. Three of these trenches (2, 3, and 4) were laid in at a length of 100 feet; however, the testing plan changed during excavation in response to field circumstances. The length of trenches was altered due to safety issues when unconsolidated modern fill was encountered. Trench 4 was excavated as two 25-foot segments. Trench 1 measured 150 feet and Trench 5 measured 50 feet in length. The average trench width was 5.5 feet.

Trenches were mechanically excavated by backhoe to sterile soils, except in locations where brick features or the Station Shops' foundation prevented further excavation. Field archeologists then used trowels and shovels to scrape down features and trench walls. A minimum of two soil profiles was drawn for each trench, generally drawn in three foot segments. Trenches 1, 2, and 3 contained features, each of which was individually drawn and photographed. A datum was established at the western end of Trench 2; when mapping was completed in the field, a measuring tape was laid along the western boundary as a base line.

Once the initial five trenches were completed, Dames & Moore personnel consulted with *Alexandria Archaeology* staff and developed a work plan for the remainder of the Phase I fieldwork. The plan included the excavation of four additional trenches to explore architectural features that were exposed in the initial five trenches. These trenches were sighted in by compass. Their locations were adjusted from the pre-field estimate based on the results of Trenches 1 through 5. In addition, Blocks 1 through 4 were opened as 100-foot squares in areas that contained the largest brick features: Furnaces 1 and 2, the small oven, and Lehr 1. Blocks were only excavated to the top of brick features.

6.2 PHASE II/III EXCAVATION AND DATA RECOVERY

6.2.1 Research Objectives

The three goals for the Phase II/III investigation were to: 1) horizontally expose and record archeological remains of the factory and associated components to see the entire site and record the relationship of features in the factory to one another; 2) investigate and record individual features and recover site-related artifacts; and 3) recover a sufficient collection of bottles, bottle portions, glass from different stages of production and factory-related equipment/machinery for use in developing a type collection for research purposes.

6.2.2 Field Methods

Mechanical earthmoving equipment was monitored closely by Dames & Moore archeologists while fill was being removed from feature surfaces during Phase II/III investigations. The excavations were conducted by a Gradall, a front-loader, and a mini-excavator. Once surfaces were exposed, archeologists scraped the remaining overburden from the features with trowels and shovels. At the direction of *Alexandria Archaeology*, the site was excavated horizontally to the top of the brick features before vertical excavation of the site could begin. After the site had been scraped to one level, several site photographs were taken, and individual features were photographed.

Each feature identified in the field was assigned an individual **Context Number (CN)**. A context number list was compiled for the entire site with numbers for each feature. The list was modified as excavations proceeded. Context numbers were changed only when two features identified separately in the Phase I survey were proven in Phase II/III excavations to be parts of the same larger feature (i.e. Furnace 1). All artifacts associated with a given feature were designated with the same context number.

After consultation with the staff at *Alexandria Archaeology*, specific site areas--the factory furnaces and ventilation system--were excavated with a backhoe and a mini-excavator. The small equipment was chosen for the furnace interiors so that the small chambers within the brick furnace could be excavated with a minimum of damage. Trench 10 was also excavated during this process, with the purpose of exposing and documenting features within Furnace 2 to facilitate understanding of the furnace and ventilation system in the factory. After the features had been scraped and cleaned by the archeologists, notes and feature drawings were completed. Photographs were taken of each feature, as well as the general factory area.

Three test units were excavated for the Phase II/III investigation in different site locations: the potential midden area; the small oven, and the smaller lehr. Test units were excavated to sterile soils or to the base of the feature. Test units were excavated by fill level; elevations were taken for each distinct level. Archeologists kept field notes explaining the unit contents, Munsell soil classifications, and types of artifacts present. All features were documented and a minimum of one unit wall was photographed and drawn in a measured profile. The sizes of test units varied, defined by the type of feature being investigated.

After Phase III data recovery was completed, the entire site was mapped by surveyors from DH&R, using a TopCon theodolite. Elevations of various reference points throughout the site were also recorded. The surveyors map and the hand drawn field map were combined to produce the scaled plan view of the glass factory site on AutoCadd 13 at the Dames & Moore office in Bethesda, Maryland.

6.3 LABORATORY METHODS

Upon completion of field investigations, recovered artifacts were transported to the Dames & Moore archeological laboratory in Bethesda, Maryland. They were cleaned, catalogued and analyzed according to the *City of Alexandria Archaeological Standards* (1996) and the Secretary of the Interior's *Standards and Guidelines for Curation* (36 CFR 79). Appendix B lists the context numbers, trench, feature and unit registries.

6.3.1 Artifact Processing

In total, 3,073 historic artifacts were recovered from Phase I, II, and III archeological investigations of the Virginia Glass Company site. Most artifacts were gently washed using plain water and a soft toothbrush. Delicate and/or unstable materials, such as decayed metal and organic matter, were carefully dry-brushed with a toothbrush. After they dried, the artifacts were sorted according to provenience and type for cataloging. Whole or nearly whole bottles were generally given unique catalog numbers, although identical bottles from the same provenience were grouped together. An acid-free paper label with full provenience information (including stratum, location, context number, catalog number, and site number) was created for each catalog number.

Artifacts larger than one-square inch were also labeled directly with the site and catalog number, unless they would be adversely affected by such treatment. Window glass, metal, marbles, shell, coal, and fabric-like materials were not labeled. Permanent labels were written with a rapidograph pen over an undercoat of clear nail polish. Dark, opaque artifacts received an undercoat of white gesso before being labeled. When the ink dried, an overcoat of clear nail polish was used to seal the label. The artifacts and accompanying acid-free labels were then placed in 2-mil or 4-mil perforated polyethylene zip-lock bags. The site number and artifact catalog number were written on the exterior of each bag with a permanent black marker. Bags were then placed in archival-quality acid-free Hollinger boxes for transport to *Alexandria Archaeology*'s storage facilities in Alexandria, Virginia, for permanent curation.

6.3.2 Artifact Cataloging and Analysis

Artifacts were separated first according to whether they were cultural or non-cultural materials. Cultural material included bottles and other vessel glass, window glass, nails, ceramics, brick, iron and other metal, buttons, plastic, and marbles. Non-cultural material included wood, shell and bone. Artifacts were catalogued according to accepted historic artifact

categories defined on the basis of manufacturing technique, material, and function (Miller 1980, South 1977, Jones and Sullivan 1985). The catalog was entered into Microsoft Excel 7.0; Appendix C of this report includes the artifact inventory. In most cases, broken bottles were mended prior to their being cataloged in order to record as much information as possible (the number of fragments was still noted on the cataloging sheets). Table 6-1 summarizes the categories, and specific artifact types within each category, used during cataloging.

The function of the project site as a glass factory was known from historic documents and maps prior to excavation. Therefore, artifact collection and analysis focused on those artifacts that would provide information about the glass factory in particular. The artifact catalog of bottles includes more detail than the catalog of other artifact types collected. Bottle descriptions used in cataloging and analysis were based on terms defined in *The Parks Canada Glass Glossary* (Jones and Sullivan 1985). Dames & Moore laboratory technicians created additional terms and descriptions to describe the particular bottles in the Virginia Glass Company site collection. An explanation of terms (including drawings of examples) used in artifact cataloging, description, and analysis is included in Appendix D, the *Glossary of Archeological and Glass-Making Terms*.

6.3.3 Analysis of Bottles

Bottles are composed of five basic parts: the finish, neck, shoulder, body, and base. These parts can be further subdivided to describe a bottle in finer detail (Figure 6-2). The lip type, type and number of string rims, bore shape and diameter, neck shape, shoulder form, body form, base shape and diameter, base profile, resting point form, bottle height, color, and basal and other markings constituted the components of bottle descriptions for the glass factory site. The presence of vent marks, valve marks, machine scars, or finishing-tool striations, and the placement and number of mold seams suggested the technique of manufacture for each bottle; these details were noted where possible. Other characteristics, such as the original function of the bottle, also contributed to bottle descriptions. Fragments of bottles were likewise recorded in detail for the parts of the bottle present.

Table 6-1.Artifact Categories and Types

Category	Type	Total
architectural	asphalt shingles	8
	bolt	1
	brick	13
	mortar	4
	nail	138
	screw	1
	spike	4
	strap	1
	window glass	6
architectural Total		176
ceramics	ceramic	20
	coarse earthenware	10
	coarse red earthenware	2
	coarse stoneware	1
	dry bodied stoneware	1
	flow blue	1
	ironstone	57
	ironstone/hard white earthenware	103
	pearlware	5
	porcelain	85
	porcelain/stoneware	3
	redware	14
	Rockingham-like earthenware	1
	stoneware	9
	whiteware	125
	yellow bodied earthenware	8
	yellow ware	7
ceramics Total		452
electrical	fuse	2
	insulator	10
electrical Total		12
factory tools	cart wheel	1
	clock	1
	file or chisel	1
	metal handle	1
	pincers	1
	saw	1
	shears	1
	spline shaft	1
	tank buck stay	1
	unknown	1
	valve wheel	1
	vent cap	1
	wedge	1
	wheel	1
factory tools Total		14

Category	Type	Total
glass	base	56
	bottle	189
	bottle fragment	76
	glass fragments	932
	lip/neck	301
	lump glass waster	71
	melted	32
	special	71
glass Total		1728
glass-nonfactory	base	33
	bottle	44
	bottle fragment	8
	glass fragments	2
	ink well	3
	jar	21
	jar lid	2
	jelly glass	3
	lip/neck	26
	mason jar	15
	mason jar base	3
	mason jar lid	8
	mason jar lid liner	30
	mason jar lip/neck	18
	milk glass	1
glass-nonfactory Total		217
kitchen items	bowl	2
	drinking glass	7
	spoon	4
kitchen items Total		13
organics	bone	25
	shell	25
	wood	1
organics Total		51
other	asbestos	10
	beam	1
	beam support	1
	bolt	4
	bracket	1
	cable	11
	can	9
	carbon rod?	1
	chicken wire	1
	clinker	7
	coal	25
	cork screw	1

Category	Type	Total
	finial?	1
	frame	1
	furnace lining?	1
	graphite	3
	grog and clay	1
	hinge	2
	hoe blade	1
	hook	1
	hook and wire	1
	iron	1
	latch	2
	latch?	2
	leather?	3
	light bulb	1
	metal	93
	metal brace	1
	metal cover	1
	metal lid	1
	metal plate	1
	metal washer	1
	mica?	1
	nut	1
	nut and bolt	1
	paper	1
	pipe	32
	plastic	7
	rebar	3
	rod	13
	rubber	2
	slag	13
	sluice	1
	spike	15
	spring	10
	stopper	1
	strap	11
	tube	1
	washer	1
	wire	95
other Total		400
personal items	button	3
	shoe	1
personal items Total		4
recreational	marble	5
	toy tire	1
recreational Total		6
Grand Total		3073

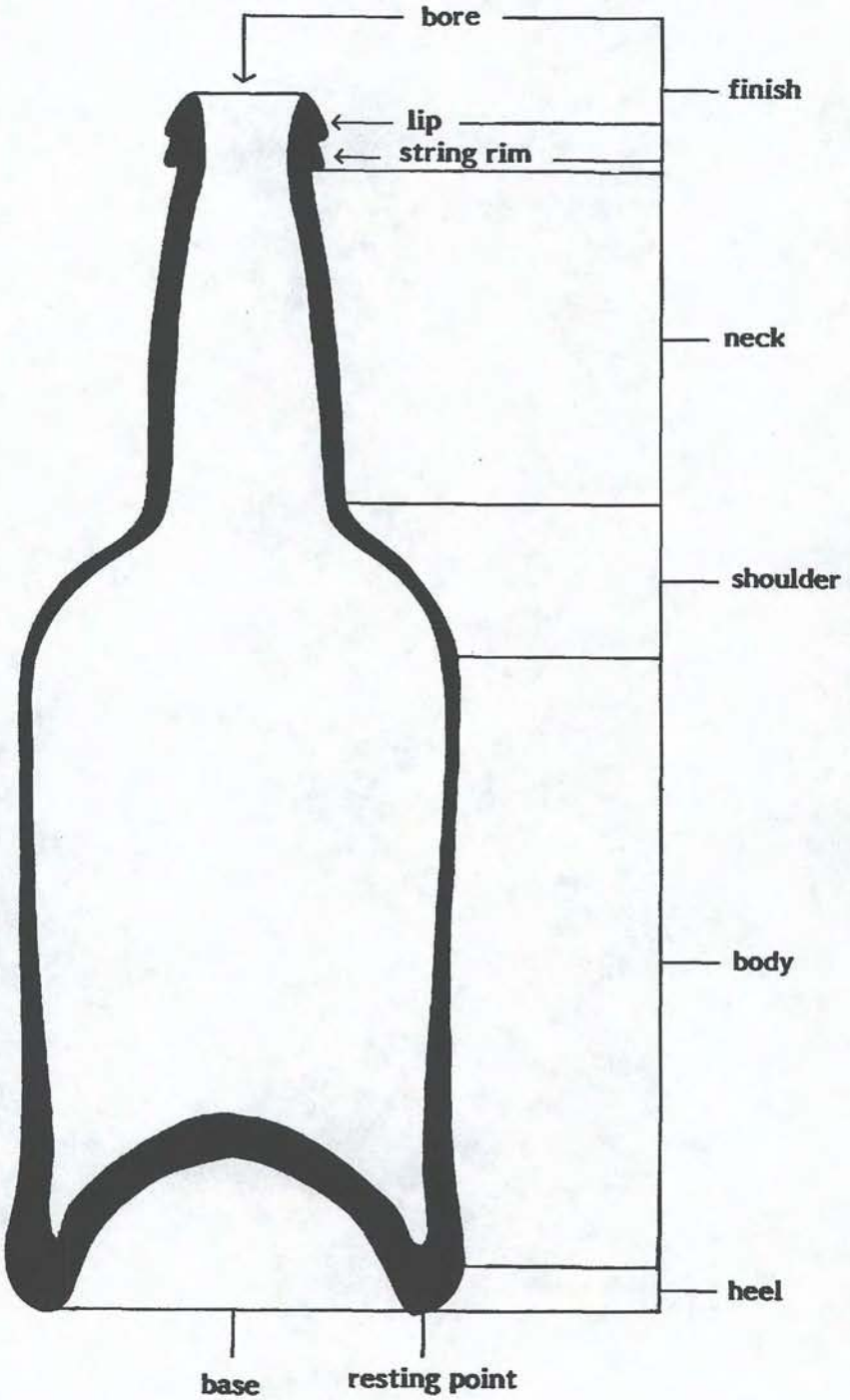


Figure 6-2. Parts of a Bottle (based on Jones and Sullivan 1985:77)

Sets of similar characteristics found on different bottles (basically bottles that looked alike) were used to define certain 'types'. These bottle types helped maintain consistency in cataloging similar bottles, and were useful for determining which bottles were made at the factory. Bottle fragments that included both the lip and neck (from here on referred to as lip/neck fragments) were similarly categorized into 'lip/neck types'. A scaled drawing was made of each bottle and lip/neck type. Drawings of bottle types are included as Appendix E; drawings of lip/neck types are in Appendix F. Development of the bottle and lip/neck typology is discussed in more detail in Section 9 of this report, entitled *Artifact Analysis*.

7.0 PHASE I ARCHEOLOGICAL FINDINGS

The objective of Phase I testing was to excavate trenches that would reveal the maximum amount of information, based on the configuration of the factory on the Sanborn Map. A major part of the research design was to use the 1907 Sanborn map of the Virginia Glass Company footprint to determine the placement of trenches and blocks. Locations of Phase I trenches 1 through 5 were overlaid on the factory footprint as shown in Figure 6-1. The actual locations of the trenches varied from this design depending on the field findings and conditions.

7.1 SOIL STRATIGRAPHY, GENERAL OVERVIEW

The general soil stratigraphy was variable throughout the site. The fill levels were mostly re-deposited materials that had shifted and intruded into other levels. Fill levels are related to several episodes of demolition and construction disturbances that are summarized below:

Virginia Glass Company fires, in 1895 and 1916. Burnt materials were re-deposited in various sections of the factory. Evidence for fires is found within the historic fill level from deposits of ash and debris in areas not associated with furnace activity.

Demolition of the Virginia Glass Company around 1916. Large amounts of disarticulated brick, metal, bottles and cullet (broken glass) were found throughout the entire site mixed in the historic fill level. The context of these artifacts had been compromised during the demolition and subsequent back-filling of the factory.

Construction of the Station Shops in 1961. Construction of the shops required the excavation of some foundation areas to subsoil. Excavations cut through sections of the brick architectural remains of the factory. Additional disturbances

were caused by the utility trenches excavated for the copper and iron pipes used for the Station Shops.

Placement of PVC and other pipes at the Station Shops post-1970. These more recent pipes were located near the center of the site and are found associated with orange sand, gravel and cinder blocks. These pipe trenches further mixed the historic fill and destroyed areas containing architectural remains.

Recent construction of John Carlyle Street and drainage ditch. The eastern section of the project area, nearest John Carlyle Street, had been completely filled in with modern materials (sand, gravel and debris) during road construction. Although the Sanborn map indicated that this area would contain architectural features, historic fill had been removed during street construction and no archeological materials were found.

Station Shops demolition during the 1990s. The removal of the concrete Station Shops resulted in the mixing of fill from the Station Shops into the historic fill from the glass factory.

During trenching, the fill associated with the construction of the Station Shops and John Carlyle Street was designated overburden. This layer consisted of yellow to orange sand, buff colored bricks, cinder blocks and modern debris. In the east-central section of the project area, the overburden included an area of dense clay. The fill associated with the recent construction of John Carlyle Street, in southeastern section of the project area, included unconsolidated orange sand, large gravel and clay.

Stratum A appeared beneath the overburden as a loose historic fill associated with the glass factory occupation of the site. Stratum B was glass factory fill with distinctive characteristics. Stratum C was clay subsoil.

The uppermost level beneath the overburden, Stratum A, was historic fill dating to the demolition of the glass factory. The historic fill was re-deposited, and showed no indication of being *in situ*. The soil matrix was unconsolidated and consisted of 10YR 3/2 very dark grayish brown sandy loam. The fill contained varying amounts of broken bottles, moil (glass that was never formed), ceramic fragments, metal hardware, ballast and even railroad spikes. The fill was a combination of glass factory waste, topsoil, railroad waste and domestic waste. The glass factory was in proximity to domestic structures (facing Duke Street), and the railroad tracks, which undoubtedly contributed to the variety of historic artifacts found in the Stratum A fill. Stratum A was sometimes mixed with modern overburden containing buff-colored bricks and orange sand dating from the Station Shops' construction.

Stratum B was generally found beneath Stratum A. It was highly variable because it was a by-product of both the fires and the operations of the glass factory. Stratum B was mixed and re-deposited during the factory demolition process to fill areas of the factory that contained holes (such as the interiors of the furnaces or the gas producers). As a result of this mixture and redeposition, this stratum contained raw materials from glass production, architectural materials, bottles, implements, waste glass, ash, topsoil and clay. In very few locations could these multiple fill elements be distinguished as a separate deposit. For the purpose of more clearly defining Stratum B, sub strata (B1, B2, etc.) were designated. Each sub-stratum always contained artifacts and soil components that were directly associated with the glass factory.

All of the strata that sat immediately on top of the brick structural remains of the factory were designated Stratum B. Thirteen variations of Stratum B were documented, and each is detailed in the soil profile drawings presented with the trenching results. At some locations, the stratum was so dense that it had to be peeled away from the brick features using the front-loader, shovels or trowels. Unlike the unconsolidated fill of Stratum A, Stratum B fill included large amounts of compact brick rubble mixed with clay. This matrix was mixed with historic artifacts, which were primarily bottle fragments and metal hardware. Throughout the site there were many variations in the content and color of Stratum B. Ash and burnt materials such as brick and slag were frequently noted. The burnt deposits probably date to the 1916 factory fire.

One unusual variation was Stratum B-13, a solid red clay surface that appeared in several sections of the site. Atop the ventilation system of both furnaces, the red clay layer capped the brick flues that extended south from the furnaces. The 2.5 YR 4/8 red clay was highly plastic and also occurred in walkway areas between the furnaces and lehrs, as well as on either side of the arch of Furnace 2. Three alternative theories have been developed to explain the function of the clay layer: 1) the clay may have been imported to the glass factory for the purpose of providing a solid and insulating sub-surface layer for the ventilation system and furnaces; 2) the layer may have functioned as a walking surface for exposed brick areas on the ventilation vaults (Richard O'Connor personal communication); or 3) the clay layer may have provided a cap for the fill in the southern section of the project area, deposited after the demolition of the glass factory for the purpose of leveling out the ground surface.

Stratum C was the silty clay subsoil that lay beneath the brick features in the northern section of the site (the lehr and oven features area). Subsoil chroma varied greatly depending upon the amount of heat to which it had been subjected. The subsoil was more uniform in the shallow sections of the site. It was generally a yellowish brown (10YR 5/6) clay. This subsoil was sometimes mottled with clays of other chromas, but the clay texture was consistent. In the northern section of the site, subsoil was reached within three to four feet of the modern ground surface and was generally sterile.

In the southern portion of the site, (the area south of Trench 2) subsoil was only reached in areas that were excavated outside the factory footprint. The sterile yellowish brown clay was uncovered south and east of the chimney (Feature 10) and outside of the southeast factory corner (Feature 23). In these areas, the subsoil was generally reached within three to four feet of the existing ground surface.

Inside the factory footprint, south of Trench 2, subsoil was not reached. This portion of the site was excavated to greater depths than the rest of the site, and buried factory intake and

exhaust flues and other parts of the ventilation system showed every indication that they were continuing downward. Excavations stopped at the maximum safe depth allowable.

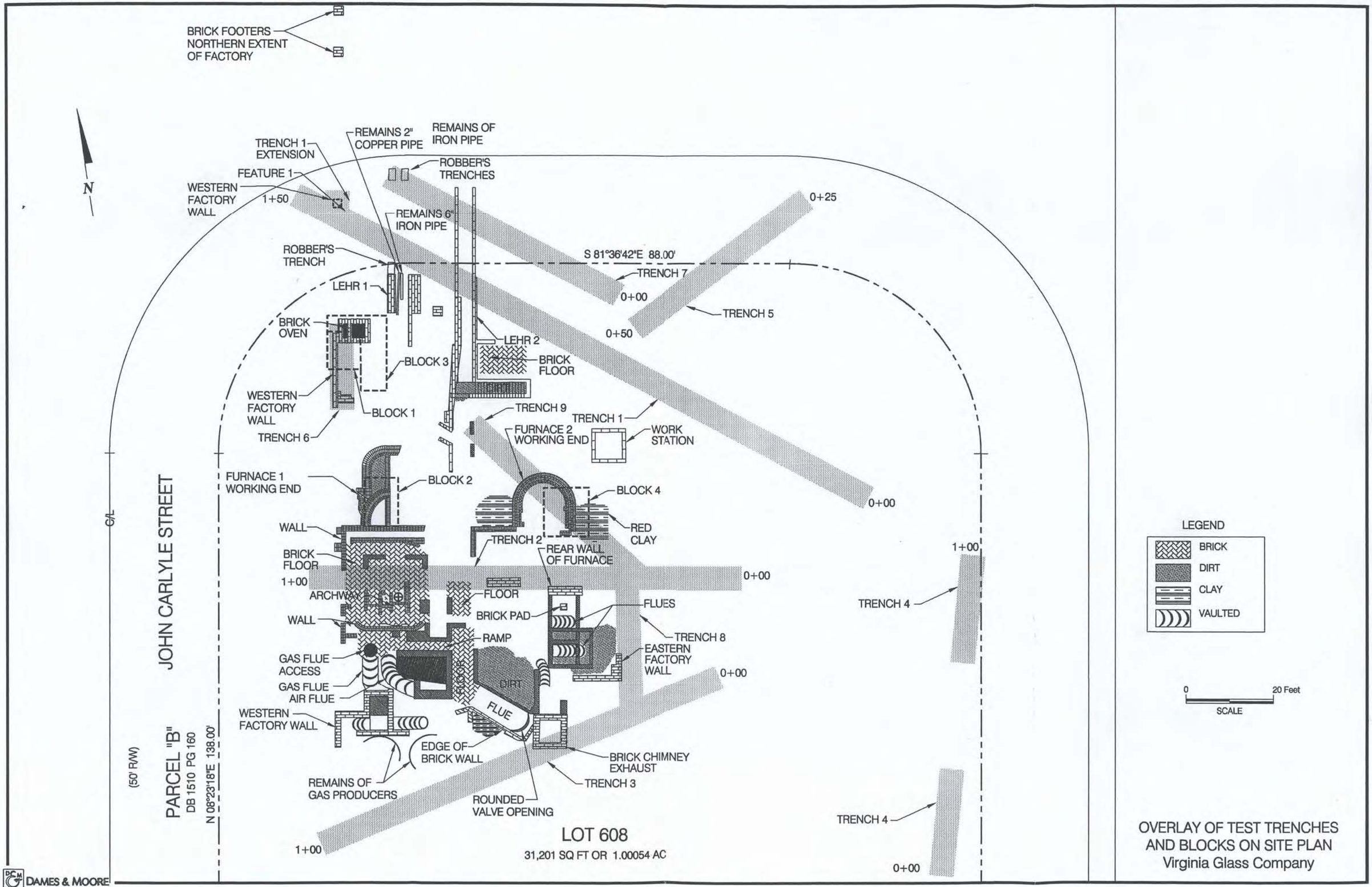
7.2 PHASE I TRENCHES

During Phase I archeological testing Dames & Moore archeologists monitored backhoe excavation of nine trenches and the backhoe clearing of four blocks. The length and depth of each trench was dependent upon the testing plan and the features encountered. Trenches were generally 5.5 feet wide, with some variation depending upon the size of the backhoe bucket. Soils, stratigraphy and features for each trench are detailed below. Figure 7-1 shows the Phase I trenches and blocks overlain on the features uncovered during the Phase I, Phase II, and Phase III investigations. Soil descriptions are presented in Table 7-1. Drawings of Phase I soil profiles are presented in this section; drawings of features are presented in Section 8.

7.2.1 Trench 1

Trench 1 was located in the northern section of Lot 608 and intersected the proposed John Carlyle Street on the current site plan. Based on the 1907 Sanborn map, Trench 1 was placed where it was believed it would intersect the western factory wall, Lehrs 1 and 2, and the glass factory engine shop. Trench 1 measured 150 feet in length.

The Station Shops foundation was encountered immediately upon opening Trench 1. In an effort to get better leverage, and to see the extent of the foundation, the backhoe switched orientation and opened up the Trench 1-extension. At this location, a small section of brick building foundation from the factory's western exterior wall was identified and designated Feature 1. A builder's trench was associated with Feature 1, but was not assigned a separate feature number.



OVERLAY OF TEST TRENCHES AND BLOCKS ON SITE PLAN
Virginia Glass Company

Table 7-1. Soil Descriptions of Trench Profiles

Figure	Trench	Stratum	Color	Name	Description
7-2	1	Overburden	10YR6/6	brownish yellow	mixed modern fill
		B1	2.5Y3/1	very dark gray	thick sandy clay, with glass sherds
		B3	Gley 1 2.5/n	black	loam with burnt glass
		B4	2.5Y6/2	light brownish gray	sand w/bricks
		C	10YR5/6	yellowish brown	sterile clay subsoil
7-3	1	Overburden	10YR6/6	brownish yellow	mixed modern fill
		B1	2.5Y3/1	very dark gray	thick sandy clay with ash
		B2	10YR4/3	brown	clay, intrusion into subsoil, w/charcoal flecks, pebbles and broken brick
		C	10YR5/6	yellowish brown	sterile clay subsoil
7-4	2	Overburden	10YR6/6	brownish yellow	mixed modern fill
		A	10YR3/2	very dark grayish brown	rubble fill
		B3	Gley 1 2.5/n	black	loam with burnt glass
		B5	2.5Y3/2	very dark grayish brown	mixed fill and brick, very sandy with clay peds
7-5	3	Overburden	10YR6/6	brownish yellow	mixed modern fill
		A1	multiple	yellow, olive, brown, gray	mottled debris and soils from dumping unrelated to either the glass factory or Station Shops
		B8	10YR2/1 and 2.5Y4/3	black mottled w/olive brown	silty clay, gritty, mottled with olive clay
		B9	2.5Y3/2	very dark grayish brown	silty clay with brick and other historic debris
7-6	4	Overburden	10YR6/6	brownish yellow	mixed modern fill
		Gravel			dumped gravel
		Concrete			foundation
		C	10YR5/6	yellowish brown	sterile clay subsoil
7-7	5	Overburden	10YR6/6	brownish yellow	mixed modern fill
		A	10YR3/2	very dark grayish brown	rubble fill, clayey silt, ash, brick, glass, coal, charcoal and sand
		C	10YR5/6	yellowish brown	sterile clay subsoil
7-8	6	Overburden	10YR6/6	brownish yellow	mixed modern fill
		B10	10YR4/1	dark gray	compacted clay with silt and charcoal
7-9	7	Overburden	10YR6/6	brownish yellow	mixed modern fill
		B1	2.5Y3/1	very dark gray	thick sandy clay, with glass sherds
		C	10YR5/6	yellowish brown	sterile clay subsoil
7-10	8	Overburden	10YR6/6	brownish yellow	mixed modern fill
		A	10YR3/2	very dark grayish brown	rubble fill, heavily mixed with brick
		B3	Gley 1 2.5/n	black	loam with burnt glass, heavily mixed with charcoal, very, very black
		B11	Gley 1 2.5/n and 10YR6/3	black mottled with pale brown	mix of charcoal, brick and mortar
7-11	9	Overburden	10YR6/6	brownish yellow	mixed modern fill
		A	10YR3/2	very dark grayish brown	rubble fill, clay sand
		C	10YR5/6	yellowish brown	sterile clay subsoil

Two robbers' trenches were visible in the north wall profile of Trench 1. The term 'robbers' trench' is used to define an area where bricks or building materials have been removed to be used for another purpose. A robbers' trench can either be back-filled immediately or gradually becomes filled with soils or other fill materials. At the glass factory, the fire bricks in the lehr were a valuable reusable building material that were probably removed for reuse after the final factory fire in 1916. The brick remains of Lehr 1 were visible on the south wall of the trench. The transition between removal of bricks and intact structure would have been somewhere in the middle of the trench. The robbers' trenches and the associated brick feature were numbered Feature 2 (Figure 7-2). The robbers' trench identified in Trench 1 was back-filled with brick rubble and gray sand.

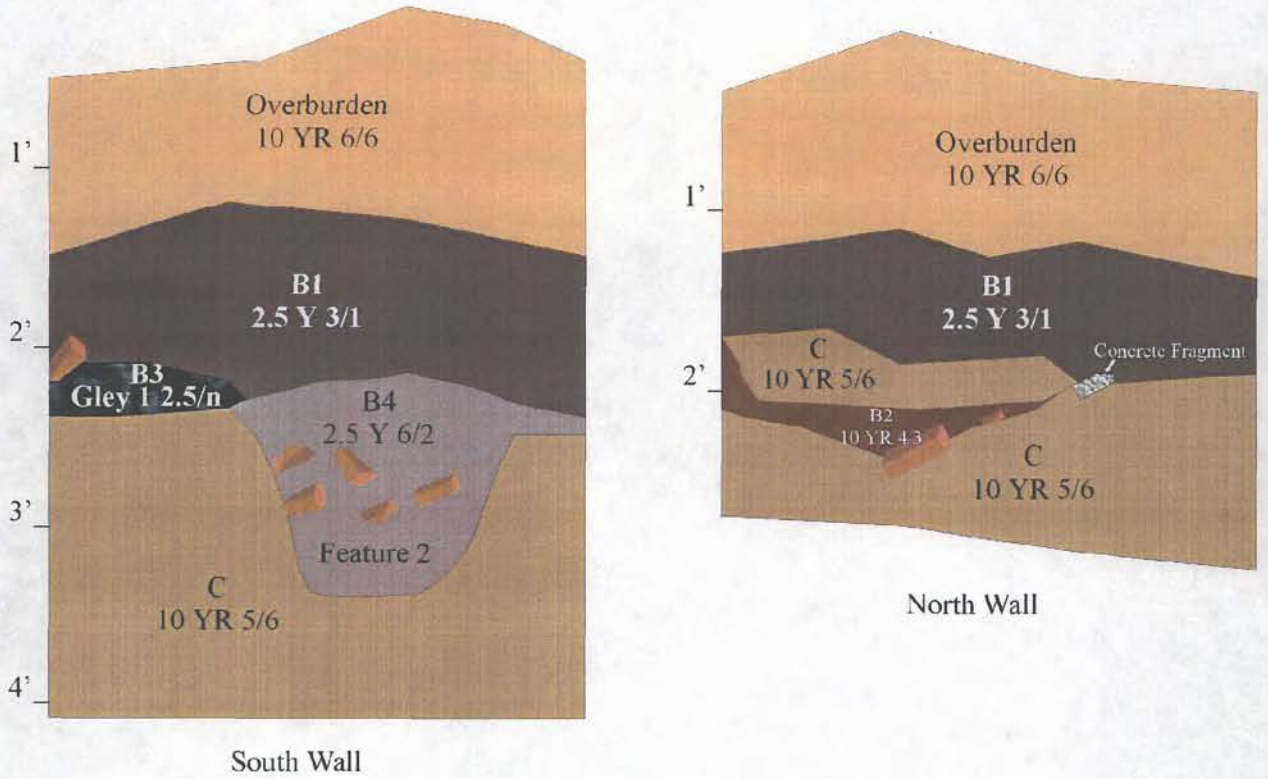


Figure 7-2. Profiles of Trench 1

Feature 3 was another lehr feature, consisting of two parallel lines of bricks. The bricks formed a single course and were placed on their long sides. This feature is part of northern section of Lehr 2 and is discussed in Section 8.

The Station Shops' foundation was encountered at three locations in Trench 1. Another modern disturbance in the eastern 30 feet of the trench was fill, probably dating to the demolition of the eastern Station Shops building. This modern fill was made up of unconsolidated sand and large cobbles above dense plastic clay. The fill contained modern debris such as plastic bags, metal stripping, wood planks and modern soda bottles.

The western end of Trench 1 contained a large horizontal deposit of broken glass mixed with ash, soil and metal hardware. It is unclear whether the glass was a by-product of Lehr 1 or if it was re-deposited from another factory location. The soil profile for Trench 1 illustrates the north wall of and the sequence of fill deposition characteristic of the northern section of the site.

7.2.2 Trench 2

Trench 2 was placed south of Trench 1 with the intention of intercepting the two melting furnaces (see Figure 7-1). Trench 2 measured 100 feet in length and was oriented east-west. The Station Shops foundation wall was about 6 inches outside the north wall of this trench. The modern foundation wall paralleled the trench nearly perfectly. In some areas, archeologists cut back the north wall of Trench 2 to expose the concrete wall. The location and east-west orientation of this trench made it an ideal reference point for mapping and defining the site. The major disturbance from the Station Shops was north of Trench 2; the area south of the trench had been minimally disturbed. The west-end datum of Trench 2 became the site datum, and all mapping of the site was measured from this point.

Opening of Trench 2 immediately exposed a six-inch diameter concrete water pipe. This pipe ran the length of the trench and lay on top of brick furnace remains. The pipe had been part

of the Station Shops utilities. Although the pipe had damaged some architectural components, articulated furnace remains were intact beneath the pipe.

Feature 4 was a small section of the western exterior foundation wall of the factory; it was uncovered within 7.5 feet of the west trench datum. This wall section was aligned with the wall section identified in Trench 1. The wall remains only consisted of three courses of bricks, two bricks wide with intact mortar. A builders' trench was clearly visible on the west side of this feature. Outside the builders' trench was sterile subsoil.

The concrete water pipe intrusion had clearly cut through parts of the furnaces; as a result it exposed the profiles of the furnaces' southern walls. Trench 2 bisected Furnace 1 (Feature 5) where brick chambers and a discarded mushroom valve cap (see Section 6) were located. The valve cap was machine debris from the Seimens Reversing Valve that was essential to the operation of the tank furnace. In two of the three brick furnace chambers, a ferrous metal had fused to the bricks on the side and back walls of the chamber. It is possible that the chambers originally contained metal machinery, but no conclusive evidence is available to prove that the Seimens Reversing valve occupied this spot in the furnace. The section of the furnace encountered in Trench 2 had excellent architectural integrity, particularly in the floor area. This feature is described further in Section 8.

The eastern extent of Trench 2 exposed a section of Furnace 2. The architectural remains (Feature 6) were in poor condition and had collapsed in most areas. However, part of the brick flooring and two sections of wall were solid and intact. One wall constructed of gray fire-brick (Feature 16) was determined to be an interior factory wall. The red brick section was part of the western exterior wall of Furnace 2. The Trench 2 profile illustrates the variations of Stratum B that were noted throughout the trench (Figure 7-3).

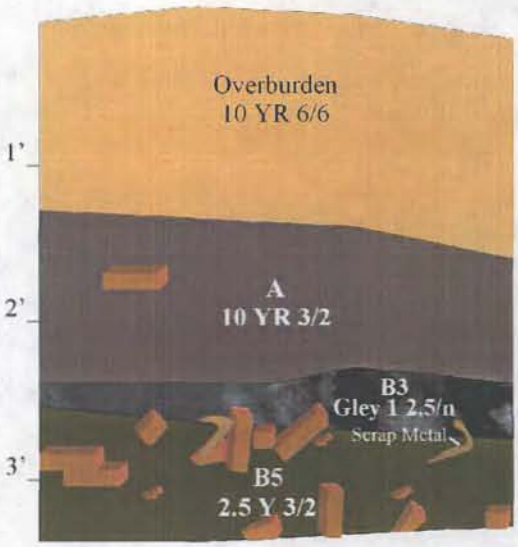


Figure 7-3. Profile of Trench 2, South Wall

Some of the features in Trench 2, initially designated as part of Furnace 2, were recorded differently during the trenching stage. After completion of Phase II/III, they were determined to be separate features and are therefore numbered out of sequence. Likewise, some remains that were recorded separately during the initial investigation of the site were later determined to be part of the same feature. For this reason some feature numbers were discontinued (for example, Features 7,8 and 9) (see Appendix B for the Feature and CN listing).

7.2.3 Trench 3

Trench 3 was placed in a diagonal orientation from southwest to northeast. It was estimated that it would intercept the two glass factory gas producers and the southeast corner of the factory foundation (see Figure 7-1). It was discovered after the trench was excavated that Trench 3 was too far south to expose the anticipated features. Instead, the trench uncovered a large deposit of railroad fill, spikes, coal and ballast (consisting of gravel and pebbles). This deposit was mixed with factory waste (such as bottles and bottle fragments) and domestic waste (such as historic ceramics and animal bones). The Washington and Southern Railroad that transported the boxes of bottles from the glass factory had tracks within twenty feet of the factory. It is possible that railroad waste would have been used for fill at this location after the factory was demolished.

The orientation of Trench 3 made it possible to expose the base of the factory's eight-foot square chimney (Feature 10). The existing nine courses of exposed brickwork were in solid condition. Hundreds of whole individual bricks from the chimney that had been used as fill were exposed in this trench. Identifying the chimney was a key factor in being able to locate and map the large number of brick features throughout the factory.

One large timber and several metal pipes were revealed when Trench 3 was excavated. These features may date to the twentieth century and probably were associated with the Southern Railroad that occupied the property until recently. A large amount of historic ceramics, some

bone fragments and numerous oyster shells were recovered from the southern wall of this trench. Initially, the debris appeared to be a sheet midden of late-nineteenth century historic artifacts. However, Test Unit 3 (which was later excavated in this trench) indicated that the midden did not represent a discrete layer or deposit. Instead, the artifacts were mixed with various fill types from railroad, domestic and glass-factory activities. The Trench 3 soil profile illustrates the complex stratigraphy found in Trench 3 (Figure 7-4).

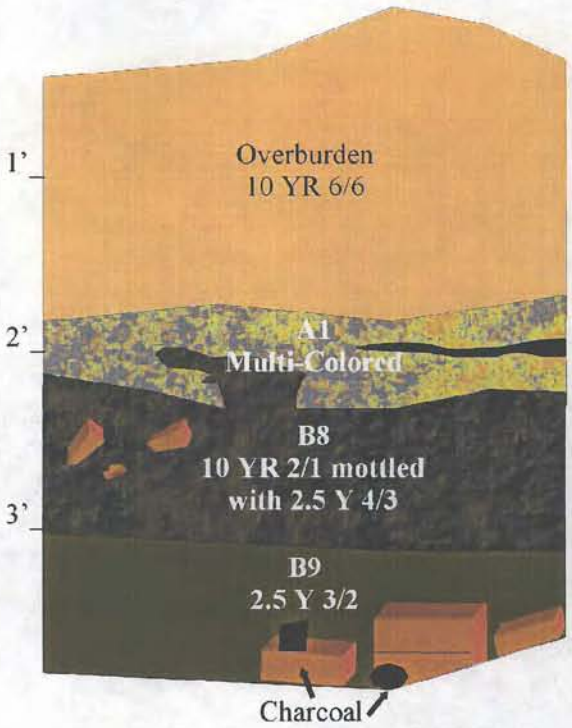


Figure 7-4. Profile of Trench 3, South Wall

7.2.4 Trench 4

Trench 4 was placed on a north-south orientation near the existing roadway/parking lot. This area is on the eastern fringes of the project area and had been recently disturbed by the construction of an office building and John Carlyle Street. The objective of opening a trench in this location was to intercept the buildings that had housed the raw materials for glass production, such as soda and sand. These buildings and the mixing area were identified on the Sanborn Map (see Figure 6-1).

The fill soils in this area near the road were extremely unconsolidated and began collapsing as soon as the trench was opened. It was decided that excavation of two 25-foot test trenches would be safer than opening up the planned 100 foot trench (see Figure 7-1). The fill consisted of 10YR 6/6 loose silty sand with gravel and contained construction debris, modern buff colored bricks, wood planks and metal stripping. A concrete slab was encountered beneath a layer of fill gravel. The trenches were excavated to a depth of approximately four feet. The

historic fill level was not present and no features or artifacts were recovered. The soil profile of Trench 4 depicts the east wall of the second 25 foot segment excavated (Figure 7-5). It provides an overview of the fill soils for Trench 4.

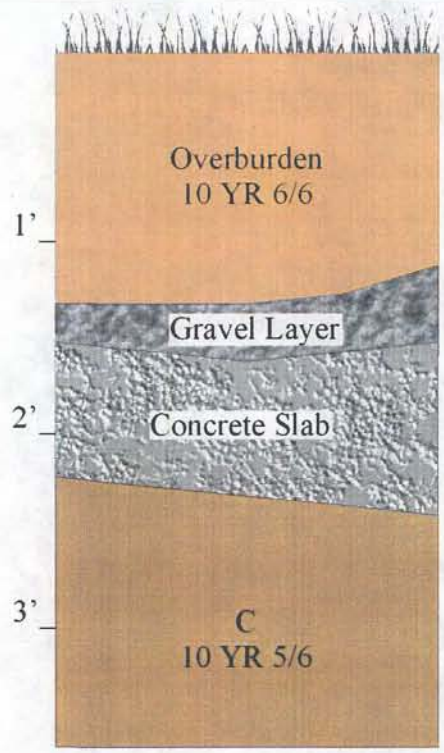


Figure 7-5. Profile of Trench 4, East Wall

7.2.5 Trench 5

Trench 5 was a small 50-foot trench oriented southwest to southeast to intercept the eastern wall of the factory and to find the remains of the adjacent box factory. This section of the project area contained approximately 1.5 feet of modern fill that was loose silty sand with gravel (Figure 7-6). Modern trash, cinder blocks, buff colored Station Shops bricks and pockets of historic brick rubble were mixed with the Stratum A soils. The red brick rubble only occurred in the western ten feet of the trench. Although the glass factory was the source of the brick, the brick rubble was not considered significant because of the small amount of rubble and the disturbed context. No remains of the box factory were identified.

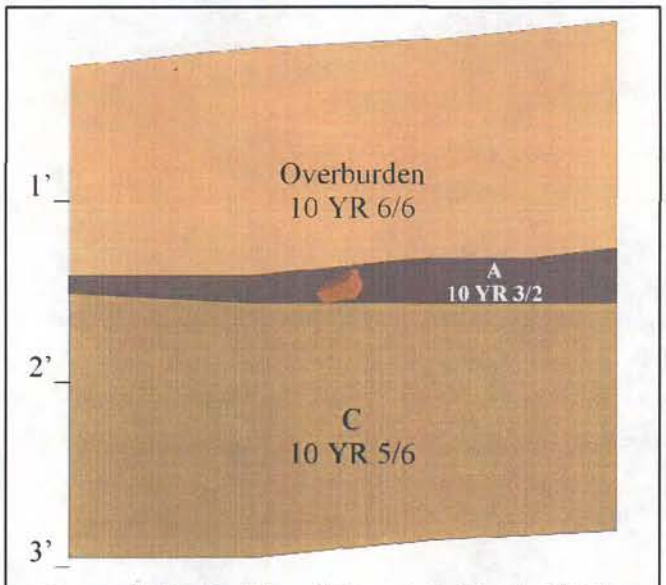
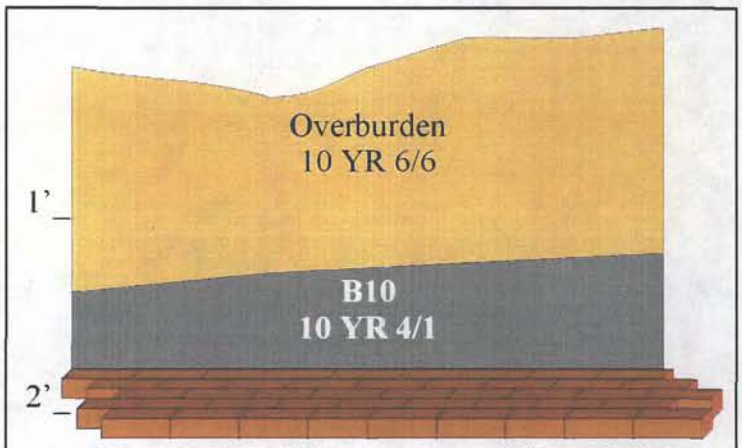


Figure 7-6. Profile of Trench 5, North Wall

7.2.6 Trench 6

Trench 6 was placed in the western section of the site and oriented north-south with the purpose of intersecting the small oven and the west wall of the factory (see Figure 7-1). The trench measured 15 feet long, one-and-a-half feet deep, and eight feet wide. Both the small oven and the west wall of the factory were designated Feature 12.

Trench 6 contained approximately 1.3 feet of overburden underlain by rubble fill (Stratum B), which was approximately 6 inches deep to the top of Feature 12 (Figure 7-7). The rubble fill layer in this trench was highly compacted clay with silt. Due to the vertical extent of the feature, subsoil was not reached in this trench. Excavators noted that this trench contained a higher quantity of amber-colored glass in Stratum B than was encountered elsewhere on the site.



Feature 12, Brick Oven, Top of West Wall

Figure 7-7. Profile of Trench 6, East Wall

7.2.7 Trench 7

Trench 7 was sighted in using a compass after the other trenches had been excavated and examined. Trench 7 was oriented to intersect additional architectural remains associated with Lehrs 1 and 2. Trench 7 measured 50 feet and was placed parallel to Trench 1, oriented from the southeast to the northwest (see Figure 7-1).

Trench 7 exposed a robbers' trench where the foundations of Lehr 1 had been removed and the residual trench had been back-filled with red brick rubble and sand. The wall profile of Trench 7 showed the conical shape of the robbers' trench. The robbers' trench was precisely aligned (on a north-south line) with the Feature 2 architectural remains in Trench 1. The robbers' trench was the northernmost extent of Lehr 1.

The brick remains of Lehr 2 were also present in Trench 7. These remains appeared as parallel lines of bricks, each line consisting of a single course. A drawing of Lehr 2 is included in Section 8. During Phase I excavations, the Lehr 2 feature was designated Feature 13. In the Phase II/III data recovery, the feature number was changed when all components of Lehr 2 were designated Feature 3.

The overburden and Stratum A in Trench 7 were shallow deposits. The subsoil (Stratum C) appeared approximately 1.9 to 2.1 feet below the modern ground surface. The profile shows the lack of depth in the northern portion of the site (Figure 7-8).

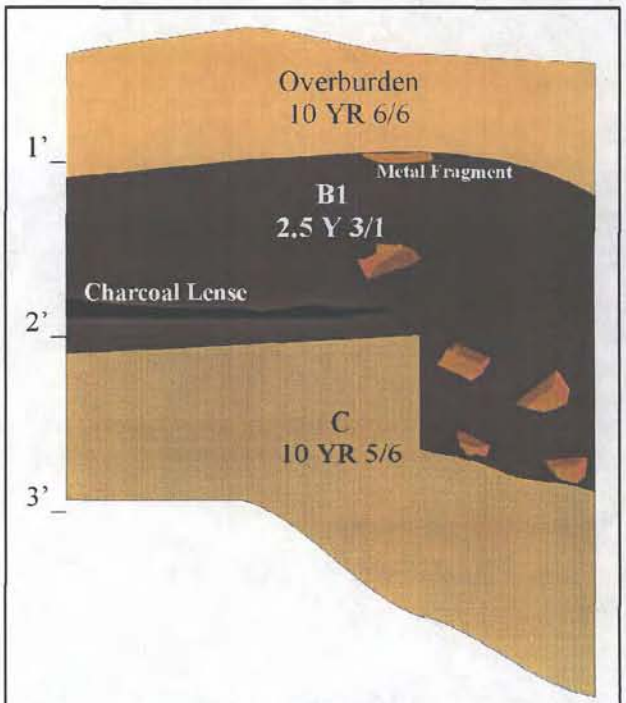


Figure 7-8. Profile of Trench 7, South Wall

7.2.8 Trench 8

Trench 8 was a 30-foot trench that was oriented north-south. The north end of Trench 8 originated in Trench 2, and was sighted in 60 feet east of the Trench 2 site datum. It extended south to Trench 3 where it terminated at the factory chimney (see Figure 7-1). Trench 8 was placed in the southeastern section of the site to define additional sections of Furnace 2, which the 1907 Sanborn map showed to be the larger of the two furnaces. Trench 8 contained large amounts of disarticulated whole brick. This made excavation difficult for the backhoe. The sidewalls were unstable, being made up of loose dirt and brick, and it was too dangerous to attempt excavating to subsoil. When the trench approached the chimney in Trench 3, one of the backhoe teeth caught on a buried pipe on the west side of the trench and nearly collapsed the entire trench. At this point, excavation of Trench 8 was terminated.

It is likely that the large amount of brick rubble represented the remains of the collapsed brick chimney. Although there was evidence that at least the bottom nine tiers of the chimney were intact, factory records indicated that the chimney had been 75 feet tall; later excavations indicated that it was eight feet square.

As expected, features relating to Furnace 2 were identified in Trench 8. A section of the rear wall of the furnace remained intact. Because the wall was part of a factory feature that was already recorded, it was not assigned a new feature number, but was designated part of Feature 6.

A section of brick flooring was uncovered near the trench midpoint. This was designated Feature 17. It consisted of at least three rows of bricks in an area that was heavily burned. The bricks appeared to extend east- to west, and would have continued had the trench been wider. Immediately south of the bricks, an earthen surface or floor, consisting of substratum B13 red clay, was exposed. This clay floor feature was at least a 1.5 feet deeper than the three rows of bricks. Feature 17 and the surrounding area rapidly filled with water as the trench was being excavated and remained filled throughout the duration of the Phase I investigation. It was not possible to draw or photograph Feature 17 during Phase I, but this area was documented

thoroughly in the Phase II/III investigation. Figure 7-9 shows the stratigraphy of Trench 8, which contained a thick burned level that was a dark, glossy black (due to the high charcoal content). In the small area of Trench 8 where a profile could be drawn, subsoil was reached at a depth of between two and three feet.

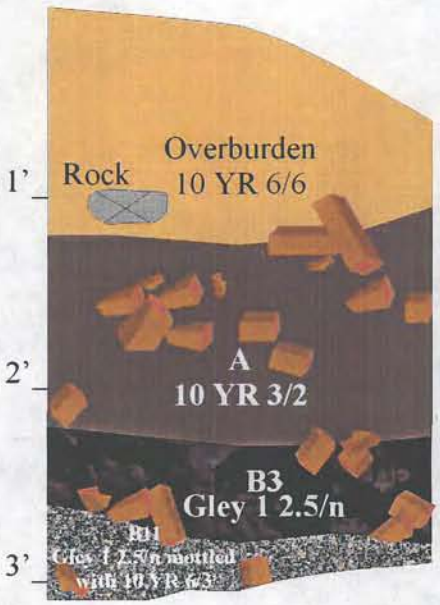


Figure 7-9. Profile of Trench 8, East Wall

7.2.9 Trench 9

Trench 9 was a 50-foot trench that extended northwest from Trench 2, and was placed 72 feet east of the Trench 2 site datum. The trench was oriented at a 45-degree angle from the southeast to the northwest. The location and orientation for this trench was selected in the field and sighted with a compass with the intention of intercepting the remains of both Furnace 2 and Lehr 2 (see Figure 7-1).

Two sections of the working end of the arch of Furnace 2 were encountered in Trench 9. Section 1 was the southeastern corner of the arch and Section 2 was part of the curving brick foundation remains of the arch. The bricks on the surface were decomposing, but the bricks at lower levels were intact, and mortar was still present between the bricks. Both sections were designated Feature 6. During the Phase I, the maximum depth of the Feature 6 could not be determined. However, plan-view feature drawings were made, and several courses of bricks were noted.

Trench 9 also intercepted a portion of a north-south interior factory wall that was constructed of gray unmarked fire bricks (refractories). This type of refractory was distinctive

because of its color and composition; it was found to only have been used for the interior factory wall. Based on its central placement in the factory, it is likely that the wall functioned to both insulate and separate the two furnaces. The wall was designated Feature 16 and it is discussed further in Section 8 of the report.

A discrete deposit of burned debris mixed with artifacts appeared in the northeast wall of Trench 9. The deposit was approximately ten feet northwest of the Trench 9 datum stake and was identified at the Stratum B level. It contained an unusual mix of ash, glass, and a high quantity of ceramic artifacts, as well as the gear workings of a clock or timer. The representative soil profile for Trench 9 depicts the south wall (Figure 7-10).

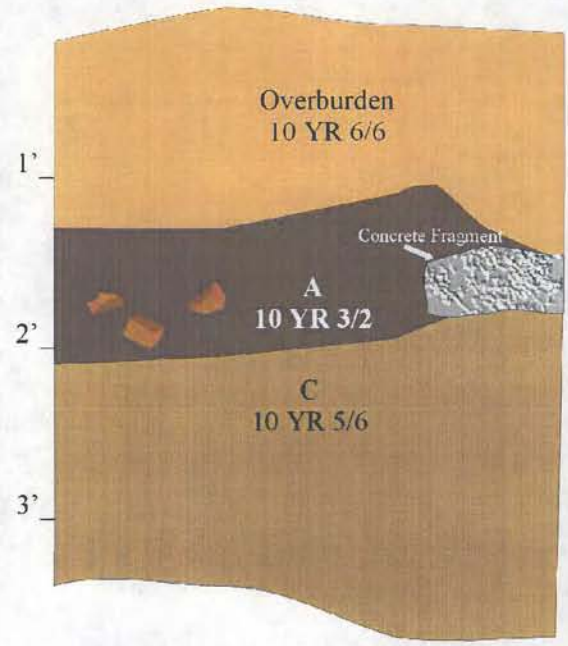


Figure 7-10. Profile of Trench 9, South Wall

7.2.10 Monitoring

During monitoring of the northern section of the factory, two brick footers were exposed (See Appendix J). Footers of this size, two-foot and three-foot square, were generally placed at uniform intervals to provide support to the factory structure. They were aligned with the another footer, Feature 1, in the western factory wall (Feature 1) and were located approximately 34 feet and 42 feet north of the feature. The two brick footers probably represent the northern extent of the factory structure. To test the theory archeologists compared the dimensions of the factory in the Sanborn map to the dimensions of the factory remains. Measuring from the back wall of the factory to the northern footers, both the field measurements and the Sanborn Map indicated that the factory was approximately 160 feet in length.

7.3 EXCAVATION BLOCKS

Four excavation blocks, each measuring 100-square feet, were excavated during Phase I. The four blocks were placed to further define features that had been revealed during trenching (see Figure 7-1). Blocks were excavated to the level of the top surface of brick features. The results of the block excavations are discussed below.

7.3.1 Block 1

Block 1, which measured 10 feet by 10 feet square, was placed to overlap with the corner of the small oven (Feature 12) and the southern end of Lehr 1 (Feature 2) (see Figure 7-1). Only the northeast corner of the small oven was exposed. This section of the feature consisted of articulated brick with intact mortar. This appeared to be the top surface of one of the oven walls. As in Trench 6, the feature was buried under approximately 1.5 feet of fill containing two levels: the overburden, and the glass-factory fill (Stratum B). Subsoil was not reached in the block excavation of Feature 12.

Part of the west wall of Lehr 1 was uncovered during the excavation of Block 1. This wall had previously been uncovered in Trench 1 as a robbers' trench. The wall was in good condition with intact mortar. However, it was evident that many courses of bricks had been removed during demolition and that only the foundation courses of the lehr structure remained.

7.3.2 Block 2

Block 2, a 100-square foot block, was excavated to find the working arch of Furnace 1 (Feature 5) (see Figure 7-1). Curving rows of bricks were uncovered in this block, roughly where the Sanborn map indicated they would be. Field archeologists determined that the brick was the foundation level of the working end of the furnace arch. The western section of the arch foundation was fully exposed. The arch was divided into compartments by a north-south center wall of bricks that bisected the arch longitudinally. Remains of the eastern section of the

working arch had been damaged as the result of the construction of the Stations Shops. The brick was laid in a complex pattern, especially just outside the arch curve on the west side. Mortar and decaying brick on the topmost level of bricks indicated many courses of bricks had been removed, probably during factory demolition. The interior compartments of the arch were filled with compacted historic rubble mixed with clay and artifacts characteristic of the Stratum B fill level identified throughout the site. The western exterior of the working arch, outside the brick foundations, was entirely clay subsoil.

7.3.3 Block 3

Block 3 was excavated to define the existing architectural remains of Lehr 1. The Block was excavated in an "L" shape that wrapped around Block 1 (see Figure 7-1). This configuration permitted exposure of the remains of the east and west walls of Lehr 1. All of the existing remains of Lehr 1 were uncovered in Blocks 1 and 3. The center section of the Lehr, between the east and west walls, was 2.8 feet wide. This area was the oven chamber described in Section 5.3; it contained dense historic fill characteristic of Stratum B. This portion of the Lehr was left undisturbed during the Phase I investigation. The oven chamber was later excavated as a test unit during Phase II/III.

The lehr walls were uneven widths; the west wall was 2.1 feet wide, and the east wall measured 2.8 feet in width. A concrete pad, presumably from the modern Station Shops, was laid atop a section of the east lehr wall. A single line of refractory bricks extended southward from the east wall. This area was not excavated to subsoil at this phase of the investigation.

7.3.4 Block 4

Block 4, a square ten-foot by ten-foot block, was excavated to examine the arch of Furnace 2 (Feature 6). The east side of the arch was excavated, and most of it was found to be intact. A cinder block Station Shops wall cut through the arch, and roughly paralleled the west wall of Block 4.

The plan view drawing of the arch depicts six lines of brick laid end to end, gradually curving to form the arched shape. This feature appears in Section 8 of this report. Sterile subsoil was uncovered outside the arch. During this phase of investigation, the arch interior was left unexcavated, but it was noted that it contained glass factory rubble fill.

7.4 SUMMARY OF THE PHASE I INVESTIGATIONS

The Phase I investigation identified many architectural features from the Virginia Glass Company Site. These features included the two melting furnaces, the two lehrs, the small oven, the western exterior factory wall and an interior refractory brick wall. It was determined that the historic fill and debris throughout the factory had been redeposited and were not *in situ*. The exceptions to this pattern of re-deposition are as follows: several discrete areas of ash and burned materials within compartments of Furnace 1 appeared intact; the burnt red clay atop the ventilation system was probably *in situ*; and the two robbers' trenches in Lehr 1 (while the original bricks had been robbed, the trenches had not been substantially modified since that occurrence).

It was apparent from the Phase I investigation that more valuable and accurate information could be derived from the examination of the architectural remains than from the disturbed fill deposits. The Phase I stratigraphic profiles represent sequences of redeposited fill, providing little information regarding activity areas within the factory. As a result of the Phase I data, the emphasis of the Phase II/III excavations/data recovery was to examine the manufacturing process and the functional and spatial aspects of structural remains within the factory.

8.0 PHASE II/III EXCAVATIONS AND DATA RECOVERY

Phase II/III investigation began on December 1, 1997. It consisted of four components: test unit excavation, Scrape 1, Scrape 2, and Trench 10. The results of these excavations are detailed below. The interpretation of the findings from the Phase II/III investigation are presented through a discussion of the glass-making process. The glass-making process is divided into various steps that occurred in specific activity areas within the Virginia Glass factory. The discussion of these steps integrates the architectural features with their associated functions. Artifacts are not included in this discussion because they were recovered from a disturbed context of re-deposited fill and were not *in situ*; the artifacts are discussed separately in Section 9. The Phase II/III discussion begins with the Test Unit descriptions below. The interpretation of the archeological remains, which is tied to the glass-making process, follows in the descriptions of Scrape 1 and Scrape 2.

8.1 PHASE II/III TEST UNITS

Three test units were excavated at the glass factory site during the Phase II/III data recovery to examine specific features that had been uncovered during the Phase I investigations. The profiles drawn of test units supplemented the profiles of trenches excavated during Phase I. The excavation of these units confirmed that stratigraphic levels contained a mix of fill sequences. Because of the lack of stratigraphic integrity documented in each of these units, it was decided that additional test-unit excavation would not provide useful information about the glass factory and test unit excavation was terminated.

Each test unit measured three-by-three feet and was excavated to sterile soil. Each feature within each individual unit was given a letter designation starting with "Feature A". Stratum levels were also given letter and number designations. The strata in the test units used the same classification system that was employed in the Phase I soil profiles, where possible. However, additional number designations were assigned to strata within units that were distinctive and were not encountered in the Phase I trenches.

8.1.1 Test Unit 1

Test Unit 1 was placed adjacent to Trench 3 in the southernmost extent of glass factory excavation during Phase II/III. The south wall of Trench 3 was the north wall of the test unit. This area was chosen so that a potential midden south of Trench 3 that contained domestic artifacts such as bone and historic ceramics could be examined. The potential midden feature was wedged between the Gas Producers of the factory and the Washington and Southern Railroad tracks that backed up to the rear of the glass factory.

Several soil strata were documented within Test Unit 1. The first was overburden consisting of modern sand and gravel fill that probably was deposited when the Station Shops were built. Beneath the overburden was Stratum A-1, a transitional layer consisting of dark soil with a mix of modern material, including 7-Up and Pepsi bottle fragments, modern bricks, iron wire and straps, and asphalt shingles. Stratum A-1 also included historic artifacts such as whiteware, ironstone, pearl-ware/whiteware transitional ceramic, bottle glass, nails, and a large amount of slag. Soils in Stratum A-1 were characteristic of Stratum A (historic fill) found within the factory footprint (discussed in the Phase I findings). However, the designation "Stratum A-1" is used to describe fill that contains both modern and historic materials. The modern materials result from dumping at this location from the 1940s through the 1960s. The historic ceramics and glass date from the early part of the nineteenth century through the late nineteenth century. Their occurrence on the site is probably due to dumping from nearby domestic residences or filling during railroad construction in the mid-1850s.

Stratum B-3 was a dark, almost black layer. It appeared to be associated with the factory demolition period, and included large amounts of brick and mortar rubble, fragments of a ceramic pipe (probably drain or water), coal, and slag. Artifacts included bottle fragments and melted glass produced at the factory, as well as domestic artifacts such as ceramics, bone, shell, window glass, and milk glass. Iron fragments, wire, and a railroad spike may relate to the railroad.

Stratum B-6 was a dense, black layer with a lot of coal, a few fragments of ceramic, and clear, aqua, dark green, and milk glass. A trench that had cut through this level was designated Feature A. The trench cut across the unit floor at this level and was also visible in the south wall of Test Unit 1 (Figure 8-1). Stratum B-7 was a transitional stratum, containing only three fragments of clear bottle glass. The soils consisted of yellow silty clay. Stratum C, appearing five inches below the water table, was the natural, sterile subsoil clay.

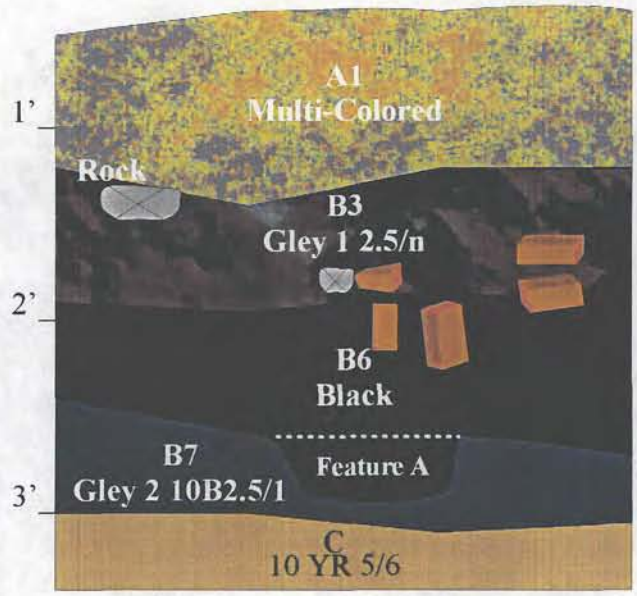


Figure 8-1. Profile of Test Unit 1, South Wall

Based on excavation of Test Unit 1, it was concluded that the southern section of the site contained soils that were highly disturbed and mixed. Although early-nineteenth century artifacts appeared in this area, they were in a disturbed context that does that not constitute a sheet midden or a discrete temporal deposit. The proximity of these artifacts to the railroad tracks, an area that had been repeatedly modified, suggested that the integrity of any domestic midden deposit would have been severely compromised during the nineteenth and twentieth centuries.

8.1.2 Test Unit 2

Test Unit 2 was placed in the center of the small oven (Feature 12). Prior to initiating test unit excavation, a backhoe was used to clear off the entire feature down to the top level of the brick square. The entire oven opening measured 3.2 feet by 3.2 feet; the test unit bisected this area and measured 3.2 feet by 1.6 feet.

No overburden level was encountered in Test Unit 2 because it had been removed by the backhoe. Stratum B-1 was a historic fill of compact, silty clay that contained a glass button, nails, regular and firebricks, slag, bottle lip/necks and bases, miscellaneous bottle fragments and wood. Stratum B-10 was silty sand with ash; it contained fewer artifacts. Only one bottle lip, one lump glass waster, and a few broken bricks were present at this level. Another row of bricks was found lining the west wall, making the oven opening smaller. Stratum B-12 was also silty sand with ash; this level had higher moisture content than stratum B10. There was a higher quantity of glass, including small glass tubes and filaments, one bottleneck, and a finished embossed amber bottle fragment in this level. Nails, bricks, and ceramics were also recovered. Stratum C was subsoil, which appeared to be directly beneath the oven feature, with no flooring of any type present (Figure 8-2).

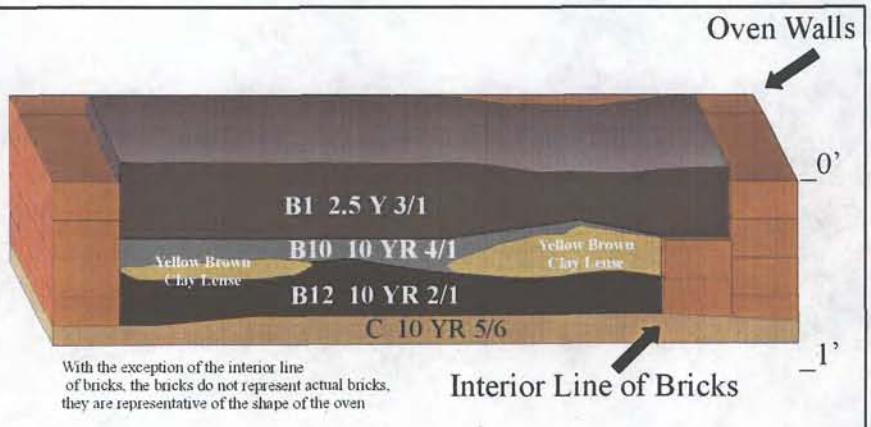


Figure 8-2. Profile of Test Unit 2, South Wall

8.1.3 Test Unit 3

Test Unit 3 was placed in the tunnel area between the walls of Lehr 1. The unit was placed three feet north of the south end of the Lehr and measured 3 feet by 3 feet. The overburden and Stratum A layers were removed by the backhoe.

Stratum B was consistent with the dense brick rubble fill found throughout the site. The second B Stratum was a mottling of dark yellow-brown clay sand, a gray clay, yellow brown clay, and very dark gray brown sandy silt clay. This stratum contained a high quantity of brick

rubble, and some glass and bottle fragments. Two pipes ran between the Lehr walls; these pipes were designated Feature A. One pipe was copper, the other iron; they were probably associated with the twentieth-century Station Shops. Excavation showed that the western Lehr wall was built on approximately two inches of sand, while the eastern wall was supported by headers that were set in subsoil (headers are bricks that are oriented lengthwise to provide additional support for a brick structure). In this case, the needed support was at the very base of the structure. At the direction of *Alexandria Archaeology*, excavations at this location were halted before the test unit was completed.

8.2 APPROACH TO SCRAPE 1 AND 2

Horizontal excavation of the site was designated Scrape 1. The excavations were conducted using a Gradall, a front loader, and a mini-excavator. Dames & Moore archeologists closely monitored mechanical earthmoving equipment while fill was being removed from feature surfaces. Once surfaces were exposed, archeologists scraped the remaining overburden from the features using trowels and shovels. At the direction of *Alexandria Archaeology*, the site was excavated horizontally to the top of the brick features before vertical excavation of the site began. The purpose of the horizontal scrape was to get a plan view of the entire factory at one level. After the site had been scraped to one level, site overview photographs were taken, and each feature was individually photographed. During Scrape 1 several new features were identified and information about the structural dimensions of known features was expanded.

Scrape 2 was the vertical excavation of features within the site. The northern section of the site was shallow and accessible. The southern section of the site, particularly south of the furnaces, contained large brick features that could not be completely accessed without removing the structural remains above. Excavations were stopped when depths were hazardous and features were in danger of collapsing. Time limitations on the excavations prevented complete excavation of the ventilation system, gas producers, and Furnace 2. A mini-excavator was used to dig the chambers within the furnaces; archeologists cleaned the surfaces of features by hand. A large part of the feature documentation was completed during this process. Detailed notes

were taken on individual features, measured drawings were completed and photographs captured the three-dimensional aspects of the factory remains.

Trench 10 was opened at the end of Scrape 2 to gain a view of the ventilation system south of Furnace 2, and was recorded in the field as a trench. However, after it was opened, the features within the trench were documented in the same manner as the general Scrape 2 interpretation. Therefore, Trench 10 does not appear in the trench descriptions or on the testing plan/site plan overlay map. Figure 8-3 depicts a plan view of the architectural remains of the factory at the end of Scrape 2.

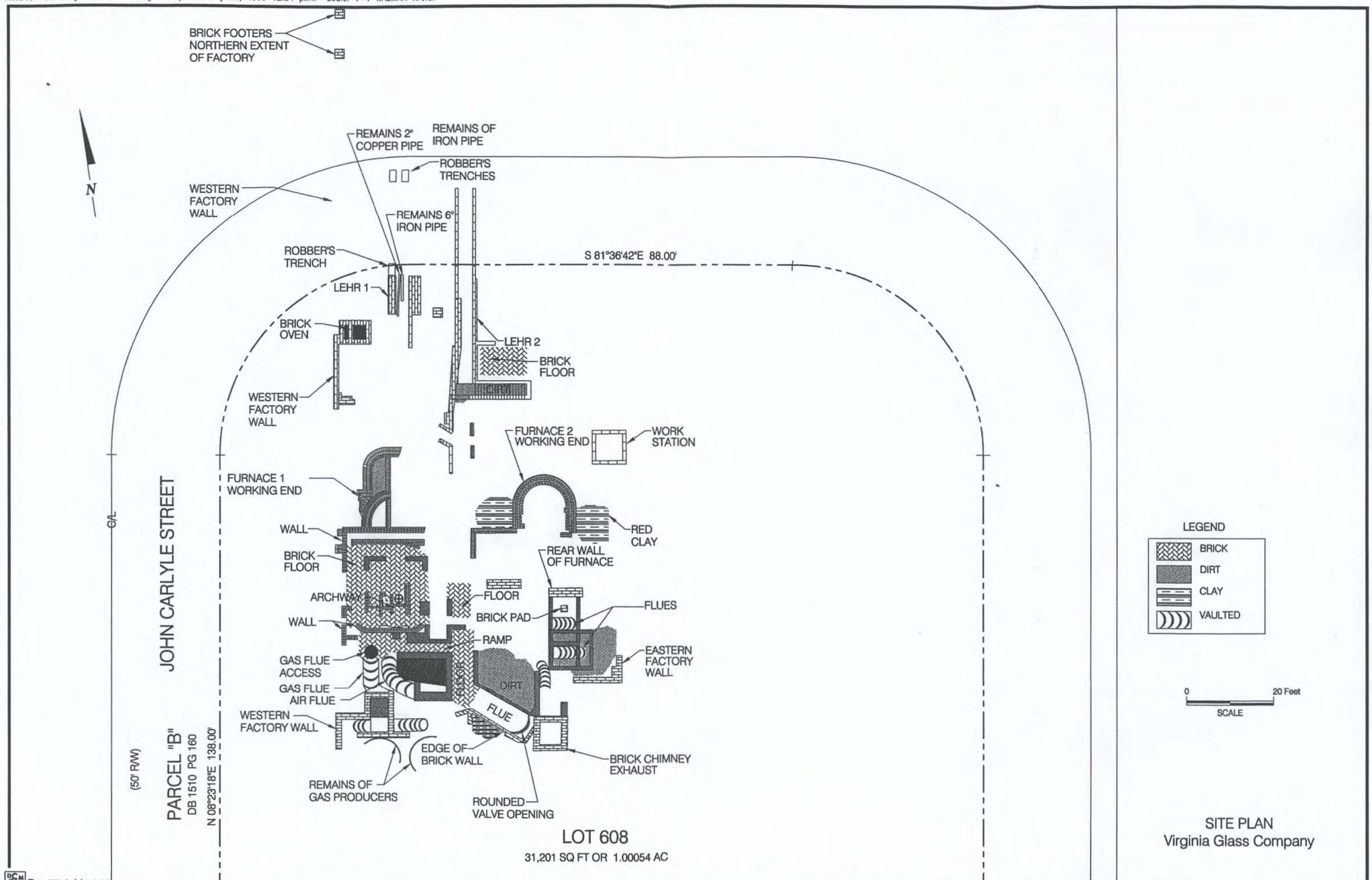
8.3 SCRAPE 1 AND SCRAPE 2 INTERPRETATION

Several steps are involved in the manufacture of bottle glass. These steps are described at the beginning of each of the following sub-sections. Glass-working activities took place in various sections of the factory complex, many of which are identified in this discussion by individual feature numbers. Some of these activity areas are labeled on the Sanborn Map (see Figure 6-1), providing historic context for the archeological information. The discussion that follows describes features and ties them to steps in the glass-making process. Photographs of factory excavations are included in Appendix I.

8.3.1 Step One: Mixing of Raw Materials

The raw materials for bottle glass at the Virginia Glass company were sand, soda and possibly lime. Varying amounts of each ingredient were added to the frit in combination with cullet (broken glass) to form the molten glass for bottle production. The mixed materials were probably transported by cart to a rear or side entrance of the factory, located near the melting furnaces.

The sand, soda and mixing house depicted on the 1912 Sanborn map was probably a frame structure (see Figure 5-6). The mixing house was situated approximately 60 feet east of


BRICK FOOTERS NORTHERN EXTENT OF FACTORY
N
REMAINS 2" COPPER PIPE
REMAINS OF IRON PIPE
ROBBER'S TRENCHES
WESTERN FACTORY WALL
REMAINS 6" IRON PIPE
ROBBER'S TRENCH
S 81°36'42"E 88.00'
LEHR 1
BRICK OVEN
LEHR 2
BRICK FLOOR
WESTERN FACTORY WALL
FURNACE 2 WORKING END
WORK STATION
FURNACE 1 WORKING END
RED CLAY
WALL
BRICK FLOOR
REAR WALL OF FURNACE
ARCHWAY
FLOOR
FLUES
WALL
BRICK PAD
RAMP
EASTERN FACTORY WALL
GAS FLUE ACCESS
GAS FLUE AIR FLUE
DIRT
FLUE
WESTERN FACTORY WALL
EDGE OF BRICK WALL
BRICK CHIMNEY EXHAUST
REMAINS OF GAS PRODUCERS
ROUNDED VALVE OPENING
JOHN CARLYLE STREET
C/L
(50' R/W)
PARCEL "B"
DB 1510 PG 160
N 08°23'18"E 138.00'
LOT 608
31,201 SQ FT OR 1.00054 AC
LEGEND
BRICK
DIRT
CLAY
VAULTED
0
20 Feet
SCALE
SITE PLAN
Virginia Glass Company
DAMES & MOORE

the factory (where John Carlyle Street now stands), and outside of the project area. The raw material storage structure may have burnt down in the last factory fire or demolished when the burnt remains of the glass factory were razed. Several small deposits of grayish, fine sand were observed throughout the factory, notably in the robbers' trench of Lehr 1. There was no certain evidence of soda or lime deposits in the fill levels associated with the factory.

8.3.2 Step Two: Preparing the Melting Pot for the Furnace

The formation of clay pots used for early glass production involved a time-consuming and costly process. Therefore, precautions were taken to prevent the cracking and eventual breakage of these pots. Pots were carefully prepared to enter the extremely hot environment of the melting furnace by being heated initially in a smaller, cooler oven.

At the Virginia Glass Company site, one small oven is illustrated on both the 1907 and the 1912 Sanborn maps. The oven, which was uncovered during Phase I investigations, is located west of Lehr 1 and abuts the exterior western wall of the factory (see Figure 8-3). Excavations revealed the base of this brick oven, which was set into dense clay subsoil. Only 13 vertical courses of bricks remained intact (Figure 8-4). It was apparent that any functional aspects of the oven (such as openings, shelves or associated hardware) had been removed during the demolition of the factory. The two combustion chambers of the oven had been back-filled with mixed dense clay fill containing fragmented artifacts associated with the glass factory. The composition of the fill is described in the discussion of Test Unit 2 (see Section 8.1.2).

It was noted during test unit excavation that the oven was constructed of common brick, rather than refractory brick, and it was too small to produce the heat required to melt glass. This immediately narrowed down the possible functions of the small oven. Although the oven seemed to match the description of the type used for preparing melting pots, this oven is located next to Lehr 1 rather than near the melting furnaces. The oven may have served dual purposes, heating the clay melting pots and providing the heat necessary for the intermittent fire polishing of flawed or poorly molded bottles. Bottles would have been fire polished near the lehrs after the

bottles were already formed. The small oven, less than ten feet from Lehr 1, would have been readily accessible. The oven may also have provided the heat for the lehrs themselves.

Figure 8-4. The Small Oven, view to the northeast

8.3.3 Step Three: Heating the Furnace

Tank Furnaces utilized one of two different methods of recapturing heat--*regeneration* or *recuperation*. The archeological excavations at the Virginia Glass Company did not go deep enough to provide conclusive evidence about what type of tank furnace was in operation. *Recuperation* involves the simple transfer of heat between the exhaust flue and incoming air flue, preheating air to approximately 1100 to 1400 degrees Fahrenheit. The proximity of the gas producers to the furnace provided the furnace with heated gas. *Regeneration* is a more complex process wherein exiting exhaust gases preheated stacked brick regenerators located on the sides of the melting tank. Fuel and air intake is alternated from one side of the tank to the other, preheating gas and air as they pass through the regenerators.

Gas Producers

Two gas producers were located south of the Furnace 1 ventilation system (see Figure 8-3). The producers were fueled by coal to gasify carbon and provide producer gas for Furnace 1 and possibly for Furnace 2. Structurally, the gas producers are iron tanks lined with refractory bricks (refractories) that were connected to the ventilation system of the tank furnace. The refractories formed a circular row to line the tank and were cemented with mortar. One historic model shows an opening in the side of the gas producer where coal could be loaded into the tank (see Figure 5-8).

At the Virginia Glass Company, the gas producers were under several feet of fill; the maximum depth of the tank bases was never reached during Scrape 1 and 2. Both gas producers were nearly the same size, each having a diameter of approximately nine feet. The diameters were not measured completely because sections of both tanks were missing. It would be expected that a one hundred percent excavation of the factory would provide information regarding the structural connections between the gas producers and the air flues (Figure 8-5). Deposits of coal ash mixed with artifacts (mostly bottle glass) were observed in both of the gas producers. The ashy soils in this area were unconsolidated.

The northern end of two air flues abutted the south wall of Furnace 1. However, the actual juncture between the flues and the furnace could not be seen. From the surface level, it appeared that the western gas producer was the fuel source for Furnace 1. The ventilation system for Furnace 2 was more deeply buried and the flues were oriented east-to-west. For this reason it is difficult to define the juncture of the ventilation flues with the south wall of the Furnace 2.

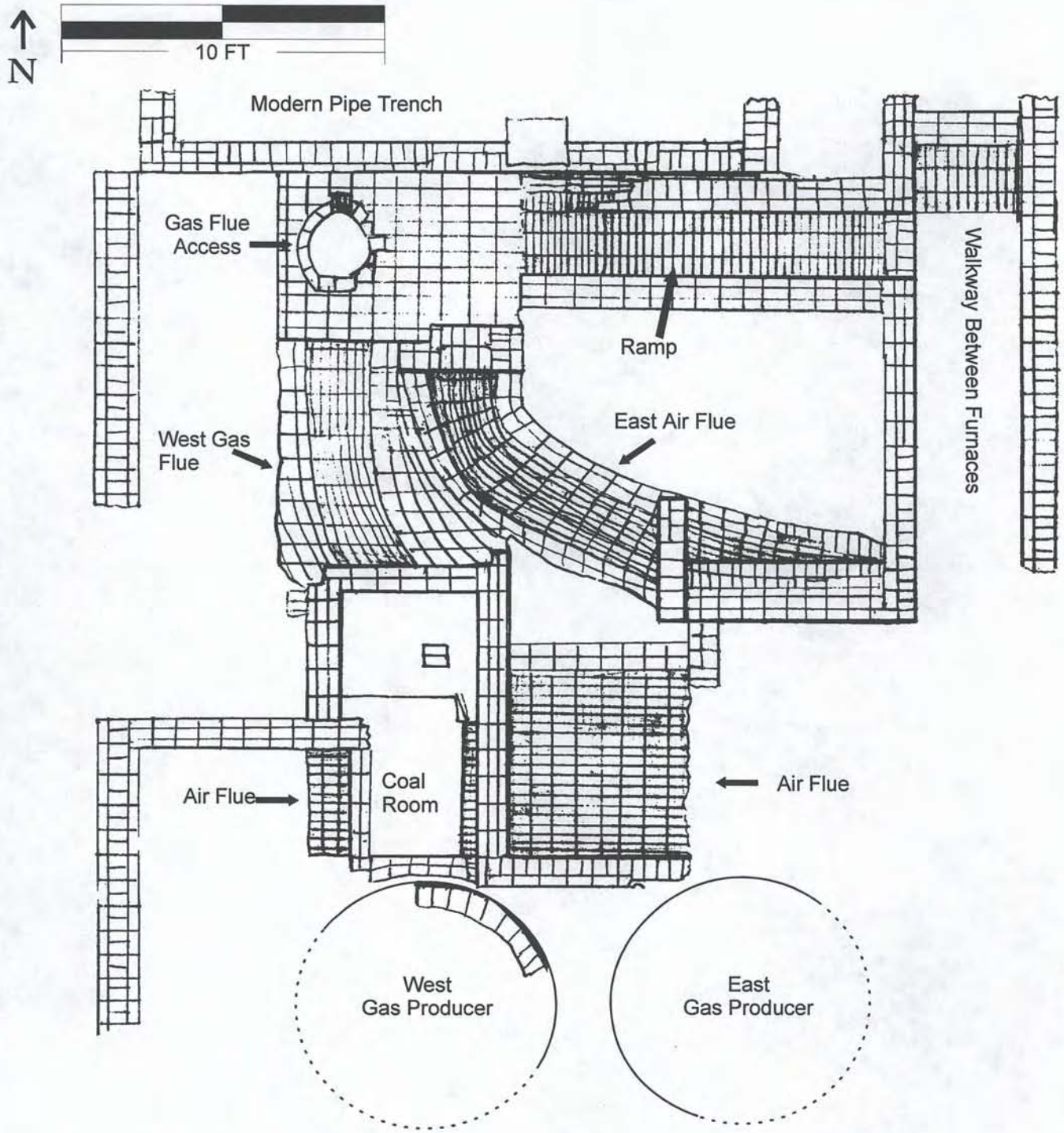


Figure 8-5. Factory Remains South of Furnace 1,
Showing Ventilation System, Ramp, Walkway Between Furnaces, and Gas Producer Remains

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The Coal Storage Room

The coal room was a rectangular brick room or compartment that was situated between the ventilation flues of Furnace 1 and the western gas producer (see Figure 8-5). The brick room measured approximately nine feet by three feet. The flooring and walls consisted entirely of common brick. On the southern wall of the room was a curved brick wall consisting of a single width of brick that wrapped around the western gas producer. Large chunks of uniformly cut coal were scattered throughout the room and coal dust had blackened the walls and floor. The base of this feature was not reached along the exterior walls, but seven courses were exposed.

The small size of the room suggests that it functioned as a coal storage area. This location would have been the logical place for a coal storage area, next to the gas producers where large amounts of coal would be required for fuel.

The Ventilation System

Two vaulted brick air flues extended from the southern wall of Furnace 1 (Figure 8-3). After additional research, the western air flue was designated an input air flue that would have carried producer gas into the tank furnace. The eastern flue was designated an out take air flue, which functioned as an exhaust flue and probably terminated at the brick chimney exhaust at the southeastern corner of the factory.

As was expected based on documentary resources, the air flues were constructed of refractories. The plan view of the ventilation system (see Figure 8-5) shows the input flue measuring four feet wide, a foot wider than the out take flue. These two flues had been capped evenly by dense red clay (Stratum B13). The red clay created a level ground surface over the vaulting brick.

Two additional air flues, oriented east-to-west, were located south of the coal storage room (see Figure 8-3). The air flues were uncovered at a depth about 1 foot lower than the input and out take flues. The two vaulted sections of the flues were connected by brick, which formed a level surface. The orientation of the air flues suggests that they may have been connected to the chimney, the primary exhaust for the factory. As a general observation, the location of air, producers, gas and exhaust flues at approximately the level of the tank base, rather than below the regenerators, suggests that the small furnace used recuperation as a method of heat recapture.

The gas flue access was a circular opening in the furnace located just north of the main air flues. The purpose of the flue was probably to provide access to the air flues during furnace maintenance (Richard O'Connor personal communication). The flue measured approximately two feet in diameter. The gas flue access was right next to a machine ramp and a rectangular metal cover.

The machine ramp structure was 12 feet long and 6 feet wide. It was constructed of common bricks that were graded to slope eastward to the walkway between the furnaces. Two elevated tracks for wheels had been constructed out of brick. The ramp floor was constructed of bricks laid on their sides, and the elevated tracks were constructed of three rows of bricks on each side (see Figure 8-5).

A small, flat, rectangular cover had been set into the brick on the south wall of the tank furnace next to the machine ramp. It had been made from a metal alloy and may have also provided access to the furnace. The cover was immovable and its purpose could not be determined without dismantling the feature (See Figure 8-5).

Trench 10

The ventilation system continued behind Furnace 2 (in the area of Trench 10), which had been opened during the archeological excavation to gain a view of the remaining structures and air flues that were south of Furnace 2. Trench 10 was a diagonal trench that was placed next to

the chimney in the corner of the diagonal air flue that leads to the chimney (Feature 28). The air flue extended northeast to Trench 2. This air flue was oriented northwest-to-southeast and measured approximately 15 feet (See Figure 8-3 and Feature drawings in Appendix J).

Trench 10 exposed the corner of the air flue enclosing a round opening, which was determined to be an access area. The access area was located approximately one foot east of the factory chimney. A valve, found at the base of the access area, consisted of a two-foot diameter, circular metal wheel that would have been turned. Workers would have entered the corner at this access location to open or shut off the valve. Presumably, this valve would have controlled the flow of air or gas into the furnaces. The round compartment was a curved refractory wall. Although the foundation courses of the wall were not reached, the visible section contained at least 16 courses of brick. The refractories had been corroded with a bubbly metal coating as the result of use (See Feature 38 Drawing, Appendix J).

An opening that was west of the metal valve was a perfectly intact ventilation flue under six feet of fill. Archeologists determined that this flue was a continuation of the lower level out take flue that began south of Furnace 1. Another flue was located on the east side of the valve in the access area. This eastern flue extended in the direction of the chimney. Three more vaulted air flues were exposed south of Furnace 2 (see Figure 8-3). The first of these, Feature 40, was oriented north-south and extended northward from the chimney. Feature 40 curved to the west at the juncture where it would have connected with the other two air flues in Trench 10.

The two other air flues were oriented east-west (See Feature 41 and Feature 42 drawings, Appendix J). One unusual characteristic of these air flues was that they were constructed so that the bricks lay on their sides rather than flat. Each air flue was approximately three feet wide and was capped with dense red clay. The air flues were placed about three feet apart and were separated by dense red clay. A brick-lined pit filled with black soot, measuring three feet by two feet, was located at the western edge of the southernmost air flue.

The Chimney

The major exhaust flues of the factory led to the brick chimney, located in the southeast corner of the factory. The 1907 Sanborn map indicated that the stack rose 75 feet (see Figure 5-5). Phase II/III investigations revealed that the chimney base, which was square and measured eight feet by eight feet. The combustion chamber measured approximately five feet by five feet. Each wall was constructed of four rows of brick laid in the American bond pattern. Excavations were not deep enough to expose the base of the chimney or the juncture of the air flue and the chimney, but nine courses of bricks were observed above the ground surface.

8.3.4 Step Four: Melting the Batch

In the first two years of bottle production at the Virginia Glass Company, glass melting involved three clay pots located at the working arches of the furnaces. The furnace consisted of a combustion chamber and a wind passage, commonly known as a cave. A powerful draft drew the air through the cave and over the coal piled on the grate. The flames and heat reverberated off the top of the low flattened arch and heated the batch in the clay pots.

Pot Furnace Technology

The only remnants of the early pot furnace industry at the Virginia Glass Company site are the foundations of the original pot arches (Figure 8-6). These are labeled the 'furnace working ends' in Plan View A (see Figure 8-3). The term "arch" in this discussion refers to the arch-shaped brick foundations of the furnace, not arched openings where glass workers would have inserted pontils into the melting pots. The functional arched openings were demolished when the factory was razed.

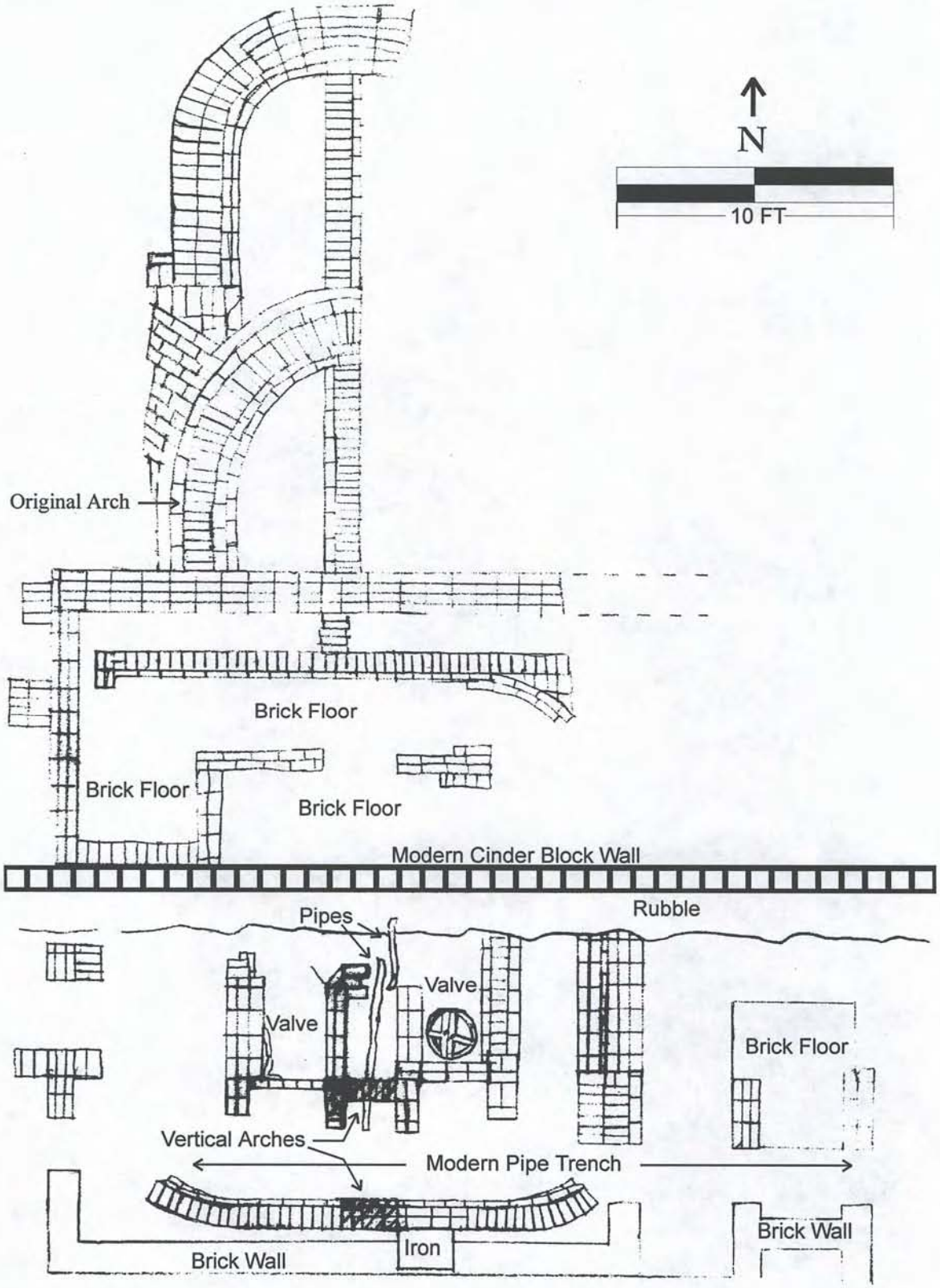

Figure 8-6. Architectural Remains of Furnace 1

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The pot arches are composed entirely of brick bound with decomposed mortar at the upper levels (the first one or two courses), but intact mortar at the lower levels. Furnace 1 has an expanded northernmost secondary arch, which was probably added after the first factory fire (Commoner and Glass Worker 1899). The evidence of this addition is a patchwork of bricks at the juncture of the two arches. The length of the original pot arch was 10.5 feet and the second arch was approximately 10.6 feet. Estimating from the intact side of the pot arch, the arch width for both arches would have been approximately 15 feet.

It is probable, based both on the size of the arches and on the historic glass factory records, that the first arch was constructed at the beginning of the factory operations. Following this premise, the second arch would have been added onto the furnace after the first factory fire when the factory was converted from pot furnace to tank furnace. This conclusion is logical considering the size of individual pot arches and the number of pots that would fit at the working end of Furnace 1.

Like the small oven, the bottom course of the pot arch foundations had been set into thick clay subsoil. A straight wall of bricks, oriented in a line perpendicular with the western wall of the factory, separated refractory chambers within the pot arches. If it were possible to reconstruct the pot arches of the furnace, one would see that melting pots were placed within these chambers during the time this furnace was used for traditional bottle making. When the factory was razed, the chambers had been filled with historic fill, clay and brick rubble.

According to the Sanborn maps, there was clay flooring in the area between the pot arches and the lehrs. Heated red clay appears in a walkway that ran between the furnaces. The walkway was oriented north-south and terminated in the lehr area. There, the clay flooring joined brick flooring next to Lehr 2 on the eastern side of the site. A large section of the floor was pulled up during demolition and subsequent twentieth-century construction phases.

Tank Furnace Technology

Historic records indicate that a tank furnace was in operation at the Virginia Glass Company beginning in 1886 (See Section 5.0). The tank furnaces at this site were fueled by coal gas from gas producers that were attached to a complex ventilation system. The ventilation system had both input and out take flues that controlled the temperature of the furnace. The melting tank increased the capacity of glass that could be melted in one batch.

Tank furnace construction radically changed the depth of the glass factory. Construction required excavation to greater depths into the subsoil, particularly in the area that contained the factory's ventilation system. As a result, the archeological remains in the southern section of the factory are much deeper than remains in the northern section. In order to expose the entire ventilation system, the upper portion of the factory ruins would have to have been dismantled and removed.

Newly exposed sections of Furnace 1 uncovered during Scrapes 1 and 2 were designated part of Feature 5. Furnace 1 (Feature 5) operated as a continuous tank furnace before it was partly demolished in the early-twentieth century. The furnace remains identified during Scrapes 1 and 2 included the floor of the furnace pot arch, the gas flue access, the coal storage room, and the walkway between the furnaces and the ventilation system. Portions of the factory south of the Station Shops, such as the ventilation system, remained in the best condition. The Furnace 1 walls were fairly intact, crumbling only in places, and broken where they had been cut through by the Station Shops' cinder block walls and pipe trenches. The brick flooring, at a depth of three feet below surface (generally twelve courses of bricks), was in excellent condition.

Furnace 1 measured approximately 22 feet in length, plus an additional 21 feet with the pot arches. Furnace 1 abutted the western factory wall. The exterior walls of the furnace were either three or four brick rows wide. A brick walkway or air flue between the furnaces abutted

the eastern wall of Furnace 1; on the eastern side of the walkway, a wall of refractories (Feature 19) functioned to separate the two furnaces (see Figure 8-5).

Small chambers within the furnace – one of them containing a cap of a mushroom saucer valve (not *in situ*) and another containing a large iron concretion – may have functioned to enclose the mechanical equipment in the furnace. Figure 8-7 is a plan-view drawing of Trench 2, showing the compartments within the furnace. The reason we suggest that the chambers may have held mechanical equipment is because iron concretions are fused to the wall of the chambers in a uniform pattern.

In the exposed section of the furnace there were remains of the vaulted input and outake flues that provided the gas and ventilation for the tank furnace (see Section 8.3.3). These flues were brick arches made up of two courses of common bricks laid on their long sides (see Figure 8-5). The source of the intake flue was the gas producers, south of the furnace. The outake flue probably terminated at the chimney.

The gas flue access was located near the rear wall of the furnace. The architectural remains consisted of a circular opening measuring approximately 2 feet in diameter. Inside the opening was a large area containing brick rubble, coal fragments and some historic fill. A photograph taken

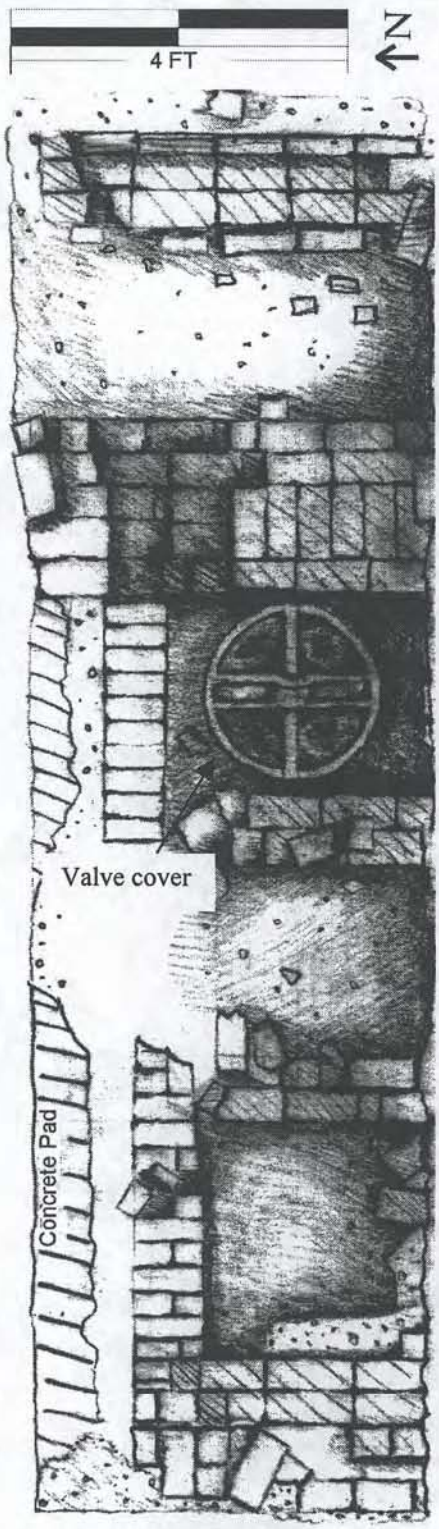

Figure 8-7. The Chambers of Furnace 1

indicates the continuation of the large input and out take flues to deeper levels of the ventilation system (Figure 8-8). These intact buried architectural remains were not accessible during the Phase II/III investigation.

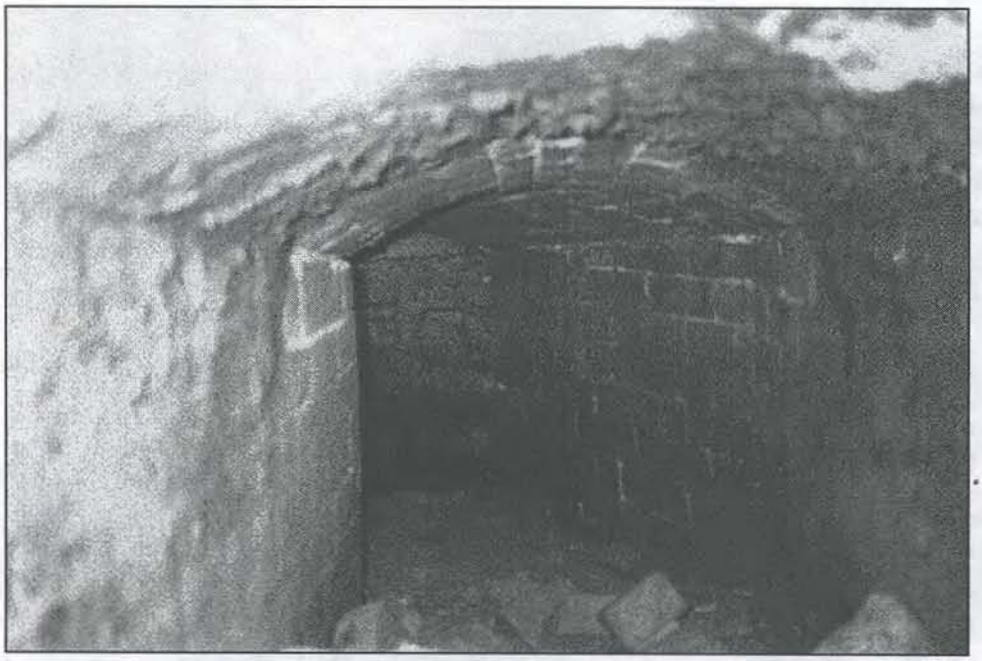

Figure 8-8. Photograph of Ventilation Interior, Showing Internal Flues, Photo Taken from Gas Flue Access, View to the South

A brick ramp, with runners for a wheeled cart or machine, was located on the east side of the gas flue access. This feature intersected with a 3-foot wide brick walkway. The walls on each side were 1.5 to 2.2 feet high (4 to 8 courses of brick). Most of the floor could not be exposed because of the presence of fused burnt material (up to 2 inches thick). In the area that could be scraped, bricks were exposed that were laid narrow side to narrow side. The exposed sub-level brick was laid perpendicular to the upper level bricks. The walkway was placed between the exterior walls of Furnace 1 and Furnace 2 (Feature 35) and was oriented north-south, parallel with the factory walls.

The use of bricks was consistent throughout the furnace, except for a few distinctive areas. In most cases, the foundations and walls consisted of stretchers of common brick. Three areas were different: 1) the furnace flooring was made up of several different combinations of headers and stretchers to create a slanted floor of common bricks; 2) two of the exterior walls of

the ventilation flues were laid in the American bond style, with the seventh row of headers consisting of yellow brick; and 3) the ramp from the gas flue access was made of refractory bricks laid on their sides.

Furnace 2 was located in the southeastern section of the factory, approximately three feet from Furnace 1 (see Figure 8-3). Documentation of this area was limited because some of the architectural remains were disturbed and the furnace was only partially excavated. No information was derived regarding the configuration of compartments or chambers within Furnace 2 based on the excavations that have been conducted. It is clear that the area of the ventilation system near the chimney has maintained good integrity.

Field archeologists documented and illustrated the pot arch in the northern section of Furnace 2 (Figure 8-9). The pot arch measured approximately 13 feet long and 16 feet wide. The arch joins an east-west extension wall that measured 10 feet on each side. Based on the remains that could be documented, the length of Furnace 2 from the arch to the rear wall was approximately 47 feet. Phase I trenching revealed an intact brick floor outside of—but adjacent to—the furnace. The flooring measured approximately three feet by two feet and consisted of refractories laid vertically on their narrow sides.

8.3.5 Step Five: Forming the Bottles in Molds

In traditional bottle production, after the molten glass was gathered from the furnace, it was marvered or rolled on an iron marvering surface. Molten glass then was placed in two-part or three-part molds. The glassblower forced air through the blowing iron into the mold to form the shape of the bottle. The lip and neck of the bottle were formed separately, and bottles were placed in the 'glory hole' for reheating and remelting the bottle top. The lip of the bottle was given its final shape with a special tool that created the outside lip (Department of Commerce 1917:73).

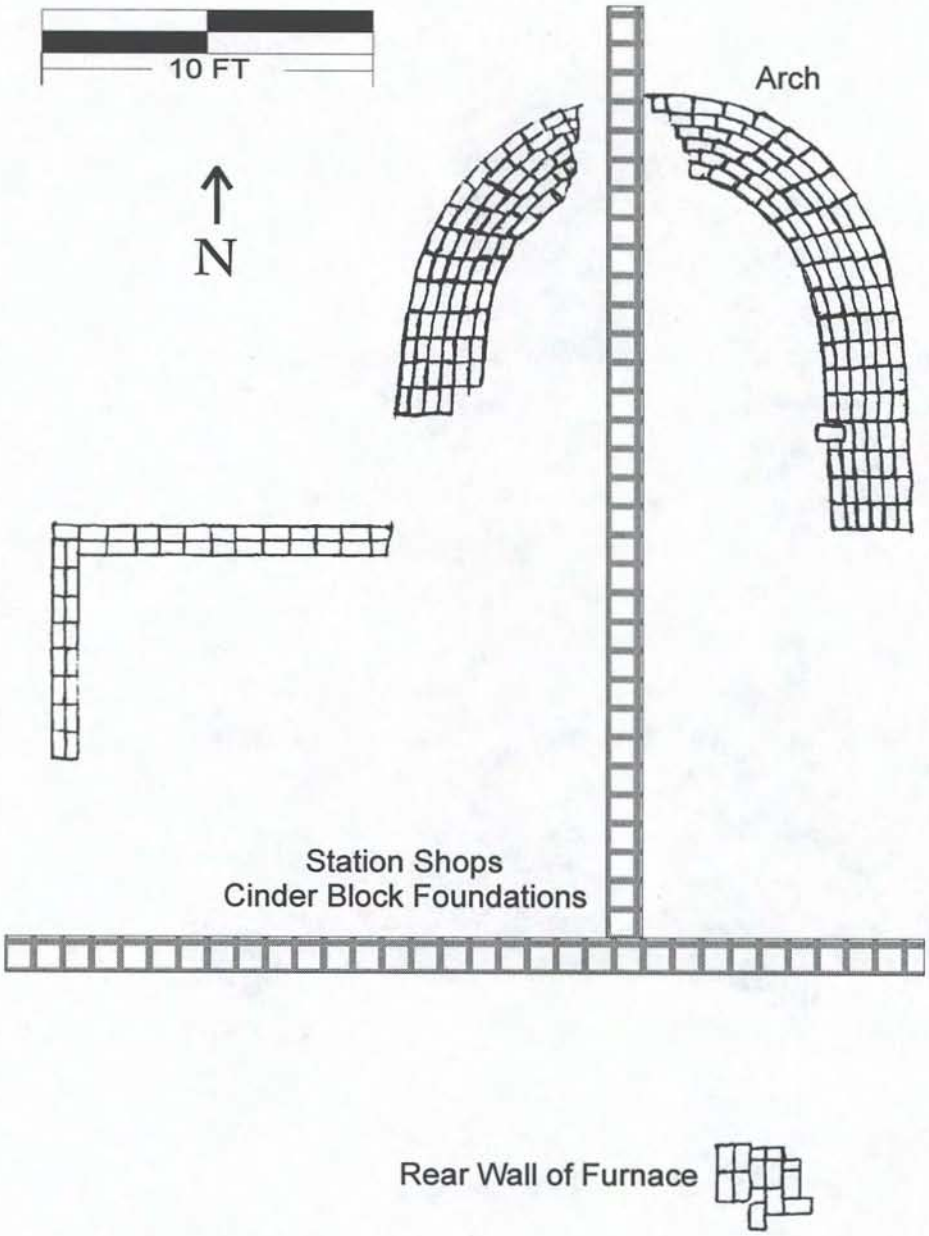

Figure 8-9. Structural Remains of Furnace 2

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The activities associated with forming the glass bottles would have occurred at the working end of the melting furnaces. The pot arches would also have been situated at this end of the furnace (see Figure 8-6). This area of the factory would have contained workstations for marvering and molding, and possibly glass workers' chairs where the senior glass workers sat to finish bottles. The brick square remains of one possible workstation, Feature 18, were exposed at the Virginia Glass Company site. The feature was situated northeast of Furnace 2, measured 4.5 feet by 4.6 feet, and consisted of a single row of bricks. Because it had only one course of bricks, it appears to be the base of the feature imbedded in the subsoil that would not have supported much weight. The placement of Feature 18 near the working end of the pot furnace suggests that it may have contained a table or workstation for the glassblowers. It is possible that the square of bricks could have been the foundation of an oven with a glory hole (See Figure 5-8). However, following this premise, one would have expected to find a sturdy foundation and ash or burnt fill similar the deposits found in the small oven. These indicators were not present in Feature 18.

Phase II/III excavations did not yield any bottle molds. It is likely that reusable equipment such as molds would have been sold if they survived the fire. However, several tools associated with bottle manufacturing were identified in the historic fill near the furnaces. These tools included a chisel, pincers, shears and a saw. These artifacts are described in the discussion of artifacts in Section 9.

8.3.6 Step Six: Annealing the Bottles

After the bottles emerged from the glory hole, in which tops were fused to bodies, they were transported by a conveyor to annealing lehrs in which jars and bottles slowly cooled. Lehrs were basically brick tunnels that were heated to approximately 1200 degrees Fahrenheit at the mouth. Gas heat was gradually lowered through the tunnel. Bottles traveled through the gradually decreasing heat before emerging fully annealed at the opposite end. The purpose of annealing was to reduce internal stresses in the glass container that might cause later breakage.

Intact remains of the Lehr 1 tunnel provided information regarding the width, length, and construction techniques of the structure. The remains of Lehr 1 measured approximately 27 feet in length and 7.5 feet in width. The west wall measured two feet, the east wall three feet, and the combustion chamber (or tunnel) was also three feet wide (Figure 8-10). It appears that the more intact section recovered during excavations would have been near the extremely hot southern entrance to Lehr 1, because an extension of black refractory brick was revealed at this location.

The bricks of Lehr 1 had not been laid in at traditional bond style. It was noted, instead, that the very base of the lehr foundation contained a row of all headers. The architectural remains were only eight courses high and the foundation bricks were set into a dense clay subsoil. Iron and copper pipes were found within the combustion chamber of Lehr 1, but it was determined that these were modern and part of the Station Shops plumbing.

The walls of Lehr 2 had been reduced to three lines of foundation bricks, generally one course each. The lines represented the width of the lehr combustion chamber and its placement within the factory. The length of these foundation brick remains (51.5 feet) corresponds closely with the

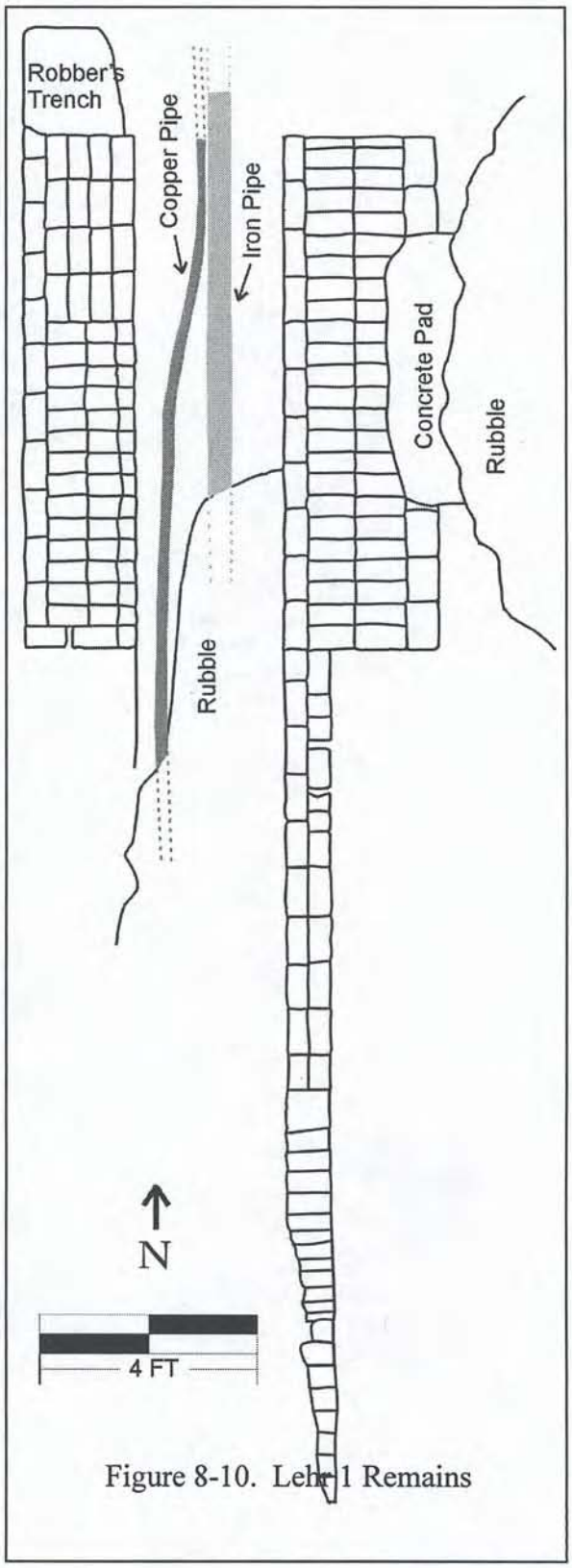


Figure 8-10. Lehr 1 Remains

length of Lehr 2 as illustrated on the 1907 Sanborn map. A brick floor was uncovered south of Lehr 2. Labeled Feature 22, it is the only flooring found in the part of the site that is north of the furnaces (Figure 8-11). Bricks were laid as stretchers, and the bricks formed at least two courses. In the eastern section of the floor, the top courses had been pulled away. The entire floor area measured approximately nine feet by fourteen feet. Other sections of the factory may have had similar flooring prior to demolition of the factory.

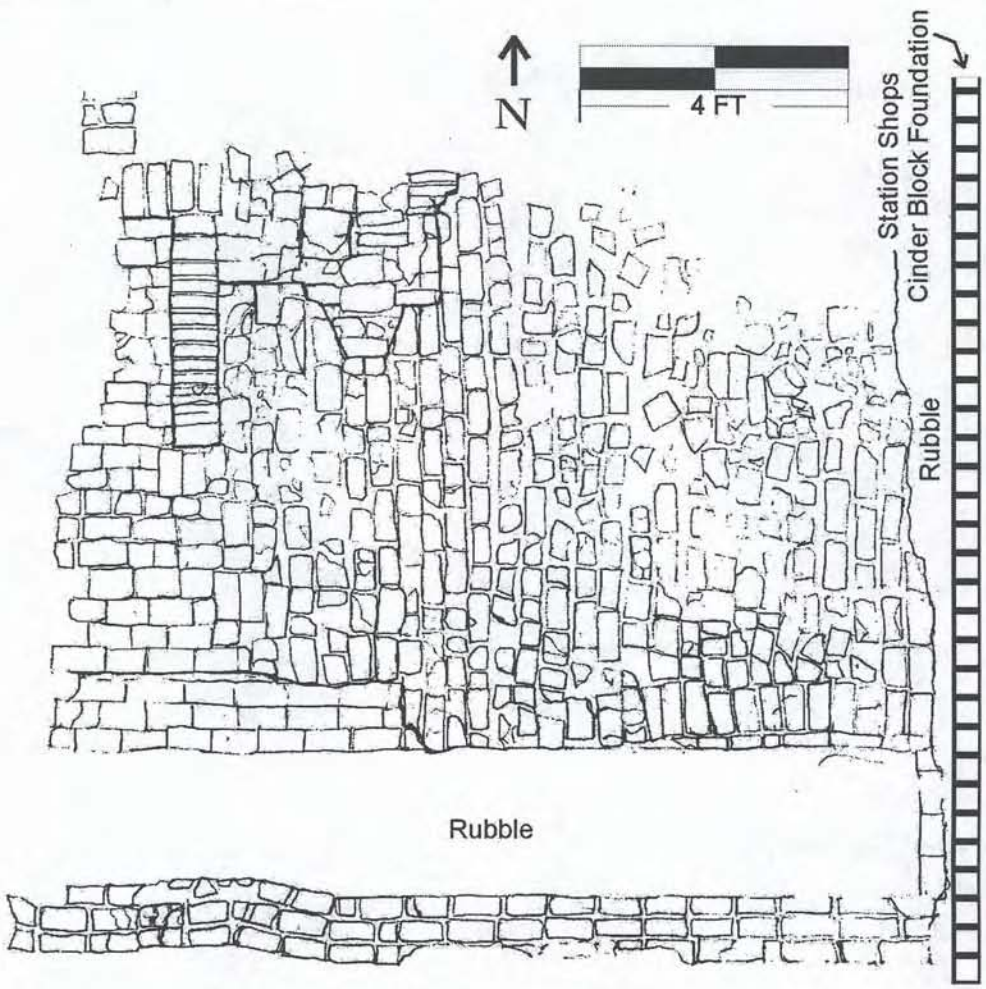


Figure 8-11. Brick Floor Adjacent to Lehr 2

9.0 ARTIFACT ANALYSIS

9.1 GENERAL ARTIFACT DISCUSSION

9.1.1 Collection Strategy

The function of the project site as a glass factory was known prior to excavation on the basis of historic documents and maps. Therefore, artifact collection and analysis focused on those artifacts that would provide information about the glass factory. Field archeologists also collected a sample of all types of artifacts found at the site (see Table 6-1). Because of the large amount of broken glass present, non-diagnostic glass was not collected outside of test unit excavations. Quantities were observed and qualitative descriptions were included in field notes. Very recent artifacts were generally noted in the field but were not collected; modern artifacts found in deep levels of the factory were retained as evidence of a disturbed context.

9.1.2 Artifact Context

Both test unit excavation and general archeological investigations revealed that the site did not retain stratigraphic integrity. In general, artifacts were concentrated in a thick, dark, sooty layer below modern sand and gravel fill. Bottles from the 1920s through 1960s were intermixed with bottles that were produced at the factory between 1893 and 1916. Although the amount of factory-related artifacts generally increased as modern artifacts decreased with depth, a few modern artifacts found at the lowest depths (bottom of Scrape 2) revealed a disturbed context. Even large artifacts and pieces of the actual factory, including an approximately 2.5-foot diameter iron mushroom saucer valve cap, were uncovered in a disturbed context during excavation. Although stratigraphy at the site was mixed, the factory's brick foundations were generally intact, and the factory layout itself retained integrity.

That the area may have been used for dumping following the factory's closing was suggested by the presence of numerous bottles dating to the forty-year period after the factory

shut down plus the lack of stratigraphic integrity. When the Station Shops were built in 1961, all the deposited trash and the factory artifacts remaining on the site were pushed into the factory building foundations. This would account both for the mix of artifacts and for the fact that numerous artifacts were found in places where no material would naturally have been deposited, such as the interior of the furnace, gas producers, and oven.

The disturbed context complicated artifact analysis. Archeologists working in the laboratory were able to define criteria to differentiate between those bottles that were made at the factory and those that were deposited after the factory closed (discussed in Section 9.3.1 *Method of Defining the Bottle Typology*). However, it was difficult to determine if other categories of artifacts common from the late-nineteenth century through the 1940s (such as whiteware, ironstone ceramics and other kitchen refuse) were associated with the factory or deposited later.

9.1.3 Overview of Artifacts Found

Artifacts recovered from site 44AX181 included a wide range of historic and modern material. No prehistoric artifacts were found. In total, 3,073 historic artifacts were recovered from archeological investigations of the Virginia Glass Company site. The majority of diagnostic historic artifacts recovered during excavation included ceramics and bottles manufactured between c. 1870 and the 1950s. The only artifacts that predated the factory were five sherds of pearlware and artifacts associated with the railroad situated directly south of the glass factory (including slag, railroad spikes and other metal fragments). These artifacts may date to as early as 1848 when the railroad was first built. Early ceramics may also relate to this earlier railroad activity or to early-nineteenth century domestic structures that were near the project area before the factory was built. These results suggest that the factory was the first use of the project area. Oyster shells, clam shells, small mammal bones, and sawn bones comprised the faunal remains at the site.

Artifacts potentially associated with the factory included: items produced at the factory (such as bottles, glass wasters, and decorative canes); metal tools and other metal artifacts used

at the factory; architectural material (including nails, brick, and window glass); kitchen items (such as ceramics, bottles, drinking glasses, and copper, steel, and silver spoons); and personal or recreational artifacts (like marbles and a shell button).

Bottles were the main type of historic artifact that post-dated the factory. Domestic artifacts, like ceramic and bone, may also post-date factory operation. These artifacts may be associated with dumping on the site after the factory burned.

Modern artifacts included: bottles and jars from the 1950s to the present (including Pepsi and other soda and beer bottles); medicine and shoe-polish bottles with plastic screw tops; various plastic artifacts (including bubble wands and buttons); various metal items (including paint and soda cans); and construction materials (like asphalt shingles, bricks, concrete, cinder block, and metal I-beams). Some modern artifacts may be associated with construction of the Station Shops that were built in 1961. Other modern artifacts are related to later dumping or casual deposition.

As was expected from investigation of the glass factory, the most common artifact found was bottle glass. Glass represented 63 percent of all artifacts collected, compared to metal items (13%) and ceramics (15%). Table 9-1 summarizes the artifacts from all periods found during excavation. See Table 6-1 for a more detailed description of the types of artifacts found.

Table 9-1. Artifact Summary

Category	Percentage
architectural	5.73%
ceramics	14.71%
electrical	0.39%
factory tools	0.46%
glass	56.23%
glass-nonfactory	7.06%
kitchen items	0.42%
organics	1.66%
other	13.02%
personal items	0.13%
recreational	0.20%
	100.00%

9.2 METHOD OF BOTTLE MANUFACTURE BASED ON FACTORY ARTIFACTS

The discussion of bottle manufacture, bottle typology, and artifact analysis depends on an understanding of specialized terms specific to bottle manufacture. Please consult the *Glossary of Archeological and Glass-Making Terms* in Appendix D for definitions of terms.

All bottles found at the project site were either molded or machine-made; no free-blown bottles were recovered. Only molded bottles were made at the Virginia Glass Company factory, which was never fully mechanized. Machine-made bottles found at the site were deposited after the factory closed; maker's marks on many of these bottles confirm this conclusion. Section 5.0 (*Virginia Glass Factory)* and Section 8.0 (*Archeological Findings)* of this report describe in detail the methods of bottle manufacture used at the glass factory based on documentary evidence and archeological investigation of the factory features. The current section (Section 9) focuses on evidence of the type of bottle manufacture used at the factory based primarily on artifacts recovered.

The primary method of bottle manufacture at the factory was blow-in-mold. Evidence for each step in the production process was found in the artifacts excavated from the site. First, skilled glass workers gathered a particular amount of molten glass onto the end of a blow pipe, and rolled and smoothed it on a flat piece of iron called a 'marver', while blowing a small amount of air into the solid glass. The result was a small glob of glass with a small cavity of air in its interior (Department of Labor 1927). The glass factory excavation yielded eleven of these air-filled glass globs (called preforms in the artifact catalog) that were not formed into bottles. Preforms from the factory tended to be roughly rectangular or oval. This contrasts with documentary information in which they are described as pear-shaped. Only one additional preform was found that was pear-shaped. Most preforms resembled Type 2 medicine bottles.

Waste glass was produced primarily during this early stage of manufacture, although waste glass can be made at any time. Scraps of broken glass, or cullet, were gathered for remelting. Angular and globular lumps of glass, like those fragments found at the glass factory

excavation, were also used as raw materials for glass production. Although all of the glass lumps from the glass factory were cataloged as glass wasters, many of the lumps may have been created from raw materials (sand, etc.) for melting prior to bottle manufacturing; other lumps may have been produced as a bi-product of the bottle manufacturing process. Glass wasters, both angular fragments and globular fragments, were the most common artifact observed at the glass factory site (except for brick). Only a sample of the glass wasters was recovered and cataloged. The most common waster color observed was aqua, which is surprising because the majority of bottles produced were clear. Some wasters included a mix of colors or inclusions of color. Other fragments had air bubbles that looked like opaque white globs throughout the lump of glass.

After he formed the preform, the glass blower placed it into a hinged mold, and blew into the pipe to spread out the glass to fill the mold. This step in the process leaves a variety of characteristic marks on the body of a bottle produced in this manner, including vent marks and seams.

All molds must be vented to allow trapped air and steam to escape and glass to fill the mold. Thus, small holes were drilled in molds to allow gases to escape. When glass was blown to the size of a mold, glass filled these holes, creating small embossed dots (vent marks) on the finished bottle. Often molds were vented at the shoulders and on the base. Many manufacturers attempted to disguise vent marks by making vents within lettering or along seams so they would be less noticeable (Jones and Sullivan 1985:47). Eighty-seven bottles (46% of factory bottles recovered) included one or more vent marks; eighteen bottles had 1 vent mark, forty-four had 2, six had 3, nine had 4, two had 5, two had 6, one had 7, one had 8, one had 9, and one had 10 vent marks. An additional thirty-seven lip/neck and base fragments also had vent marks. Although all molds required venting, bottles may not have vent marks if they did not fill the mold completely or if the small glass marks were eliminated while the glass was still hot. Vent marks may be so small that they are easily overlooked. Few bottles made at the factory included any lettering or other design in the molds; for those that did, vent marks were disguised within the lettering.

Although one-part molds existed, molds were usually made of two or more parts that were hinged together. The result was a small indent where mold parts fit together. Similarly to the creation of vent marks, a linear mark on the final bottle (referred to as a seam) formed when a small amount of glass filled the indent at the mold seams when glass was blown to the extent of the mold. This linear mark is usually nearly imperceptibly raised, although some marks are more obviously raised. The presence or absence of seam marks, as well as the number and location of seams provides information on the type of mold used.

A two-part mold left two seams opposite each other on the body of a bottle; the seams connected in a diagonal line on the bottle's base. Molds with separate base sections included a seam that ran around the base of a bottle, but not across it. Molds may be any number of pieces, therefore producing more seams. However, four-part or more complicated molds were not common for commercial production. A three-part Ricketts-type mold included no seams on the body, but it had a seam around the shoulders and two opposite seams running the length of the shoulders and necks (Jones and Sullivan 1985:24-30).

Two of the most common types of separate base molds were post-bottom and cup-bottom molds. On post-bottom molds, a raised area centered in the bottom of a bottle mold created a central, often circular, shallow indentation and a mold seam inside the resting point. Cup-bottom molds were formed by cutting the desired base shape into the base section of a mold. Glass filled these cuts during bottle blowing. Cup-bottom molds produced seams on or above the heel of a bottle, outside of the resting point. Many cup-bottom molded bottles had beveled heels.

The majority of bottle types made at the factory were formed in a two-part vertical body mold with a separate cup mold base. This mold type was common from ca. 1850 to the mid-1920s, encompassing the dates of the factory (Jones and Sullivan 1985:28). Bottles had two seams opposite each other on the sides of the bottle bodies, and a seam around the base of the bottle, either on or above the heel. One flask was found that was formed in a two-piece mold with a circular post bottom mold push-up in the center; the two vertical body seams connected in

a diagonal across the base. This bottle was the only bottle or base fragment recovered that exhibited a circular post bottom mold; it may have been produced at a different factory.

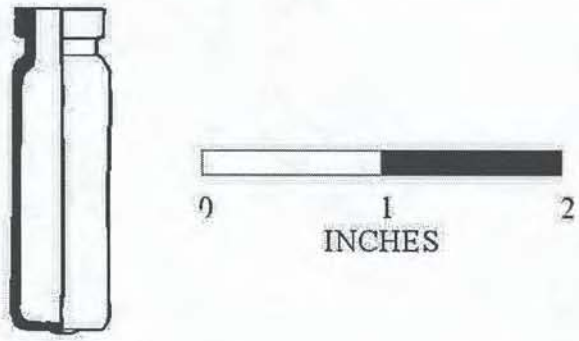
Additional mold seams resulted from the use of panels with embossed lettering or decoration. Because it was often too expensive to purchase or make a whole mold for each bottle, many product vendors purchased plates with incised lettering advertising their company's products. These plates could be inserted into a variety of molds to produce embossed lettering on bottles. Plates left seam marks around the exterior of the panel. Separate plates with lettering could also be inserted into the base mold. Most bottles from the Virginia Glass factory did not include embossed lettering produced with a plate. One of the more common types of medicine bottles found during excavation (Type 15) had embossed graduations that appear to have been part of the mold, rather than a separate plate that would have left seam marks.

The most common bottle type, Type 2, was not manufactured using the same techniques observed on the other bottles. Type 2 bottles appear to have been made in a more automated way. Although the bottles were hand-tool finished, many of them (63%) include a valve mark on their bases. This small circular mark was left on bottles when a gas-release system was used to eject bottles from one production stage to another (generally the preform to final blowing stage). Also, on approximately half of the Type 2 bottles it appears that the cylindrical body was made separately from the cylindrical neck; these Type 2 bottles included two seams opposite each other on the body, two seams (generally lined up with the body seams) on the neck, a seam around the joint between the shoulder and neck, and a seam around the base of the bottle where the separate base mold was attached. In some cases the joint between the shoulder and neck included a fairly thick ring of glass more substantial than a seam mark. The neck on some bottles was placed off-center from the shoulders. Type 2 bottles may represent an attempt to increase mass production of bottles at the Virginia Glass Company site.

Forty-seven percent of the Type 2 bottles, however, did not include a valve mark, and about half of the Type 2 bottles appear to have been made in a two-part mold with a separate base rather than the neck and body being made separately from each other. It is possible that the

same bottle type was made both in the traditional mold-blowing technique and in the more automated technique. The Type 6 bottle also appears to have been made in a semi-automatic manner. Only one example of a Type 6 bottle was found.

A few bottles in the glass factory collection did not show evidence of mold seams or any other marks. Some bottles appear to not have been blown to the full capacity of the mold, including many Type 2 bottles that ended up with uneven or rounded bases. These bottles did not show vent marks or seams because glass had not reached the edge of the mold. Bottles produced using the lampworking method of manufacture also had no seams. Lampworking bottle manufacture involved drawing glass out with tools to form a small tube (these tubes were often used in light bulbs). Tubes were then manipulated over a Bunsen burner or small flame to form a base and lip (Jones and Sullivan 1985: 49). Two small vials (Type 9) recovered from the excavation appear to have been made in this manner (Figure 9-1). Bottles with no visible seam marks could also be free-blown, or molded in a turn- or paste-mold where a layer of steam separated the glass from the mold; but these types of manufacture were not employed at the Virginia Glass Company factory.



(Cat. 261)

Figure 9-1. Type 9 Bottle Made by Lampworking

After the full-blown bottle cooled in the mold to the point that it could be removed without deforming it, a mold tender opened the mold and removed the bottle with a pair of pincers. One pair of pincers was recovered from the Virginia Glass Company site excavation. The bottle was then placed in a snap-case for final finishing (Figure 9-2). At this point the lip had not been formed, and the seams ran up the length of the bottle neck. Nine bottles and

lip/neck fragments were found in the excavation that were deposited at this stage of production; the lip was not yet completed.

Bottles in the snap case were placed in a reheating furnace to make the glass pliable again. A skilled glass maker then used a wooden finishing tool to form the finish (lip and string rims) (Figure 9-3). This tool included indentations to form a variety of different lip forms to accommodate different closures. The tool was a clamp with three prongs; the plug prong was placed inside the bottle neck, and the two prongs that included a pattern of cuts and projections, were placed on the outside of the neck. The tool was turned to form a lip and any number of string rims. The plug portion of the tool formed the bore shape and could also include projections (i.e. for forming interior-gasket bores, or interior shelves for cap-seat or stopper bore finishes). The finishing-tool process removed evidence of seams on the lip, and part way down the neck. Often the twisting motion of the finishing tool also left horizontal striations parallel to the lip, or even slightly twisted the neck if the glass was more pliable (Jones and Sullivan 1985:42). All bottles produced at the Virginia Glass Company factory were hand-finished with a finishing tool; many of the bottles included evidence of horizontal striations or twisting.

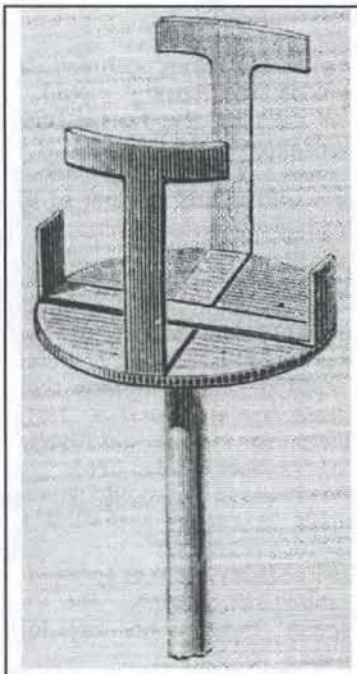


Figure 9-2. Snap Case
(Peligot 1877: Fig. 48)

Figure 9-3. Finishing Tool
(Jones and Sullivan 1985:42)

The final step in bottle manufacture at the Virginia Glass Factory was the annealing process. Finished bottles were transported to and placed in a separate lehr oven. Bottles were reheated and slowly cooled in the lehr to remove impurities and internal stresses. Many Type 2 bottles recovered from the glass factory excavation had apparently not gone through the final annealing process. Twenty-five Type 2 bottles (approximately 19%) shattered into conchoidal fragments about three minutes after washing. Washing the bottles may have removed specks of dirt from small cracks in the bottles, slightly shifting the internal stresses, and causing shattering in bottles that had not been annealed. Other types of bottles, however, did not shatter in this manner, and probably had been annealed.

In addition to bottles produced at the glass factory, nineteen decorative glass canes or rods made at the factory were found. The canes and rods provide further evidence that skilled glass workers with knowledge of how to manipulate glass were employed at the Virginia Glass Company bottle factory.

Documentary, architectural and artifactual evidence together provide a picture of bottle manufacturing at the Virginia Glass Company. The Virginia Glass Company most likely produced bottles by hand throughout its period of operation, despite mechanized methods of bottle manufacture that were developed during this time, and implemented in other glassworks in America. Most types of bottles from the glass factory were made in a two-part vertical mold with a separate cup mold base; bottles were hand-finished with a finishing tool. This manufacture method required the presence of skilled glass workers on the site. Production of decorative canes and twisted glass is further evidence that skilled glass workers worked at the factory. An attempt at more mechanized or mass-produced manufacture technique, however, may be evidenced in the Type 2 medicine bottles.

9.3 BOTTLE TYPOLOGY

One goal of archeological investigations and laboratory analysis of site 44AX181 was to identify the types of bottles produced by the Virginia Glass Company. The glass typology could be used to identify bottles from other historic sites. With the comparative typology, the manufacture of bottles found on other sites in Alexandria could potentially be traced back to the factory. Dames & Moore archeologists developed a list of twenty bottle types produced at the Virginia Glass factory based on artifacts found in the field. Initially 30 bottle types were defined, but some types were later eliminated or combined based on further research. Appendix E includes a drawing of each factory bottle type defined.

Unfortunately, most bottles found at other sites would be difficult to trace definitively to the Virginia Glass Company factory based on the typology developed for the site. Maker's or other distinguishing marks seem to have been used only rarely by the company, in contrast with the nearby Old Dominion Glass Factory which included an 'O.D.' on the base of their bottles. A comparison of the Virginia Glass Company bottle collection with the Old Dominion Glass Factory collection housed at Alexandria Archaeology revealed that many bottles from site 44AX181 closely resemble or are identical to Old Dominion bottles (except that the examples from Old Dominion have an 'O.D.' on the base). Bottling and product companies often provided or sold their own molds to various bottle factories to ensure consistency in bottle manufacture. Therefore it would not be uncommon to find the same bottle produced at different factories, making the origin of individual bottles difficult to discern.

Although, in general, bottles from the Virginia Glass Company factory did not include a mark indicating their origin, four bases found at the site did have the mark "V. G. Co." probably referring to the Virginia Glass Company. These bases were all rectangular with chamfered or rounded corners; the bases were approximately 1.5 inches by 3 inches in size and included between two and four vent marks (small dots left on bottles blown in vented molds). Two bases were clear and two were manganese-tinted. One of the manganese-tinted bases incorporated a portion of the bottle body as well; the body markings said:

...X & CO.

...CHEMISTS
...MD.

The bases appear to have been manufactured in a two-part vertical mold with a separate base. However, no intact bottles corresponding to these bases were found so their method and place of manufacture could not be definitely ascertained. The small number of bottle fragments found with "V. G. Co." on the base suggests that this mark may have been an isolated instance specific to a few molds, rather than a mark common to the factory.

9.3.1 Method of Defining the Bottle Typology

A typology list of bottles that were produced at the factory was developed based on artifacts recovered during excavation. A separate bottle type number was given to each new bottle form (bottles with the same base, body, neck, and lip forms) that was thought to have been produced at the factory. Bottle types were numbered consecutively as identified during artifact cataloging; every example of the bottle type later cataloged was referred to by the type number. The bottle-type numbers simplified artifact analysis, and ensured that similar bottles were described consistently. However, specific details (including manufacturing technique, shoulder, base, lip, neck, bore and body form, height, base and opening diameter, markings, valve or vent marks, and color) were still recorded in the artifact catalog for each bottle.

Because artifacts were recovered from a disturbed context, the first task in creating the bottle typology was to define criteria to determine which bottles were produced at the factory, and which were either used at the factory, but not made there, or deposited after the factory closed. The only documentary evidence that was found listing the types of bottles produced by the Virginia Glass Company were the *Glass Factory Directories* dating between 1894 and 1916. The directories indicated that the factory produced green and amber medicine, soda, beer, flask, and preserve bottles. The company was known to have a contract to supply the Tivoli branch of the Robert Portner Brewing Company with bottles (Alexandria Gazette 12/19/1895). Although the Portner Brewing Company was based in Norfolk, Virginia, the Alexandria branch (called

Tivoli) was located in the 600 block of N. St. Asaph Street in Alexandria (Rawlinson 1968:135). The company also had contracts to supply other companies in the South with bottles (Alexandria Gazette 12/19/1895).

Initially, maker's marks found on bottle bases provided the best indication that a bottle was not made at the factory. Most makers' marks were found in *Bottle Makers and Their Marks* (Toulouse 1971) and could be assigned to a particular date and often factory of origin. Almost all bottles with maker's marks found at the site dated between 1910 and 1960; the Virginia Glass Company factory closed in 1916. Bottles with marks originated mainly from Pennsylvania, Illinois, West Virginia, and Ohio.

The presence of misshapen or unfinished bottles that resembled one of the defined bottle types suggested that that bottle type was produced at the Virginia Glass Company factory. Bottle types of which a large number of examples were found were also generally assumed to have been produced at the factory. After documentary research, analysis of the factory furnace features, and analysis of bottles known to have been produced at the factory based on the factors just described, it was determined that the factory had never been fully automated. Therefore, all fully-automated machine-made bottles were removed from the typology list.

Different sized bottles with the same characteristics were classified as the same type. The typology, therefore, does not directly correspond to different molds used because two different molds would have been needed to produce the same bottle in different sizes.

Generally only whole or nearly whole bottles were included in the bottle type list. However, where possible, bottle fragments that clearly belonged to one of the identified types (based on characteristic lip/neck forms, relative proportions of the bottle parts, decoration, etc.) were included in the type count. This was only possible for two bottle types (Type 2 and Type 15). Other bottle fragments, like crown finishes, could have been on different bottle types.

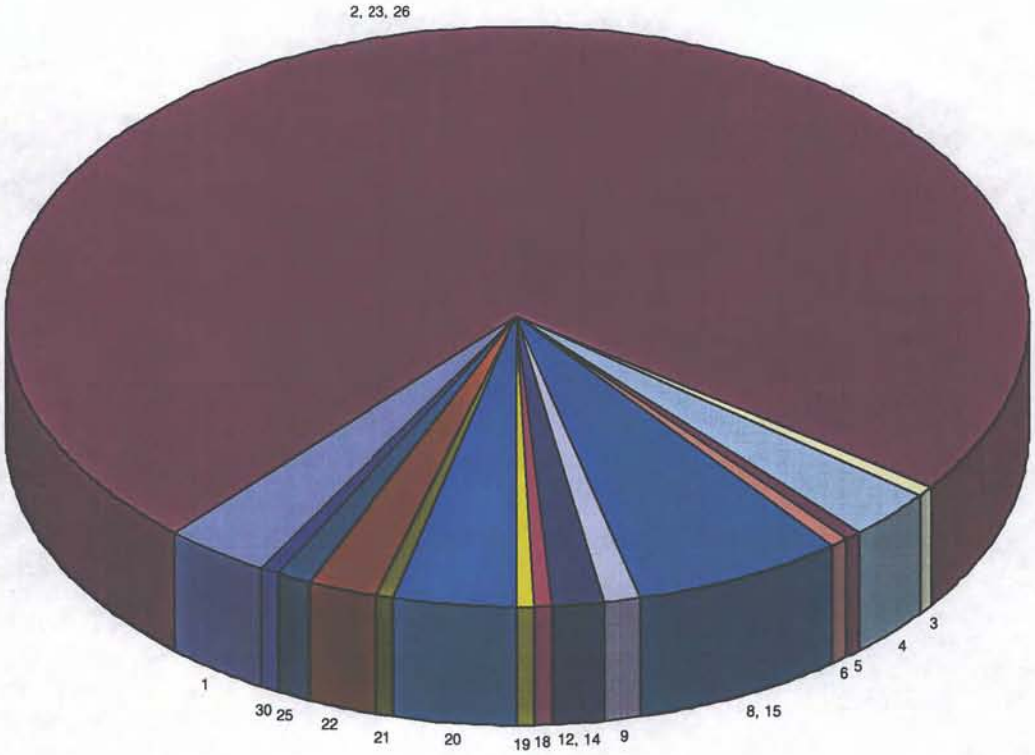
9.3.2 Typology Biases

The bottle typology list is not necessarily complete because it is based solely on artifacts found at the site, rather than on documentary evidence. The typology list may represent only bottle types that were produced near the end of the factory operation, and may not include examples of earlier bottles produced at the factory. One bottle form (Type 2) comprised 68 percent of the factory bottles. These findings seem to present a picture of bottles made at a particular time (perhaps when the factory burned down?) rather than bottles manufactured at the factory over its span of operation.

The bottle typology may be biased in favor of smaller bottles that did not break as easily as larger bottles. Most bottles types (13 of the 20 types) in the typology list are small medicine bottles less than 3.5 inches tall. Although the factory may have produced more small bottles than large bottles, it is more likely that the small ones simply survived better in the ground. One fact that seems to support this latter conclusion is that the only contract known from documentary resources for the factory was with the Portner Brewing Company, yet only four whole Portner bottles were found during excavations (three different types). Analysis of broken bottle fragments (bases and lip/necks) suggests that a larger percentage of bottles over 3.5 inches in height was present at the site than is represented through analysis of whole bottles. The analysis of bottle bases and lip/neck fragments is discussed in Section 9.3, *Diagnostic Factory Bottle Fragments*.

9.3.3 Whole Bottles Produced at the Virginia Glass Company Factory

Twenty bottle types found during excavations were probably made at the glass factory. Initially, thirty types were defined, but some types were eliminated after further research revealed that they were not made at the factory. A drawing and brief description of each of the twenty types is included as Appendix E of this report. Figure 9-4 presents the numbers of each bottle type produced at the factory that was found during archeological excavation. On this figure, Types 2, 23, and 26 were included as one type because 23 and 26 were determined to be



Bottle Type	Count	Percentage	Description
1	6	3.31%	small, rectangular medicine bottle, cylindrical neck, prescription lip
2, 23, 26	133	73.48%	small, cylindrical medicine bottle, cylindrical neck, semi-automatic manufacture
3	1	0.55%	small, cylindrical medicine bottle, cylindrical neck, flanged lip
4	5	2.76%	small, cylindrical medicine bottle, cylindrical neck, straight finish
5	1	0.55%	small, octagonal bottle
6	1	0.55%	medium, cylindrical medicine bottle, cylindrical neck, semi-automatic manufacture
8, 15	12	6.63%	medicine bottle, some with graduated markings, Philadelphia oval base with 3 flat sides
9	2	1.10%	small vials, lampworking manufacture
12, 14	3	1.66%	Portner beer bottles
18	1	0.55%	conical garminativ bottle
19	1	0.55%	rectangular medicine bottle "Bear Drug Co."
20	7	3.87%	strapped flask
21	1	0.55%	large beverage bottle, "Northwestern Bottling Works"
22	4	2.21%	conical bottle, cylindrical neck
25	2	1.10%	small flask
30	1	0.55%	large beer bottle, "Home Beer"
Total	181	100.00%	

Figure 9-4. Bottle Types

variations of Type 2. Type 23 had a burst-off lip, and Type 26 had a rounded lip rather than the prescription lip seen on the Type 2 bottles. Types 12 and 14 were both Portner bottles and were lumped together for this figure. Types 8 and 15 were similarly lumped because they were essentially the same bottle, although Type 15 included embossed graduated measurements.

Based on artifacts recovered during the excavation, the glass factory produced primarily beverage and pharmaceutical bottles. Three percent of the whole bottles recovered were beverage bottles, while Eighty-six percent of the bottles originally contained medicines. (These percentages are more balanced for bottle fragments: fifty-three percent of the lip/neck fragments were probably medicine bottles, while thirty-two percent were probably beverage bottles. These results are discussed in section 9-4 Diagnostic Factory Bottle Fragments.)

Beverage Bottles. Three types of Tivoli Portner beer bottles were recovered from factory excavations (Types 11, 12, and 14). Type 11 was machine-made and therefore was not produced by the Virginia Glass Company. The Type 12 Portner bottle was clear with a green tint. The bottle was missing its lip, but included ten inches of the body before the break. The base was circular and three inches in diameter. The Portner Tivoli trade mark was located on the center front of the Type 12 bottle body. The two Type 14 Portner bottles were both missing their lips. These clear bottles included sloped-down shoulders, a cylindrical body that measured between 6.5 inches to 7.5 inches in height to the break, and a 2.5-inch diameter circular base. The Portner Tivoli trade mark was situated on the shoulder of Type 14 bottles. Both the Type 12 and Type 14 Portner bottles appear to have been made in a two-part vertical mold with a separate base. Figure 9-5 includes a photograph of the four Portner bottles, and a drawing of the Type 12 bottle.

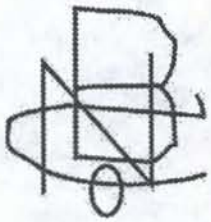
The Portner bottles found during the glass factory excavation resemble Portner bottles produced at the Old Dominion Glass Factory that are curated at Alexandria Archaeology, except that the lettering is slightly different. On Old Dominion Portner bottles, the lettering "ROBERT PORTNER BREWING CO., ALEXANDRIA, VA" forms an angular diamond shape around the

diamond "TIVOLI" logo. On the Virginia Glass Company Portner bottles, the lettering curves in an oval shape around the diamond "TIVOLI" (Figure 9-5).

In addition to the Portner beer bottles, two other beverage bottles from local brewing or bottling works were recovered (Types 21 and 30). These bottles may have been produced by the Virginia Glass Company. Alternatively, the bottles may have been produced elsewhere and the contents consumed at the factory site. The Type 21 bottle was made for the Northwestern Bottling Works. The bottle is 8.5 inches tall with a crown finish. It bears the words:

"NORTHWESTERN BOTTLING WORKS
1601-5TH ST NW
WASHINGTON D.C.

REGISTERED THIS BOTTLE NOT TO BE SOLD"



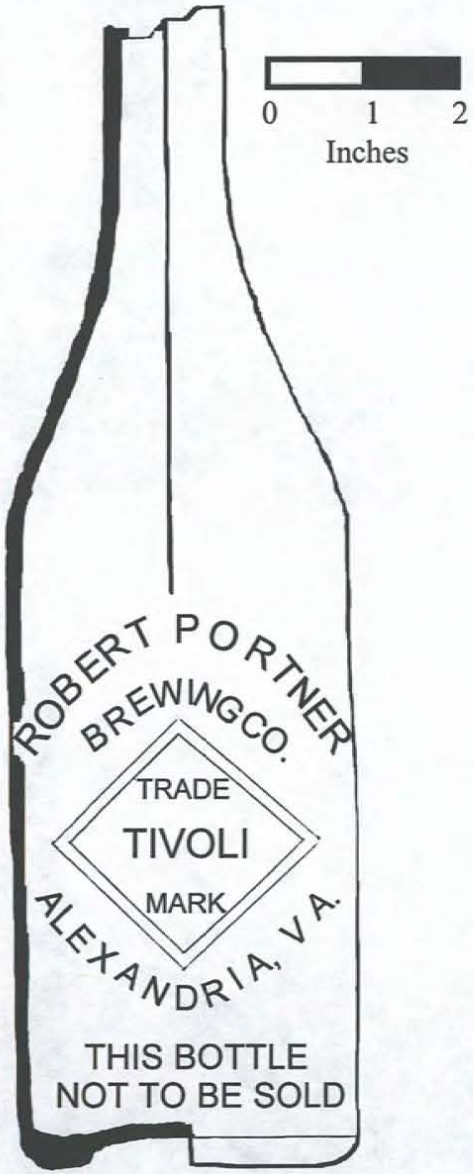
The bottle also includes the Northwestern Bottling Works trademark (shown above) on the bottle shoulder. The Northwestern Bottling Company started operation at the 1601 5th St. NW location in 1901. The company was called the Northwestern Bottling Works from 1901 to 1920. After 1925 the company is listed as the Northwestern Bottling Co. (Ketz and Reimer 1990:13). The mended Type 30 bottle is 9.5 inches tall and aqua colored with a bulged neck shape and a round lip. The part of the trademark and words remaining say:

"...E BREWING
RICHMOND, VA
HOME BEER
TRADE MARK

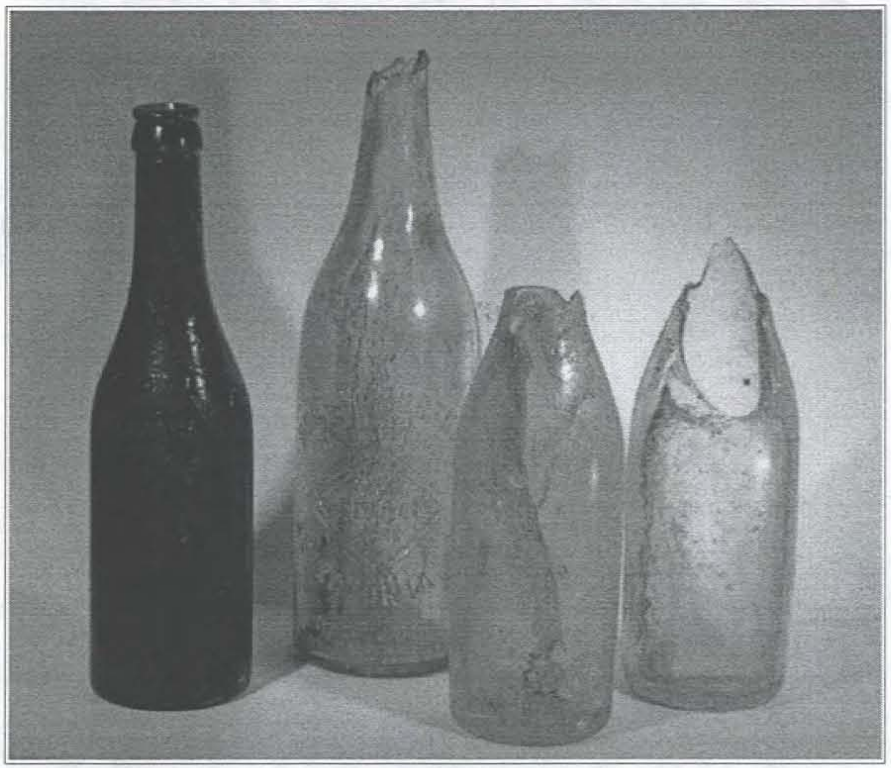
REGISTERED THIS BOTTLE NOT TO BE SOLD"

The Home Brewing Company was based in the Richmond, Virginia area at the end of the nineteenth century (Rawlinson 1968:135). The company trademark is an eagle on a stump with a horizontal barrel (shown above).

Pharmaceutical Bottles. Archeological excavation revealed that the Virginia Glass Company produced a wide variety of medicine and other pharmaceutical bottles (Types 1, 2, 3,



Type 12, Catalog #123



From left to right: Type 11 (Cat. 122), Type 12 (Cat. 123), Type 14 (Cat. 126 and 127)

Figure 9-5. Robert Portner Tivoli Beer Bottles

DAMES & MOORE

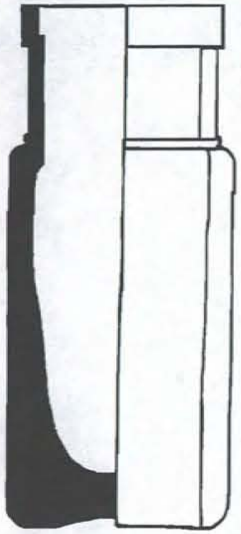
4, 5, 6, 8, 9, 15, 18, 19, 22, 23, and 26). One hundred sixty-five medicine bottles were recovered. Most medicine bottles found at the site were small (less than 3.5 inches tall), although one Type 15 medicine bottle with embossed, graduated measurements on the side was seven inches tall. Figure 9-6 illustrates a sample of the variety of small medicine bottles found at the site.

The most common bottle type found at the factory site was the Type 2 medicine bottle. Type 2 constituted sixty-eight percent of bottles found that were produced at the glass factory. These bottles included a patent lip, cylindrical neck and body, and a circular base (Figure 9-6). Most Type 2 bottles were either 2.75 inches tall (49 bottles), 2.875 inches tall (15 bottles), or 3 inches tall (7 bottles). Most Type 2 bottles and bottle fragments had a base diameter of 1.125 inches (37 bottles), 1.1875 inches (33 bottles), or 1.25 inches (26 bottles), and an opening diameter of 0.5 inches (5 bottles), 0.625 inches (23 bottles), 0.6875 inches (5 bottles), or 0.75 inches (56 bottles). The base and opening diameters did not coincide with particular bottle heights. In other words, all three base diameters and all four opening diameters appeared on examples of each of the bottle heights.

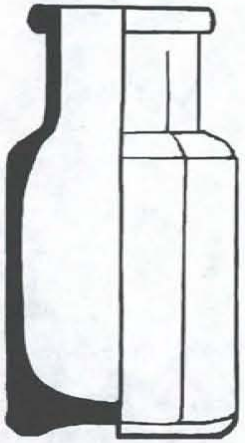
The glass wall thickness of Type 2 varied considerably from bottle to bottle, and within different parts of each bottle. Type 2 bottles were produced in clear (including yellowish/greenish tinted), aqua, and manganese-tinted glass. Many of the Type 2 medicine bottles found had not gone through the final annealing process; twenty-five whole bottles shattered in conchoidal fragments about three minutes after being washed. Removal of dirt from hair-line cracks and imperfections may have shifted the bottle stability. Because the bottles had not been annealed they were not strong enough or elastic enough to withstand any change in tension. No other bottles found at the site shattered in this manner.

Some attempt at more mechanized or mass-produced manufacture may be evidenced in the Type 2 bottles. Although the Type 2 bottles were hand-tool finished, 63 percent of them included a valve mark on the base, suggesting a semi-automatic method of production. Valve marks are small circular indentations left on the base of bottle preforms. Valve marks are

Type 1 (Cat. 41)



Type 2 (Cat. 44)



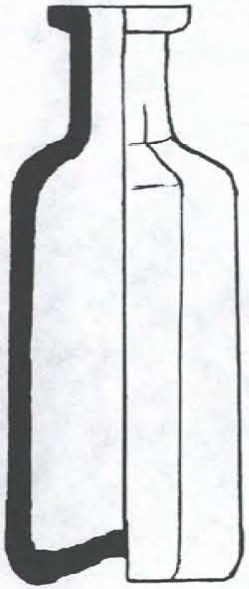
Type 4 (Cat. 63)

(Cat.113)

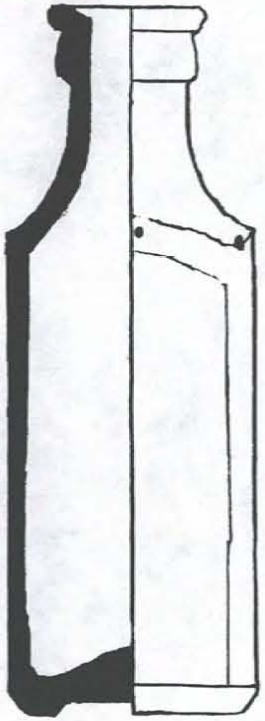
(Cat. 261)

Type 9

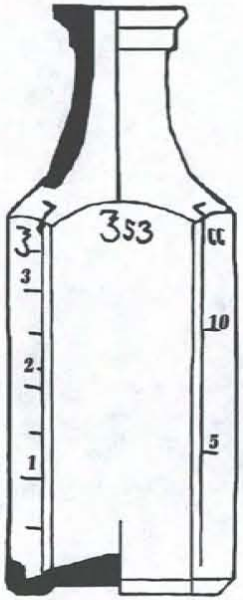
Type 5 (Cat. 65)



Type 3 (Cat. 51)



Type 8 (Cat. 98)



Type 15 (Cat. 232)

0 1 2
Inches

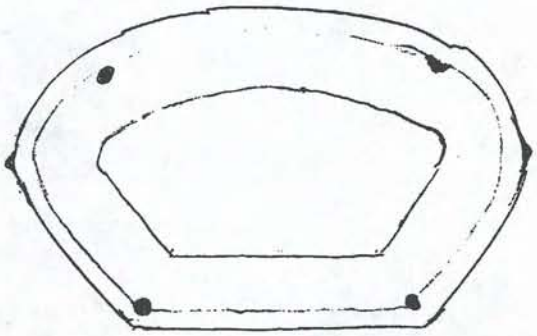
Figure 9-6. Small Medicine Bottles

produced in a semi-automatic machine when a valve ejects the preform into another chamber for final bottle formation (Jones and Sullivan 1985:39). The glass factory may have started using a semi-automatic production method near the end of its operation. It is possible that the factory was in the process of producing, or had recently completed, a run of Type 2 bottles when the factory caught fire and closed for the final time in 1916. This speculation is supported by a number of facts: Type 2 bottles incorporated a later, semi-automatic mode of production not seen on other bottles; Type 2 were the most numerous bottle type found; many Type 2 bottles were not completed and had not gone through the annealing process (unlike any other bottle type); and a larger number of preforms and distorted forms resembling Type 2 bottles were recovered than any resembling other bottle types.

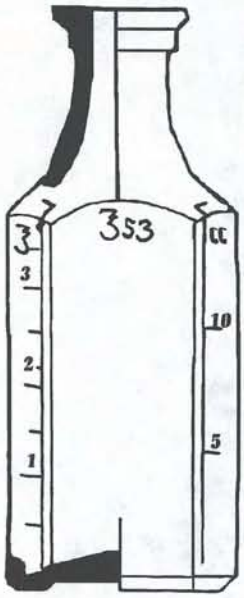
Another common medicine bottle type found was Type 15; nine whole Type 15 bottles were recovered. This rectangular bottle had a scooped neck and either prescription or rounded lip (lip types are defined and illustrated in Appendix D). The bottles ranged in height from three to seven inches. One bottle was greenish; eight were clear. Embossed graduated measurements were included on the front corners of the bottles, and an embossed volume measurement was located near the top of the front of the bottles. Figure 9-7 illustrates a sample of the Type 15 bottles.

Type 8 bottles were essentially the same as Type 15, except that they did not included the graduated measurements (See Figure 9-6). Three Type 8 bottles were recovered. Type 8 bottles had a flat front panel that may have been intended for application of a paper label. The bottles were 3, 3.25, and 4 inches in height. One bottle said "½", and one said "1" on the center, front of the bottles, at the same level as the shoulder (in the space where the volume measurement is on Type 15 bottles).

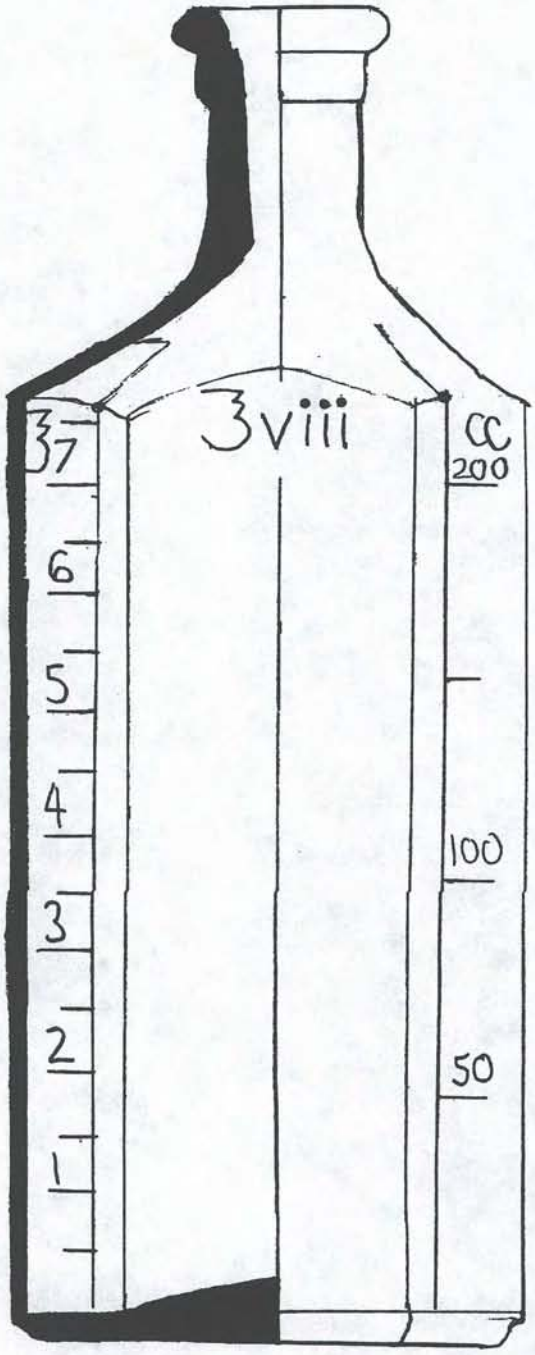
Flasks. Flasks, probably for whiskey, were lumped together in Type 25 (small flasks), and Type 20 (large strapped flasks).



Base (Cat. 128)



(Cat. 232)



(Cat. 128)

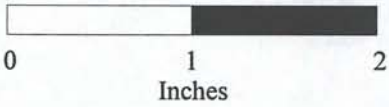


Figure 9-7. Type 15 Medicine Bottles

Dames & Moore

Miscellaneous Bottles. The function of two bottle types (Types 6 and 25) could not definitely be determined, although the bottles could have held medicine. Only one example each of Types 3, 6, 11, 12, 16, 17, 18, 19, 21, and 30 was recovered during the glass factory excavation. These types included beverage, spice, flask, and various possible medicine bottles.

9.4 DIAGNOSTIC FACTORY BOTTLE FRAGMENTS

Although whole and nearly whole bottles provided the most information, bottle fragments confirmed and expanded knowledge of bottle manufacture at the Virginia Glass Company. Bottle bases, necks with lips (lip/neck fragments), and body fragments with potentially-diagnostic decoration or lettering were included in the glass factory collection. Neck and lip fragments that did not include the other part (neck or lip) were not considered diagnostic and were not collected.

9.4.1 Lip/Necks

Lip/neck bottle fragments have the potential to provide preliminary information about the bottle size, bottle type, and the method of manufacture. Lip/neck fragments include the lip, string rim, bore, and neck. The finish is the top part of a bottle that accommodates the closure (cap, cork, etc.). The lip is the top part of the finish, and the string rim (if present) is the ring that protrudes from the neck below the lip. The bore is the opening at the top of the container (see Figure 6-1).

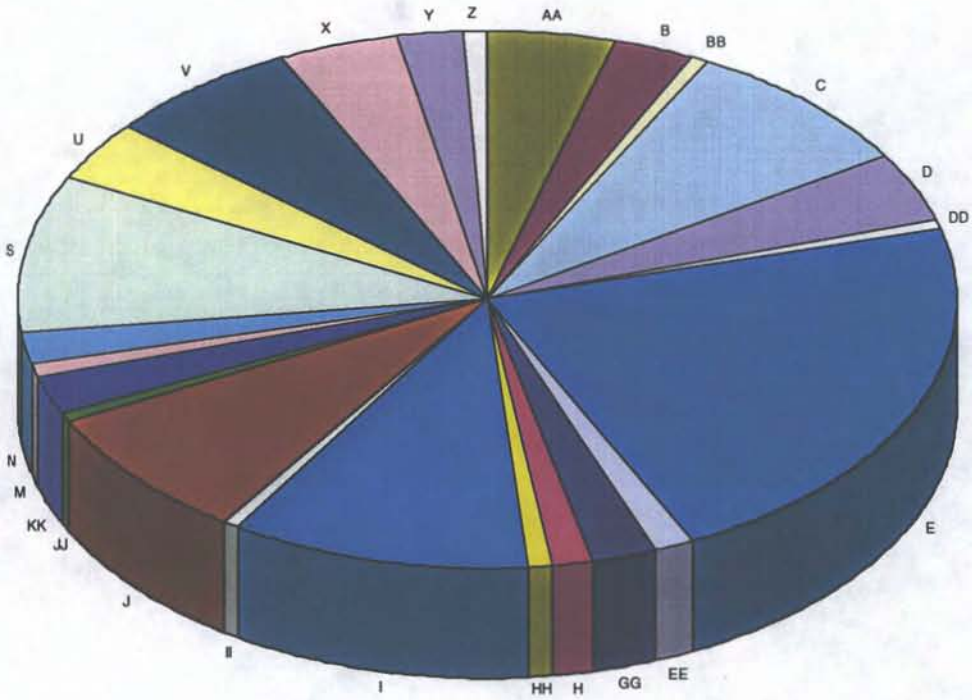
The neck width and opening diameter may suggest the overall size of the bottle. This indication, however, is not always correct because some small bottles have wide openings. The lip and finish form may suggest the type of bottle because certain forms were commonly used on particular types of bottles. For example, prescription and patent lips were commonly used on medicine bottles, while crown and Perry Davis finishes were often used on beer or soda bottles. Appendix D, the *Glossary of Archeological and Glass-Making Terms*, includes a description of each of the lip, finish, and bore types found during the glass factory archeological excavation.

The bore and finish form together can indicate the type of closure used on the bottle. Finally, the pattern of seams on the neck and lip may indicate the method of manufacture. Machine-made bottles have seams that extend the length of the neck and over the lip. Hand-finished bottles have a mold seam that stops below the lip; hand-blown bottles have no seams on the neck or lip.

Although the Virginia Glass Company factory workers formed bottles in molds, they used a hand-finishing tool on each bottle (see Figure 9-3). This tool had three prongs; one prong was inserted in the bottle neck while the glass was still pliable, and the other two prongs went on the outside of the neck. When twisted, the tool would produce the bottle finish and bore type. The finishing tool smoothed over seams left on the outside of bottles by the molds. Often the finishing tool left faint horizontal striations around the bottle neck below the lip.

A separate lip/neck typology list, similar to the bottle typology list, was created to aid archeologists in cataloging the large number of glass bottle fragments recovered during excavation of site 44AX181. Although descriptions of the lip and neck parts of whole bottles were entered into the artifact catalog, whole bottles were not included in the lip/neck typology list. Like the bottle typology, each new lip/neck form was numbered consecutively, illustrated, and described. The numbers were later changed to consecutive letters (A, B, C, etc.) to avoid confusion with the bottle typology list. Thirty-seven lip/neck types were defined; these types are illustrated in Appendix F.

Because the lip/neck typology list was created in order to organize a large number of lip/necks (301 fragments) for analysis, no attempt was initially made to eliminate fragments that were not made at the factory. During analysis, however, it was concluded that fully-automatic, machine-made bottles were not produced at the factory. Therefore, lip/neck types with seams that ran the length of the neck and over the lip (evidence of machine manufacture) were separately characterized as bottles deposited after factory operation ceased. These artifacts are discussed in Section 9.8 and include Types A, F, K, L, O, P, Q, R, T, W, CC, FF, and GG. Several lip/neck types were produced at the factory. Figure 9-8 presents the percentage of each of the factory lip/neck types.



Lip/Neck Type	Count	Percentage	Description
AA	10	4.50%	patent lip, cylindrical neck
B	6	2.70%	prescription lip, scooped shoulders
BB	1	0.45%	down-tooled lip, 2 bead string rims, cylindrical neck
C	19	8.56%	crown finish
D	9	4.05%	bead rounded lip, flattened stirng rim, scooped shoulders
DD	1	0.45%	flanged lip
E	49	22.07%	prescription lip w/reg. Bore, cylindriacal neck, ball neck treatment
EE	3	1.35%	down-tooled lip, bead string rim
GG	5	2.25%	bead rounded lip, cylindrical neck
H	3	1.35%	bead rounded lip, cylindrical neck, ball neck treatment
HH	2	0.90%	up flattened side lip, cylindrical neck
I	23	10.36%	flattened side or town-tooled lip
II	1	0.45%	stopper bore, flattened site lip, cylindrical neck
J	18	8.11%	Perry Davis finish
JJ	1	0.45%	straight lip, cylindrical neck
KK	5	2.25%	burst-off lip, cylindrical neck
M	2	0.90%	short flanged lip, cylindrical neck
N	4	1.80%	flanged lip, cylindrical base
S	21	9.46%	prescription lip w/reg. Bore, cylindriacal neck
U	8	3.60%	short flanged lip, tapered neck
V	15	6.76%	internal gasket bore, rounded lip, tapered neck
X	9	4.05%	bead rounded lip, cylindrical neck
Y	5	2.25%	short flanged lip, slightly bulged string rim, cylindrical neck
Z	2	0.90%	bead rounded lip, v-tooled string rim, cylindrical neck
Grand Total	222	100.00%	

Figure 9-8. Lip/Neck Types

Beverage Bottles. Four common lip/neck types probably held beverages such as beer, soda, and possibly whiskey. Eighteen Type C lip/neck fragments (8% of the total) were recovered during the glass factory excavation. Type C included a crown finish that was made up of a small bead lip and a round string rim (Figure 9-9). The crown finish was patented in 1892 and used primarily for beer, soft drink, and mineral water bottles (Jones and Sullivan 1985:79). Machine-made crown finishes are still used today on many pop-top soda and beer bottles.

Figure 9-9. Type C Crown Finish

Another common bottle finish that is produced mechanically today is the Perry Davis finish (Type J). This finish consists of a round lip and a V-tooled string rim (Figure 9-10). It was used commonly from the late-nineteenth to early-twentieth century on beverage, druggist and extract bottles. Nineteen Type J lip/necks represented nine percent of the lip/neck fragments recovered.

Figure 9-10. Type J Perry Davis Finish

Fifteen Type V blob top lip/neck fragments (7% of the total) were found. This type of bottle lip was particularly common on soda bottles (Figure 9-11).

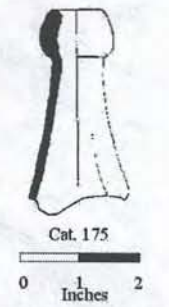


Figure 9-11. Type V Blob Top Finish

Twenty-one Type I lip/neck fragments (10% of the total) were found. Type I fragments feature a down-tooled lip; three varieties of Type I lip/necks were found (Figure 9-12).

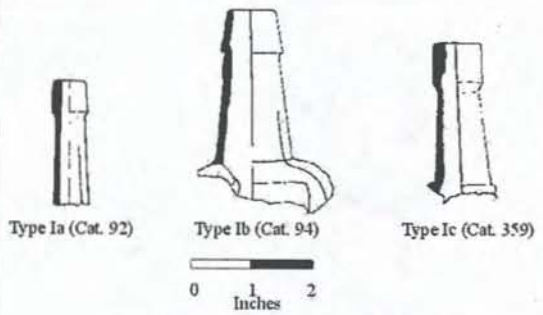


Figure 9-12. Type I Lip/Neck Fragments

Pharmaceutical Bottles. The most common lip/neck type found was Type E. Type E fragments include a prescription or patent lip and a ball neck (a single ring encircling the lower part of the neck) (Figure 9-13). Forty-nine Type E fragments were recovered, representing approximately twenty-three percent of the lip/neck fragments. Type H lips resembled Type E, but they were smaller and had a rounded lip with a ball neck. Both Types E and H were probably used on medicine or druggist bottles. Type KK lip/necks resembled Types E and H except that they were not finished; the lips are burst off and the necks are distorted.

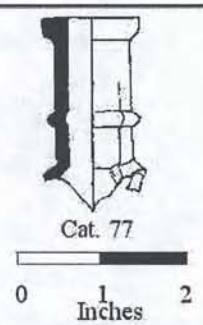


Figure 9-13. Type E Lip/Neck Fragment

Other common lip/neck types that possibly held medicines were Types S and AA. Type S is a prescription lip with no string rims and a fairly straight cylindrical neck. A wide variety of bottle neck sizes included this lip type; twenty-one Type S lip/neck fragments were found (10% of the total). Type AA is similar to Type S except that it has a patent lip. Ten Type AA fragments were found (5% of the total). Other medicine bottle lip/necks include Types B, D, N, U, Y, JJ, and DD (see Appendix F). The medicine bottle lip/necks resembled bottles included in the whole-bottle typology (specifically Types 15, 8, and 25).

Comparison of the Lip/Neck Typology List and the Whole Bottle Typology List. Although a description of the lip and neck parts of whole bottles was entered into the artifact catalog, whole bottles were not included in the lip/neck typology list; two separate typologies were created. For two bottle types, bottle fragments were included in the whole bottle typology; this was not usually possible, however, for other bottle types because the same lip/neck form could have belonged to numerous bottle types. Eleven lip/neck types resembled bottle types included in the whole bottle typology (Table 9-2).

Table 9-2. Comparison of Lip/Neck Fragments with Whole Bottles

Lip/Neck Type	Bottle Types that Resemble the Lip/Neck Type
C	21
J	20
S	1, 3, 25
U	3, 25
V	30
X	4, 18, 22
Y	8, 15
D	8, 15
AA	2
GG	6
JJ	26

Thirteen lip/neck types that may have been made at the factory were not represented in the whole bottle typology. These types included B, E, H, I, M, N, Z, EE, BB, DD, HH, II, and KK. The large percentage of ball neck fragments (Types E, H, and KK) and Type I lip/neck fragments was surprising because no whole bottles were recovered that had these finish types. The only whole bottles not represented in the lip/neck typology were Type 9 vials.

The lip/neck typology expanded our knowledge of the bottles produced by the Virginia Glass Company beyond information available through study of the whole bottles. The lip/neck typology suggests that a higher percentage of beverage bottles were produced at the factory than the whole-bottle typology indicates. Fifty-three percent of the lip/neck fragments found that were produced at the glass factory were probably medicine bottles, while thirty-two percent were probably beverage (beer or soda) bottles. The function of the remainder of the lip/neck fragments could not be determined. Although medicine bottles outnumber beverage bottles, the

counts are more balanced for the lip/neck fragments than the whole bottle information suggests. Eighty-six percent of the whole bottles probably held medicine, while only three percent held beverages. These data support the conclusion that small medicine bottles survived intact in the ground better than the larger beer and soda bottles.

9.4.2 Base Fragments

The artifact collection included fifty-six bottle bases. Generally, these fragments did not provide as much information as the lip/necks and whole bottles.

The lip/neck fragment provides evidence of automation that is very useful in developing a typology. A continuous seam over the bottle lip provides the best evidence of automatic machine manufacture seen on bottles recovered during excavation. This information was useful in distinguishing between hand-made bottles produced at the factory and machine made bottles produced later. On the other hand, both machine-made and blown-in-mold bottle bases generally included similar seams; these seams resulted from a separate base mold piece on both types of bottle. Therefore bases were not considered as diagnostic as lip/neck fragments. Bases with markings were considered more diagnostic in the field and the collection strategy focused on marked bases. Further archival research, however, revealed that most marked bottles post-dated factory operation.

Bases were not sorted into a typology because a typology had been developed for the lip/neck fragments, and it was unknown which bases went with which lip/necks. Many bottle bases recovered were circular (43%). Other common shapes included rectangular (2%), rectangular with rounded corners (12%), rectangular with chamfered corners (22%), square (4%), square with chamfered corners (4%), Philadelphia oval (3%), Philadelphia oval with five flat sides (2%), and flask (4%).

Bottles produced at the Virginia Glass Company factory were made primarily in two-part vertical molds with separate bases that were formed either in a cup mold or push-up base mold.

The type of base mold used could be determined for some bottles recovered from the archeological excavation. However, it is often difficult to tell them apart because the cup mold and push-up mold can both produce similar shapes and marks.

Of the bases recovered during archeological investigation that were produced at the factory, thirty-three percent had between one and ten vent marks. Vent marks were tiny raised dots created during the mold process when glass seeped into pin-hole vents in the molds. Vents in molds allowed trapped gasses to escape as the glass was pressed into shape.

Analysis of the bases augmented conclusions about the method of manufacture and the types of bottles produced by the Virginia Glass Company reached through analysis of the whole bottles and lip/necks. Bases, like lip/necks, helped correct for the bias in the whole bottle typology against larger bottles.

9.4.3 Diagnostic Body Fragments

The artifact collection included seventy-six potentially-diagnostic bottle body fragments (pieces with a design or lettering). Generally, these fragments did not provide a great deal of information because few fragments were large enough to identify. Like the bases, body fragments were not sorted into a typology because it was unknown which body fragments went with which lip/necks. Generally unless the body fragment was a color not produced by the Virginia Glass Company (like milk glass or cobalt glass) it was difficult to determine which fragments were made at the factory and which were deposited later (glass color is discussed in the following section, Section 9.5). For the purposes of this discussion, all fragments that potentially could have been made at the factory are assumed to have been made there.

Thirty-two bottle body fragments were collected that included embossed lettering. Table 9-3 lists the words and parts of words that appeared on the bottle fragments. Fragments of two Portner Brewing Company Tivoli beer bottles were the most diagnostic body fragments recovered. Three bottle segments had only the words (or part of the words) "THIS BOTTLE

NOT TO BE SOLD". This statement was included on many beverage bottles in the late nineteenth and twentieth centuries. Many bottle fragments had part of an address or place name, including Virginia, Maryland, Washington D.C., Baltimore, and Alexandria. A few fragments indicated the function of the bottle based on key words like 'brewery' or 'remedy'; these fragments included two probable beer bottles, a remedy bottle, and a nerve tonic bottle.

Table 9-3. Lettered Bottle Body Fragments

Catalog Number	Markings	Count
0155	"ALEXANDRI[A]" on front of bottle in label area, "THIS BOTTL[E] NOT TO BE S[OLD]" above base on front	1
0171	"RE..." on side above base	1
0181	"...F" "...TO MD"	1
0188	"ROSSLY[N]" on side an inch above base	1
0213	"THIS"	1
0214	"KINGS" "[R]OYAL" "PATENT" "[G]RANT[ED]"	1
0219	"THIS BOTTLE", just below shoulder on body	1
0238	"C.C. Co. 487" on body just above base	1
0319	"[BREW]ING CO." "TRADE TIVOLI MARK" "[ALEXAN]DRIA"	1
0323	"...OLD..." "...NRD..." "...STOL...." "EYE W..." parallel to sides	3
0339	"...ERY" "[BALTIM]ORE MD" "...ING COMPANY"	1
0349	"...[B]OTTLE"	1
0409	"...NN & SON" "...TH ST." "...N. D.C."	1
0436	"[BAL]TIMORE..." "OF" and "...ANY" is written upside down	1
0637	"RA..." "...NERVE..." "...BROWN MFG..."	1
0640	"PHIL ^..."	1
0648	"...&..." "...[ALE]XANDRIA, VA..."	1
0708	"...ECK BREWING CO." "...VA" "TRADE MARK"	1
0709	"...ALXAN[DRIA]..."	1
0709	"...L MFG..."	1
0711	"....DAILY & SUN..."	1
0792	riged design on glass	2
0799	"...FIRST ST. NW..." "WASHINGTON, D.C." "...LF PINT I..."	1
0803	decorative v-cut flutes on sides	1
0865	in diamond: "TRADE TIVOLI MARK" "ALEXANDRIA, VA."	1
0901	"...LUNG S... REMEDIES... [FRED]ERICK MD..."	1
0945	"THIS BOTTLE NOT TO BE SOLD"	1
1019	seal on body, "...N, D.C..." w/very small animal figure	1
1162	raised/pedestaled rectangles like a barrel	1
Total		32

9.4.4 Conclusion: Bottle Fragments

Analysis of bottle fragments supported and augmented conclusions about the manufacturing process and the types of bottles produced at the factory that had been determined from analysis of whole bottles. Analysis of diagnostic bottle fragments revealed that a wider variety of bottles was produced at the glass factory than is reflected in the whole bottle typology list. Investigation of bottle fragments helped correct for the bias in the bottle typology against larger beverage bottles. However, because of the disturbed stratigraphic context, it was not always possible to tell if bottle fragments, especially those lacking a lip, came from the glass factory. Although this reduced their information potential, analysis of diagnostic bottle fragments provided useful information.

9.5 COLOR

Glass color is generally not considered a useful category of description for artifact analysis because the same colors have been produced throughout history. However, color was useful for analyzing artifacts from the glass factory because certain colors were not made at the factory. Artifacts made from these colors, including cobalt and milk glass, could be eliminated from the discussion of factory artifacts.

The majority of the glass from the glass factory excavation was clear (60% of all glass). Aqua-colored glass constituted eighteen percent of all glass; amber made up nine percent. Yellowish glass (1%), greenish glass (5.7%), and manganese-tinted glass (2.8%) were also found. If these lightly-tinted glass colors are considered variations of clear glass, the overall percentage of clear glass found at the site increases significantly. Iron impurities in the sand used to make glass produced a range of pale yellow and light green tints. Large amounts of iron produced amber-colored glass. Manganese was sometimes added to glass to counteract the natural yellowing caused by iron impurities; when exposed to sunlight over time the manganese tinted the glass slightly purple or pink (Jones and Sullivan 1985:13). Most aqua-colored glass found during excavation included a light to heavy, white patina that had developed over time.

Something in the chemical composition of the aqua glass seems to have broken down or reacted with the surrounding soil more than other colors of glass.

The Alexandria *Glass Factory Directories* (Commoner and Glass Worker) from the years 1900 to 1917 noted that the Virginia Glass Company produced amber and green-colored glass and flint glass. It is surprising therefore that archeological investigations recovered primarily clear glass and almost no green glass. And it does not appear that the green glass found at the factory was produced there. It is possible that glass from the excavation that was cataloged as greenish-tinted or aqua glass was considered green by the factory directors.

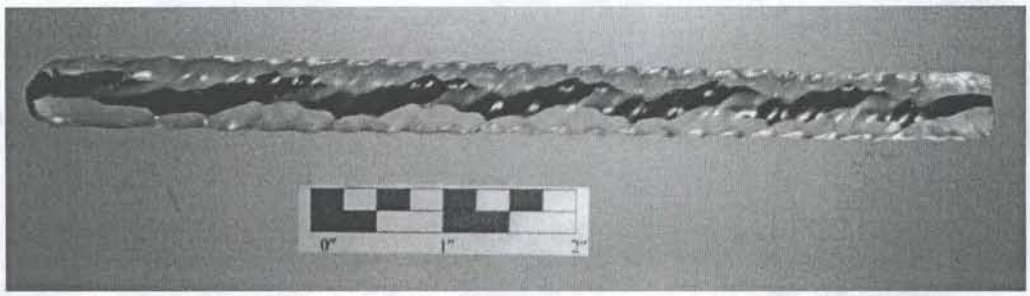
A small number of cobalt-colored (0.6%), dark green (0.16%), opaque green (0.05%), opaque pink (0.11%), bright green (0.27%), and milk glass (1.97%) fragments, bottles and jars were found at the glass factory site. However, these artifacts were not made at the factory.

9.6 STOPPERS, CLOSURES, TUBES, DECORATIVE CANES AND PREFORMS

Fifty-two rods of glass were collected during glass factory excavation that appeared to have been intentionally manipulated by factory workers, rather than just trails of glass waster. Some of these fragments were decorative rods or canes; other fragments may have been glass stoppers or stopper preforms. In addition to the decorative canes and stoppers, glass tubes and small rods with a very tiny diameter (0.01 inch) may have been formed intentionally.

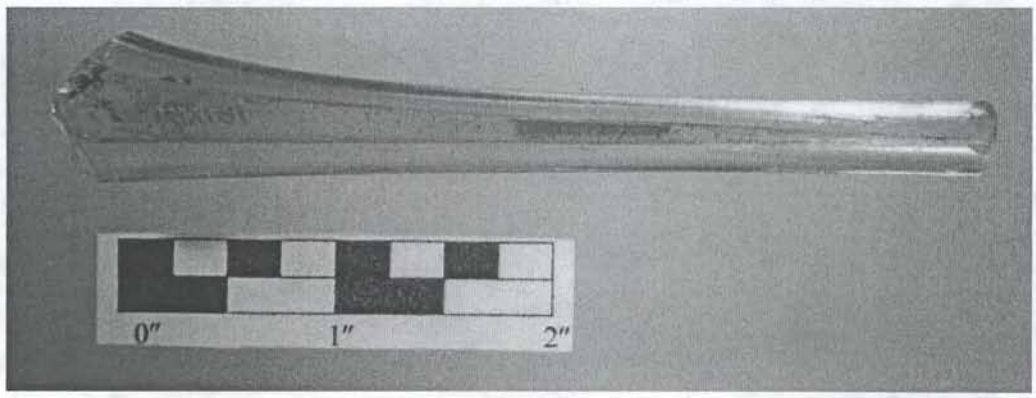
Glass canes and rods were solid, linear glass fragments used in decorations. Often multiple canes of glass were encased in clear glass, or twisted together. Canes were most often used for stemware (like wine glasses), but also could be used to make marbles or to decorate the tops of wooden canes. Two canes with opaque twists encased in clear glass were found. Although white was the most common color of opaque twists (Jones and Sullivan 1985: 50), the canes found also included red and black. Other canes of glass recovered were simply twisted or incised with lines resembling a twisted pattern. Figure 9-14 illustrates representative canes found during the glass factory excavation.

Catalog #265



Catalog #1068

Catalog #234



Catalog #338

Figure 9-14. Representative Examples of Canes Produced by the Virginia Glass Factory

Approximately twenty fragments of glass tubing of various diameters were found on the site. The majority of these tubes were clear. Tubes may be used for light bulbs, medical supplies, or chemist supplies. One of the aqua-colored tubes was twisted like a cane, and, like the canes, may have been intended for use in stemware.

The four glass artifacts catalogued as stoppers from the site were roughly cylindrical, but tapered at one end (Figure 9-15). These items were distinguished from glob-like glass wasters because they were straight, basically symmetrical, and had smooth sides. No stoppers recovered from the excavation included a finial, although a finial may have broken off of the top.

Most glass stoppers were wrapped with cork to fit different bottle necks. A ledge in a stopper-type bottle bore was intended to keep the cork from falling into the bottle contents if the cork became separated from the stopper when the stopper was removed. Thirty-three bottles and lip/neck fragments included a stopper bore. Most of these bottles were Type 2 bottles. Because of the labor-intensive method of making glass stoppers, which have to be ground to fit each container individually, ground glass stoppers were not commonly used on commercial vessels (Jones and Sullivan 1985:151). Five lip/neck fragments had a ground bore that accommodated a glass stopper with a ground shank.

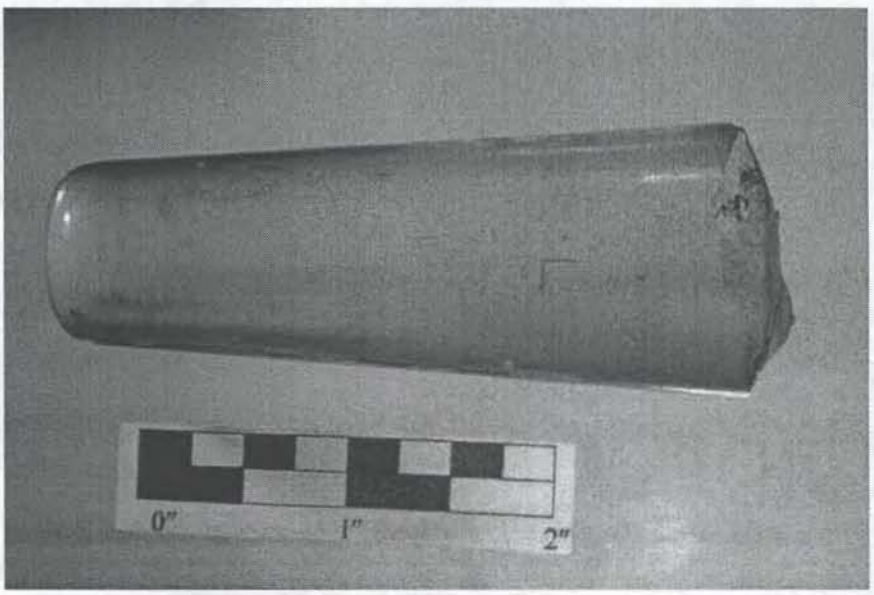


Figure 9-15. Possible Stopper, Catalog #254

Another common type of artifact recovered from the glass factory site was a possible bottle or stopper preform. Nine artifacts were collected that were cataloged as glass stopper preforms. Each preform consisted of a roughly circular glob of glass with a flat bottom and rounded top; a stopper-shaped, tapered glass glob extended from the flat side. It appears that the bottom projection was formed when glass was poured over something with a roughly 1.5-inch opening. Trail marks on the rounded top of the artifact reveal that glass was added to this side, and that this surface did not touch a mold or other form. The flat side of the circular part often included a seam mark; one artifact also included words, although these words were backwards and did not appear to be intentional (Figure 9-16). These artifacts resembled large 'club sauce'-type stoppers that likewise had a circular, flat or rounded top with a tapered shank. Perhaps these 'preforms' could have been further manipulated or cut to create more even circular tops like the club sauce stoppers. Despite the name, club sauce stoppers were used on a variety of commercial containers (Jones and Sullivan 1985:152). Although the exact function of the artifacts from the glass factory site is not known, they have been cataloged as stopper preforms.

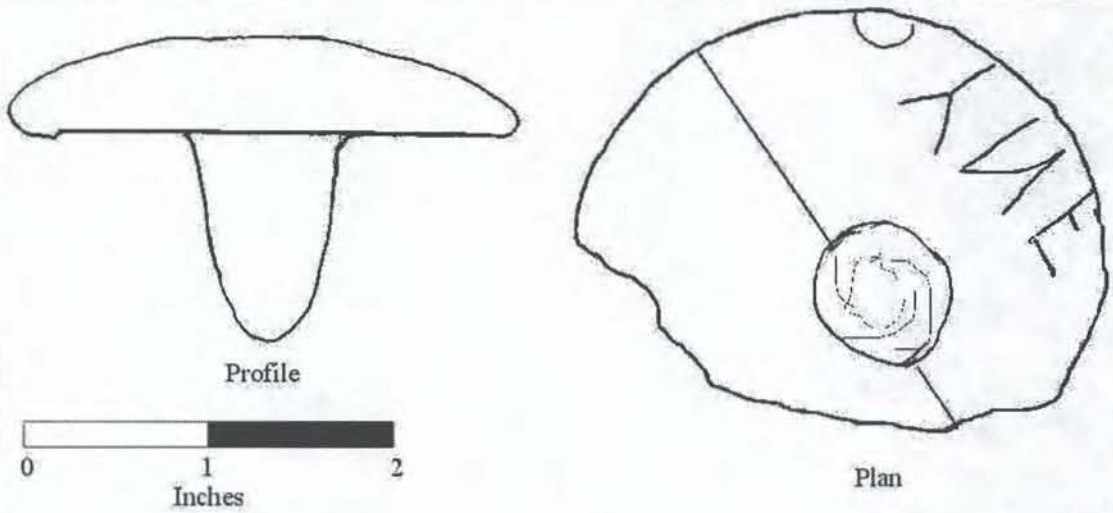


Figure 9-16. Possible Stopper Preform, Catalog # 491

Three types of non-glass bottle stoppers were recovered during excavation: corks, Hutchinson's Patent Spring Soda Bottle Stoppers, and porcelain lightning-type closures. Three bottle necks were collected that retained the remains of a cork in the neck. Two of these lip/neck

fragments were Type V and the other was Type L. Most bottles and lip/neck fragments found had a straight or slightly constricted bore. These bottles may have used a cork stopper.

Two Hutchinson's stoppers were collected; one of these stoppers was still inside a short-necked, Type V lip/neck fragment (Figure 9-17). Hutchinson's stoppers were patented in 1879 in the United States. These stoppers consisted of a thick wire loop and rubber gasket. The gasket was inserted into the neck of a short-necked bottle to form a seal. Carbonation in the beverages kept the seal in place until the wire was knocked to break the seal (Jones and Sullivan 1985:162).

Figure 9-17. Hutchinson Spring Stopper

The lightning stopper, patented in 1875, was one of the most common closure types during the late-nineteenth and early-twentieth centuries. The porcelain stopper was attached to a wire bail that was then secured to the bottle with another wire. Lightning closures were too expensive for soda bottles, but were used extensively for beer and ale bottles (Jones and Sullivan 1985:163). Five lightning-type stoppers were recovered from excavation of site 44AX181 (Figure 9-18); one of these stoppers had part of the wire bail still attached.

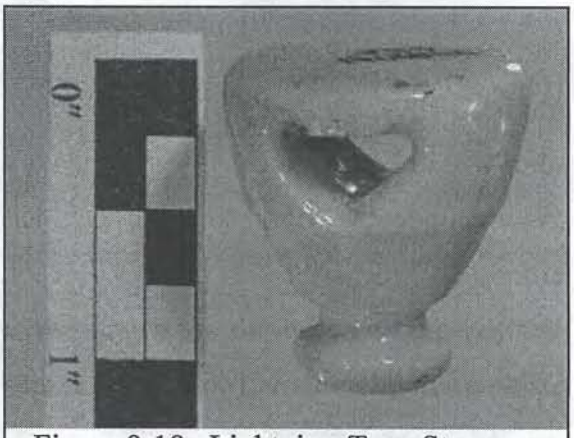


Figure 9-18. Lightning-Type Stopper, (Cat. 256)

Corks, Hutchinson stoppers, and lightening stoppers were not made at the factory (they were not glass). It is not clear whether the stoppers were deposited after factory workers drank the contents of purchased bottles, were deposited with later domestic refuse, or possibly were purchased by the factory for sale with appropriate beverage bottles.

Other non-glass closure types used on Virginia Glass Company bottles included crown tops and internal gaskets. Nineteen lip/neck fragments and bottles found during the factory

excavation had a crown finish. Crown caps, patented in 1892, were originally plain lacquered metal with an internal disc of natural cork. Early caps were manually applied with a foot-operated crowning machine to accommodate variations in the crown finish of bottles resulting from the hand-tooling process (Jones and Sullivan 1985:163). Sixteen bottle fragments recovered included an interior-gasket bore to lock a gasket in place. Many types of internal gasket seals were patented in the late-nineteenth century.

9.7 GLASS MAKING TOOLS AND OTHER IMPLEMENTS

Although many iron artifacts were found at the glass factory site, few artifacts can definitely be identified as tools that may have been used in glass making. Most iron fragments were either too corroded or too fragmented to permit accurate identification. Also, even when these factors are taken into consideration, it appears that few implements were actually left at the site after the factory closed. Tools that were easily transported were probably sold or removed for use at other glass factories.

Tools recovered that were potentially used in glass making included a pair of shears and a pincers. Shears were used in glass making to cut away excess glass. Mold tenders used pincers to remove bottles from molds for final finishing, and to transport hot materials in general (Dodsworth 1982:17). Additional possible portions of pincers were also found. A chisel or file, wedge, metal tool handle fragment, and saw may also have been used at the factory.

The remains of a chime clock were recovered from factory excavations. The clock had two wind-up springs and one escapement gear. The gears were brass and the shafts and wind-up springs appeared to be steel (Figure 9-19). Clocks were an important part of wage labor operations following the industrial revolution in the nineteenth century. Prior to this time, skilled craftsmen worked to finish entire products; they had to finish a certain number of products in a week, rather than working a certain number of hours each week. Once people started to be paid for their labor time rather than products, managers felt it necessary to keep track of this time, and often installed clocks in the workplace. The presence of a clock at the factory suggests that,

despite the presence of skilled glass workers capable of hand-making glass items people working at the factory were wage laborers.

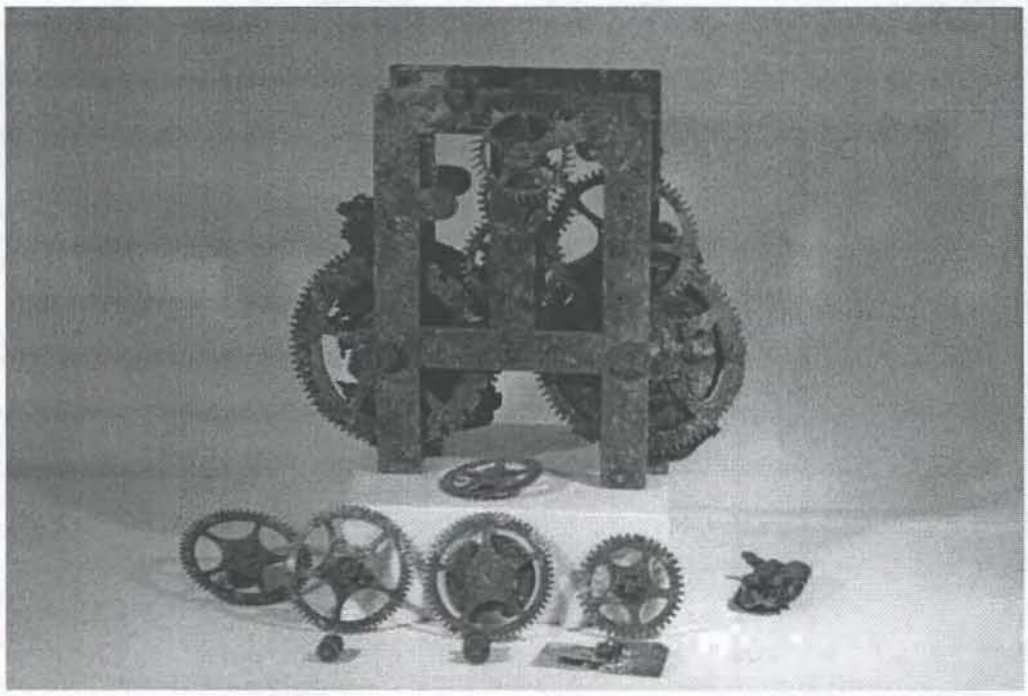


Figure 9-19. Remains of a Clock Found During Excavation

Two iron cart or pulley wheels recovered may have been used at the glass factory. One wheel measured three inches in diameter and appeared to be a small cart wheel that may either have been free-riding or have run on a narrow-gauge rail. The other wheel measured approximately ten inches in diameter and may have been a cart wheel or part of a pulley system. Carts and pulleys were used, among other things, to transport hot molded bottles from the furnace to the annealing lehr. A pulley system may also have been used inside the lehr to convey bottles through the reheating and cooling process.

In addition to tools and other devices, parts of the actual factory were recovered, in addition to the factory features uncovered that are discussed in Section 8.0, *Archeological Findings.* Parts of the factory included a tank buck stay, valve wheel, and vent cap. The tank buck stay was one of many brackets that held two or more tanks together in a continuous firing furnace. The valve wheel measured eleven inches in diameter and was probably used to open

and close a large valve in the furnace or gas producers. One circular vent cap measured six inches in diameter and bent in the middle like a hinge to allow air to escape. Another similar pressure release vent cap measured approximately four inches in diameter. One large mushroom saucer valve covering may have covered a reversing valve used to reverse the flow of air and gas between regenerators. This valve measured approximately 2.5 feet in diameter; it was not removed from the site, but was documented in place.

Cables, pipes, metal beams, wire, bolts, brackets, hinges, and other metal fragments may also have been part of the glass making process. One interesting metal artifact that may have been part of the glass factory was a brass device that appeared to have been a latch (Figure 9-20). Pieces of a flat red ceramic tile with a textured, white, painted surface may have been insulation material. Clumps of grog, asbestos, and unidentifiable materials may also have been used for insulation.

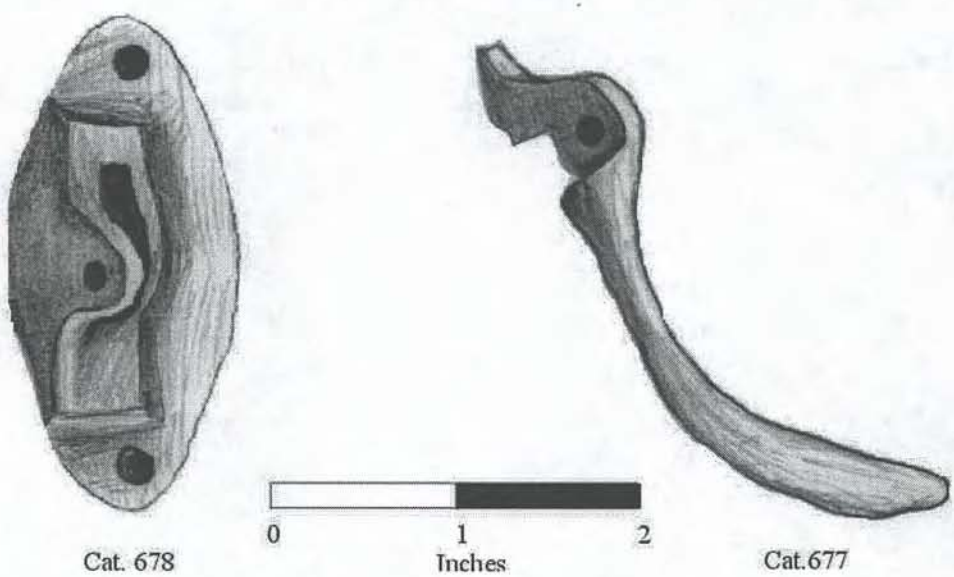


Figure 9-20. Possible Latch

9.8 OTHER GLASS ARTIFACTS

Glass artifacts not made at the factory included bottles, jars, jar lids, drinking glasses, window glass, marbles, and decorative glass bowl fragments. The glass factory site appears to have been used as a dumping area after factory closing. Numerous artifacts not related to glass production (most post-dating factory operation) were found at the site. These artifacts were interesting, however, in that they provided information on site use immediately following the closure of the Virginia Glass Company; a large percentage of the artifacts that post-dated the factory dated to the forty years following factory closing (c. 1920-1960). These artifacts were probably dumped on the site from adjacent residential areas.

9.8.1 Contemporaneous Bottles and Jars Not Made at the Factory

Some bottles and jars were contemporaneous with the Virginia Glass Company factory (based on manufacturing technique), but do not appear to have been made there (based on maker's marks, form, and color). These artifacts may have been used by factory workers.

One bottle base from the Old Dominion Glass Factory was found at the Virginia Glass Company site. The Old Dominion Glass Factory began operation in Alexandria in 1902 (Alexandria Gazette 2/3/1902). The company marked "O.D." on the bases of bottles produced at that factory.

A small cobalt-colored bromo seltzer jar featured a hand finished tooled lip. One similar machine-made bromo-seltzer jar was also found.

Twelve flasks (probably for liquor) were found that were made in molds and hand finished with a finishing tool. Based on artifact comparisons, two of these flasks were probably produced somewhere else and the contents possibly consumed at the factory. One small flask was found with an applied continuous thread that accommodated a type of closure not found on other factory bottles. The lip had been hand-tooled and the thread applied over the seam (the

seam did not run over thread or over the lip). Another flask was made in a two-part mold; the mold seams ran along two opposite corners of the flask, and met on the base to form a diagonal. These types of manufacture were not seen on any other bottles from the factory.

9.8.2 Later Bottles and Jars

Eighty glass bottles, jugs, ink wells, and jars were recovered whose manufacture post-dated factory operation. These artifacts were automatic machine-made. The earliest fully-automatic bottle making machine that became widely used was the Owens machine. Michael Owen began developing the machine around 1904; by 1917 almost half of the bottles produced in the United States were made on Owens machines. Beginning in the 1920s Owens machines were replaced with other feeder machines, and by the 1940s few bottles were made using the Owens machine (Jones and Sullivan 1985:39). The Owens machine left a distinctive feathery suction scar on the base of bottles. Twelve bottles and bottle bases recovered from site 44AX181 included Owens suction scars.

Evidence of machine production that appeared on bottles and jars included machine scars, ghost seams, and a large number of mold seams that ran the length of the bottle neck and over the lip. Thirty-nine bottles, jars, and bases found at the site had a machine-scar on the base. One bottle and one jug included a ghost seam on the side. This seam is produced when the bottle preform is formed. After the preform was transferred to the larger mold for final blowing, part of the original seam remained. All of the later non-factory bottles and lip/neck fragments had a seam the length of the neck and on the lip.

Eleven jars and jar bases were found that were machine-made in the technique of a press or plunger mold. With this technique, a glob of glass was pressed into the shape of a mold by a plunger. The outside of the jar assumed the shape of the mold; the shape of the jar's interior is based on the plunger and is usually smooth. The jars were milk glass, and shaped like Ponds jars, although only two actually said "Ponds". One interesting milk glass jar had the logo

"PONOS" rather Ponds. This jar may have been mislabeled, or produced by a company attempting to copy Ponds.

The most common artifacts found that post-dated factory operation were mason jars, lids, and lid liners. Fifteen mason jars of different sizes were found, including Gelfands, Baltimore and Perfect Mason jars. An additional twenty-one mason jar bases and lip/neck fragments were recovered. Fifteen aqua-colored lightning-type glass mason jar lids were recovered. This method of closure was based on the closure type developed for bottles; it featured a glass lid with a molded centering configuration for attaching the lid to the jar with wire. Eight metal screw-top lids and fourteen milk glass lid liners were also found on the site. The lid liners were primarily Boyd's Genuine Porcelain brand.

Ninety-five machine-made bottles were marked on their bases with a brand name or maker's mark. One of the more common marks was a cursive "Duraglas" that was produced after 1940 by the Owens Illinois Glass Company in Toledo. Another common mark was also produced by the Owen's Illinois Glass Company. This mark features a circle with the letter 'I' in the center overlaid on a diamond with numbers surrounding it. It was used between 1929 and 1954; the numbers surrounding the diamond indicated the plant number, model number, and year for the particular bottle. A third mark often seen on the artifacts from site 44AX181 was the letter A underneath a stylized letter H. This mark was used by the Hazel-Atlas Glass Company of Wheeling, West Virginia, between 1902 and 1964 (Toulouse 1971).

Other marks included numbers surrounding a diamond and circle or a circle inside a square, numbers inside diamonds, and letters inside key-holes and circles. Some bottle bases had design patent dates (including February 10, 1903, February 23, 1915, 1918, April 24, 1924, and 1975). Other bottle bases included place names (including Philadelphia, Baltimore, Cleveland, and Brooklyn, New York). Most marked bottle bases simply had a letter or number. Other featured brand names were Heinz, Noxema, Gelflands, S. C. Johnson and Son, Joubert, Walker's Killmarnock Whisky, Knomark MFG. Co. Inc., Griffin, and Vicks Vapor Rub. Most bottles date

between 1910 and 1960 based on their manufacturing techniques, brand names, and maker's marks.

Bottle fragments (including lip/necks and bases) that post-dated factory operation did not provide much information. Mold seams and other evidence on the bottles and fragments generally allowed archeologists to distinguish between those fragments that were machine-made and those fragments that may have been made at the factory. In that way, the later bottles and fragments provided a comparison for the factory bottle collection.

9.8.3 Drinking Glasses and Glass Bowls

Seven drinking glasses or tumblers and a jelly glass were recovered during the glass factory archeological excavation. Three of these tumblers featured identical decoration (tiny scratched vertical lines below the rim). These three glasses were probably part of a set. One tumbler had flutes on the interior and was smooth on the outside. This glass was machine made in the technique of optic molding. With this technique, glass was initially formed in a small mold in the shape that would eventually become the interior design. The small molded glass preform was then transferred to a larger mold and blown to full size; the original pattern remained on the inside, while the outside was smoothed (Jones and Sullivan 1985:32). The other tumblers had molded decoration, including flutes and ridges, on the outside. These glasses were machine made in press molds where the glass was pressed into a mold creating a design on the outside and a smooth inside.

Decorative glass bowl and other vessel fragments resembled 'Depression Glass' from the 1930s. One bowl was clear glass with an orange applied patina and molded rim decoration. One cut glass or crystal vessel (probably a bowl based on the curve) fragment may have been deposited around the same time. A green opaque drinking glass resembled 'Jade' glass from the Depression era. These artifacts confirm that the site may have been filled in between 1920 and 1960.

9.8.4 Marbles

Five marbles were recovered during site excavation. Three of these marbles appear to date between 1920 and 1940 based on their method of manufacture and decorative motif; one glass marble may date to between 1910 and 1940. The fifth marble, made out of ceramic, may be earlier in date. Marbles were probably deposited during factory demolition or as part of residential refuse deposited after the factory closed. Alternatively, marbles may have been made at the factory or used for recreation by factory workers near the end of factory operation.

Glass marbles began to replace stone and ceramic marbles around 1860. Germany produced the majority of hand-made glass marbles from 1860 to 1920, although England and America also made marbles in limited quantities. Hand-made marbles were produced in America between 1890 and 1915. Hand-made marbles were made by creating a cane or rod of glass made up of other rods twisted together. The end of the rod was then rounded in a hand-held device, and the marble was cut off the end of the cane with glass scissors. Hand-made marbles had a small 'pontil' mark created when they were cut from the canes.

Martin F. Christenson of Akron, Ohio, first developed a method of machine-manufacturing marbles around 1910; between 1910 and 1940, all machine-made marbles were produced in the United States. Machine-made marbles were more spherical than those produced by hand and eliminated the pontil mark, allowing America to compete with the higher quality hand-made German marbles. Between 1920 and the 1940s, the number of marble manufacturers and the variety of marbles produced greatly increased.

One marble collected from the glass factory site had a possible pontil. Because the glass factory produced decorative canes (rods made up of twisted colored glass rods), it also had the ability to produce marbles. However, potentially hand-made marbles from the site do not resemble canes from the site, and the marbles were recovered from a disturbed context. Three of the four glass marbles found were machine made and probably dated to between 1920 and 1940. Therefore it is most likely that the marbles were all deposited after the factory closed.

9.8.5 Window glass

Only six fragments of window glass were recovered during the glass factory excavation. Because very little window glass was observed during site excavation, it was collected when it was seen. The small amount of window glass is consistent with documentary evidence for the factory. The factory burned down for the final time during the summer. Windows were removed from the factory during the summer months of operation. Therefore, large amounts of window glass were not expected from the archeological excavation.

9.9 HISTORIC CERAMICS

Ceramics represented fifteen percent of all artifacts recovered from the glass factory excavation. In all, 452 sherds of ceramic were found. Only five ceramic sherds were found that might have predated the factory. These sherds included one multi-color painted pearlware, one blue painted pearlware, two plain pearlware, and one blue printed transitional pearlware/whiteware. These ceramics were all produced between c. 1780 and c. 1840. The presence of earlier ceramics does not suggest that another occupation predated the factory at this location. Pearlware may have been deposited from residential structures located in the vicinity by 1840. Pearlware may also have been deposited from the railroad located south of the factory by 1848; the pearlware was found during trench excavation south of the factory.

Almost all ceramics found were whiteware (c. 1820-present) (28%), ironstone (c. 1840-present) (13%), or later hard white earthenware (c. 1880-present) (23%). Eighty-five sherds of porcelain were also found (19%). These ceramic types are difficult to assign to a definite time period unless a particular decorative pattern can be found in research. Because ceramics (like other artifacts) were found in a disturbed, mixed context, it is not known whether they date to the time of factory operation or to a later time period of residential dumping.

Most ceramics were plain; decorated vessels featured simple pink, orange, and green floral designs, and/or gilded bands or designs. Many of the ceramics included decoration typical of the 1920s to 1940s and may have been deposited as part of residential refuse after the factory closing, perhaps from the West End development along Duke Street, located north of the factory site. One unusual ceramic vessel found was a German hard white earthenware cylindrical cup or drinking glass. The cup was white on the outside and yellow on the inside. The exterior had a naturalistic scene of a fisherman. The base was etched with the words and numbers: "2327" and "m94 Eschutzt". The maker's mark on the base read "Villeroy and Boch" "Made in Germany". Table 9-4 summarizes the types of ceramics found and the basic decorative techniques.

Table 9-4. Ceramic Summary

Type	Description	Count
ceramic	drain/sewer pipe	18
	tile, fabric-patterned front, checker pattern on back, w/plaster-like for insulation	3
ceramic total		**21**
coarse earthenware	brown interior glaze, gray exterior	1
	shallow bowl	1
	vessel fragments w/simple molded rim-floral, orange & green paint (sm. orange balls) & gilding	9
	burned cobalt glaze	1
	dark brown glaze on both sides	1
	green interior and exterior glaze, leaf shape	1
	solid baby blue exterior glaze, white interior	1
	green glaze	1
coarse earthenware total		**16**
coarse stoneware	clear exterior, brown interior, pipe or large crock	1
dry bodied stoneware	almost porcelain, beige color	1
flow blue	rim sherd	1
ironstone	fragments of a large bowl with green transfer print	8
	handle(?), yellow tinted glaze, looks like a large hollow lug handle	1
	jar fragment, with interior rim to support lid, orange transfer-printed design	1
	platter fragments with pink & green painted flowers and gold stripe on rim	14
	rim sherds with gold designs	4
	tea cup rim sherd w/orange, blue, purple, & green painted floral decoration	1
	molded vessel/s fragments with orange print, & gilding	7
	blue transfer print	1
	plain	20
ironstone total		**57**

Type	Description	Count
ironstone/hard white earthenware	cup fragments, multicolor printed nature scene of fisherman	1
	plain, some with simple molded designs	44
	fragments, gold design along rim inside, calendar with date-1911, bowl?	2
	multicolored and/or gold decoration	33
	thick marbleized glaze in diamond shapes	1
	plate fragments with blue stripe & gold design on rim	8
	yellowed glaze	14
hard white earthenware total		**103**
pearlware	painted multi-colored	1
	plain white	2
	blue painted design	1
	blue printed, transitional	1
pearlware total		**5**
porcelain	multi-colored and/or gold painted	10
	plain	14
	multi-colored, printed	19
	plate, large portion, w/gold decoration along rim, and multi-colored floral design on interior	1
	saucer base fragment, painted pink decoration	1
	shallow bowl, green and pink painted, design and gilding on interior rim, broken in 12 pieces	12
	small tea cup fragment with flutes, may be toy	1
	soap dish? With green and pink floral decoration	1
	tea cup and saucer fragments with blue, orange, gold or multi-color paint decoration	15
	tall bowl with yellow glaze, orange and yellow floral pattern	1
porcelain total		**75**
redware	clear exterior glaze, white interior glaze, deep bowl	1
	flower pot	7
redware total		**8**
Rockingham-like earth	w/fleur-de-lys decor	1
stoneware	gray salt-glazed	2
	dry-bodied, black, base rim sherd	1
	fragment gray lead glaze	3
	jug lip, brown stoneware	1
	dark brown lead glaze, cylindrical vessel	1
	white exterior, brown interior glaze	1
stoneware total		**9**
whiteware	plain	62
	dark red bands	2
	willow pattern	10
	blue decoration	14
	fragments of tea cups and saucers	7
	off-white glaze, yellow and orange floral	12
	multicolor printed design	4
	gold bands on rim	1
	soap dish with teal decoration	1
	green glaze	1
	green or purple transfer print	2
	orange, purple, red, yellow, or green bands on sherds	2
	silver design along rim	1
	deep bowl with white glaze with blue sponge design	1
whiteware total		**120**

Type	Description	Count
yellow bodied earthenware	blue glaze, burned	1
	coarse, dark yellow glaze, white slip stripe	4
	thick white glaze on interior and bright blue with speckles glaze on exterior	1
	white exterior glaze, brown interior	2
yellow bodied earthenware total		**8**
yellow ware	crock-like vessel, with 3 white slip bands around outside below lip	5
	multi-color floral design	2
yellow ware total		**7**
Grand Total		**434**

Most ceramic sherds found at the site could be mended. Mending was done after cataloging, so individual sherds retained their provenience and catalog numbers. Portions of vessels with separate catalog numbers were labeled separately prior to being mended. Ceramic sherds from the same vessel were ultimately bagged together, along with all relevant provenience information.

The most common vessel forms found were tea cups and saucers; plate and bowl fragments were also found. The presence of porcelain ceramics and tea service vessels at a site has often been considered an indication of high status (Miller 1980; Shepherd 1987). However, this was not necessarily a valid conclusion given the late date of the ceramics. After about 1850, as a result primarily of mechanized production, the price of porcelain and tea service vessels decreased to the point that they were essentially the same price as plain white earthenware of any vessel form (Miller 1980). The decorative motifs used on many of the ceramics was typical of the 1910s to 1940s. Such ceramics may have been deposited as part of residential refuse after the factory closing, perhaps from the West End development along Duke Street, located north of the factory site.

9.10 FIREBRICKS

Firebricks differed from common bricks in that they were produced from materials that could withstand more heat, and often weight, than common building bricks. Firebricks served as insulators to protect the outer architectural features that were constructed of common bricks.

The key ingredient for making firebricks was high grade sand that had a low iron content. There were different kinds of fire bricks, including silica bricks and insulating bricks. Firebricks were also made in different qualities to accommodate different levels of heat exposure. Different kinds of fire bricks were used in different parts of a glass factory.

Many parts of the Virginia Glass Company factory that were directly exposed to heat were made from firebricks. For example, Minor brand firebricks were used in the front part of the lehr, and common bricks were used in the cooler parts of the lehr.

Some of the firebricks used at the Virginia Glass Company factory included an embossed name indicating the manufacturer. Four brands of firebricks were observed during the glass factory excavation: Pope, Juniata, D - W, and Minor. Only a sample of brick was collected. Juniata bricks came from the Juniata Valley of Pennsylvania. This manufacturing town was famous for producing high-quality firebricks. The bricks were different colors, including gray, red, black, and yellow. Firebricks that made up the air shafts between the furnace and gas producers, and the furnace and chimney, were arranged in an American bond pattern. The stretchers were red and the headers were yellow.

9.11 FAUNAL REMAINS

Organic artifacts recovered from the glass factory excavation consisted of small and large mammal bones, oyster shells, and clam shells. Only a sample of shell was collected; most bones seen were collected. Organic artifacts seem to represent food remains; many bones had butcher cut marks. The faunal remains may date to the time of factory operation or to the period of residential dumping following the factory closing. Like other artifacts, organic remains were found in a disturbed context with both modern bottles and jars and bottles produced at the factory. Most of the shell and bone remains were found in a part of the furnace that included a large cache of bottles and mason jars from c. 1910-1960. This distribution suggests that the bones were probably dumped at the site after the factory ceased operation.

9.12 ELECTRICAL ARTIFACTS

The glass factory probably had electricity after about 1910. Early electrical wires were not grounded or insulated and had to be separated from each other by insulators. The glass factory excavation yielded twelve porcelain and glass insulators and other items related to early electricity. Artifacts included one bright blue glass insulator and one brown-glazed porcelain insulator; these larger insulators would have been placed outside of buildings to separate main wires. The smaller porcelain insulators would have hung on interior walls above switches to keep wires separated. Portions of early porcelain electrical switch casings or mechanisms were also found at the site.

9.13 SUMMARY AND CONCLUSIONS

Skilled glass workers at the Virginia Glass Company factory blew bottles in molds and finished them by hand. Although fully-mechanized methods of bottle manufacture had been available since 1904, the Virginia Glass Company continued to hand-produce bottles throughout its period of operation. Production of decorative canes and twisted glass was further evidence that skilled glass workers worked at the factory. An attempt at semi-automated or mass-produced manufacture technique may be evidenced in the Type 2 medicine bottles. The factory seems to have produced mainly medicine and beer or soda bottles in clear, aqua/green, and amber colors.

The glass factory closed in 1916. Following the closing the factory, features appear to have been used for dumping; numerous bottles and other artifacts dating to around 1910-1960 were recovered during excavation of the glass factory. The factory buildings may also have been knocked down and filled in prior to later construction, particularly of the Station Shop building that was constructed around 1961. Although artifacts recovered from the glass factory excavation were found in a disturbed context, they provided valuable information about the types of bottles produced by, and the method of manufacture used by the Virginia Glass Company.

10.0 SUMMARY AND RECOMMENDATIONS

10.1 SUMMARY OF RESEARCH QUESTIONS

The research questions identified in Section 2 have been addressed throughout the text of the report. The answers to these research questions are summarized below.

What information does the Virginia Glass Company provide about the rise, history and end of glass manufacturing in Alexandria? In what ways is the Virginia Glass Company similar to other bottle glass companies during this time of transitional technology?

Study of the Virginia Glass Company factory provides significant information about the birth and growth of the glass-manufacturing industry in Alexandria. The Virginia Glass Company was the first bottle factory established in Alexandria. The company was formed during the Industrial Revolution, a highly transitional period in glass manufacturing in the United States. Glass workers at the Virginia Glass Company were trained in the traditional methods of glass blowing. During their years at the factory they experienced first hand the nascent mechanization of their industry, from the availability of newly patented bottle molds to increasingly-advanced melting furnaces.

The Virginia Glass Company set the standard for the glass factories that were built later in Alexandria—the Old Dominion Glass Company, Belle Pre Bottle Company, and the Alexandria Glass Factory. Alexandria census records indicate that several of the founders and some employees of the Virginia Glass Company were later hired to manage operations at the Old Dominion and Belle Pre Glass Companies. It is likely that these experienced glass workers were recruited by other companies for their skills, or they chose to leave the Virginia Glass Company because of the promise of improved facilities. Virginia Glass Company founders George Schwartzmann and Lorenzo Wolford were President and Vice-President of the Old Dominion Glass Company when it opened in 1902 (Alexandria Gazette 2/3/1902).

Another indication that the Virginia Glass Company set standards for other companies is found in the floor plans, which are seen on the Sanborn Insurance maps for all four factories. All of the Alexandria glass factories were configured on a similar plan. They all utilized producer gas for fuel, and had a single day tank or continuous furnace. The Virginia Glass Factory experimented with these new technologies first, setting the stage for the development of larger and more efficient glass factories that were then built in Alexandria. One difference among the four was that the later factory buildings were frame rather than brick structures (Miller 1991).

The Virginia Glass Company operated for the first half of the glass-manufacturing boon in Alexandria, from 1893 to 1916. The end of the bottle-manufacturing era in Alexandria in the late 1920s coincided with economic depression and prohibition (Miller 1991). Other factors contributing to the decline of the industry in Alexandria were the costs of rebuilding facilities after numerous fires and the lack of local natural resources—such as natural gas—that were necessary for glass production.

What can we learn about the growth of industrialization in the late nineteenth century from studying this factory?

The factory system of production was prevalent throughout the United States by the close of the nineteenth century. The Industrial Revolution introduced new forms of energy and fuel, such as electricity and natural gas, to the industrial world. For cities along the eastern seaboard, such as Baltimore, Richmond and Alexandria, new industries harnessed these fuel resources and revolutionized the steel, textile, ship-building and glass manufacturing industries. The Virginia Glass Company represents an industry that reaped the benefits of the revolution and was later surpassed by other companies with better capabilities.

However, Alexandria was not an ideal location for producing bottles. The Virginia Glass Company did not have the capability to use natural gas and had to rely on expensive imported coal. Fuel outlays alone could account for 20% of the cost of materials for glass production when inexpensive natural gas was not used (Scoville 1948).

Another major factor in the success of any urban industry is transportation, both to bring in raw materials and to send products to market. In the late-nineteenth century the rail system in Alexandria was extensive and effective for developing a regional market for local products and for importing the raw materials for glass production, such as silica, sand and clays. The Virginia Glass factory had a competitive advantage because their facility literally backed onto the Washington and Southern Railroad tracks. Bottles could be loaded into cars directly from the factory without secondary transport systems.

During the 1890s, fully-mechanized bottle production was employed for the first time. The Virginia Glass Company rebuilt their furnaces twice to keep up with advancements in melting technologies so that they could mass-produce bottles and sell them on a regional scale. Despite their success, they did not upgrade to fully-mechanized bottle production and could not compete with the newer factories. There are three factors that may have contributed to the inability of the Virginia Glass Company to upgrade when advanced bottle-making machinery became available: adding additional machinery to their small factory would have required them to make huge outlays of capital and to retrain workers; by the early-twentieth century, several of the founders of the company were developing interests in establishing glass factories elsewhere; owners stopped investing in the growth of the company.

Although the Virginia Glass Company did not keep pace with the newer twentieth-century factories in Alexandria, the company survived for over twenty years because there was a demand for their high-quality bottles, both locally and regionally. It is true that their capability to mass-produce bottles was enhanced by advances made during the Industrial Revolution and their capability to transport bottles regionally was improved by their location near an extensive railway system. However, the geographic setting of the Virginia Glass Company in Alexandria also worked against them, for they were required to use costly producer gas and import many of their raw materials. Lack of local raw materials, their failure to fully mechanize the factory, and destructive factory fires all contributed to the eventual closure of the Virginia Glass Company.

What was the trade sphere of materials produced at the Virginia Glass Company? What were the sources for raw materials used for bottle production and which companies was the Virginia Glass Company supplying?

Archival research did not produce any business records or inventories that described the suppliers of the raw materials for the Virginia Glass Company. However, general information about bottle manufacture, supported by archeological data, provides a picture of the imports and exports involved in glass manufacture at the Virginia Glass Company.

Imports

Raw materials used for glass production at the Virginia Glass Company included domestic and German clays mixed with potsherds for producing the clay melting pots. Sand, silica and soda were required elements for mixing the glass prior to melting. Certain types of sand and soda were available locally, but refined silicate sand was probably imported from Pennsylvania or West Virginia.

Firebricks were used for the furnace melting tanks, recuperation chambers and areas that needed to be insulated, such as ventilation flues. The key ingredient for making firebricks was high-grade sand that had a low iron content. Historic records and illustrations suggest that fire or refractory bricks were often made on-site at glass factories. This was probably not the case at the Virginia Glass Company. The archeological evidence at the Virginia Glass Company site indicates that four distinctive types of firebrick, including silica bricks and insulating bricks, were bought from different brick companies. Firebricks were also made in different qualities to stand up to different levels of heat exposure. Some of the firebricks used at the Virginia Glass Company were embossed with the name of the manufacturer. Four brands of firebricks were documented during the glass factory excavation: Pope, Juniata, D - W, and Minor. Juniata bricks were produced at the Juniata Valley of Pennsylvania, a manufacturing town famous for producing high-quality firebricks.

Exports

The trade sphere of the Virginia Glass Company was local at the beginning, but developed rapidly to include an extensive regional market. The Virginia Glass Company supplied bottles to Alexandria's Portner Brewing Company beginning in 1893. There is a Tivoli trademark that was registered on November 28, 1893, for the Robert Portner Brewing Company. The trademark dates to the year when the Virginia Glass Company started producing Portner Bottles. Several Portner bottles were recovered at the Virginia Glass Company site that exhibit the Tivoli trademark. The Alexandria Gazette (12/19/95) stated that the Virginia Glass Company had a $20,000 contract with the Portner Brewing Company for the year 1896. The same article also stated that the Virginia Glass Company expanded operations and secured large contracts with pop and beer companies in the south.

The glass directories at the Library of Congress provided specific information on the types of bottles being produced at the Virginia Glass Factory during the years 1900 and later (Section 5). In the early years (1900-1908), the glass factory was producing green and amber bottles for beer, sodas, preserves and medicines. In the later period (beginning in 1914) flint glass and medicinal or druggist wares became their main product. Archeological evidence supports the documentary sources; the majority of bottles and bottle fragments recovered from the Virginia Glass Factory site were pharmaceutical or beverage (including beer and soda) bottles. Of all lip and neck fragments recovered, 53% were probably pharmaceutical, 32% were probably beverage bottles. Whole bottles seem to represent the later period of manufacture at the Virginia Glass factory with 86% of the whole bottles probably pharmaceutical. Only 3 % of whole bottles from the site held beverages.

Archeological excavations recovered one beer bottle produced for the Home Beer Brewing Company in Richmond, Virginia. A rectangular pharmaceutical bottle with embossed lettering that said "The Lewis Bear Drug Co., Montgomery, Alabama, Bear Brand" may also have been manufactured by the Virginia Glass Company. The Virginia Glass Company later established additional contracts with companies north of Alexandria (Alexandria Gazette

12/18/96). Three extract-type bottles that were produced by the Virginia Glass Company for the McCormick Company in Baltimore, Maryland, were recovered during the factory excavations. Another semi-automatic bottle recovered indicates that Virginia Glass may have also been supplying the Northwestern Bottling Works in Washington D.C. All of these bottles fit within the technological type of bottle that was being produced during the operation of the factory. Generally, they were formed in two-part vertical molds with a separate base and hand-tool finished.

What light can be shed on the German community in Alexandria from the study of the Virginia Glass Company?

The founders of the Virginia Glass Company were glass workers of German origin who moved to Alexandria from Royersford, Pennsylvania, in 1893. At the time of their arrival, there were already established communities of Germans throughout the city. Many Protestant Germans migrated to the Alexandria area from Pennsylvania, Maryland, and the western counties of Virginia during the first quarter of the nineteenth century (Wayland 1902). Groups of Jewish Germans entered Alexandria as part of a large migration of Germans from the Bavarian, Baden and Wurttemburg regions of Germany during the 1850s. The Beth El Hebrew Congregation was established as a permanent synagogue in Old Town, Alexandria (Baker 1983).

Nineteenth-century organizations that provided support for German residents and businesses included the German Cooperative Building Association and the Hebrew Benevolent Society. A large number of German immigrants joined the merchant class of the West End community during the nineteenth century. They brought with them many aspects of their culture that were valuable to the community. For example, Alexander Strausz and John Klein, who founded the Shuter's Hill Brewery, produced a lager-style beer that was sold throughout Alexandria.

The founders of Virginia Glass Company left Royersford during the 1893-1894 economic depression in the glass industry that affected glass workers and unions throughout Pennsylvania, New York, New Jersey, West Virginia and Ohio (Scoville 1948). They were experienced glass workers and members of the Glass Blowers Union and they left behind a substantial glass factory in Royersford. A partial list of Alexandria glass workers dating from 1895 states that ten of twelve glassblowers lived on Duke Street, many of them in the same block. Peter Astryke, Henry Astryke, Joseph Ramsey, George Schwartzman, Harry Carmelia, Edwin Earnback, Joseph Mingin and Lorenzo Wolford were among those who lived in the 14th block of Duke Street. These figures suggest that the glass workers at Virginia Glass Company had established a small labor-specialized German community, located just a few blocks from the factory.

By 1907, Alexandria City Directory listed a total of 76 glass workers in Alexandria, attesting to the growth of the glass industry in a few short years. Address information from this directory suggests that the population of glass workers had dispersed throughout both Old Town and West End. All of the glass workers initially residing in the 14th block of Duke Street had moved on, many of them to residences in Old Town. Through acculturation, both the new glass industry and the tightly-knit group of German glass workers became a part of the economic and social fabric of Alexandria.

A great deal can be learned about German immigration and acculturation into the large cities of the Eastern seaboard during the nineteenth-century that is similar to the situation in Alexandria. In Baltimore, for example, the German Society of Maryland was established in 1783. This organization served to protect German immigrants from being sold into slavery and to provide aid for foreigners in a strange country. Even in the eighteenth century, German immigrants demonstrated a work ethic that enabled them to assimilate quickly, along with a cultural ethic that obligated them to reach back and help their own. German immigrants, in particular, brought valuable technical and agricultural skills that eased their entry into the workforce and gradually increased their socioeconomic status within the community. The Virginia Glass Company is a fine example of one of the many successful businesses established by immigrant Germans in the nineteenth century.

10.2 RECOMMENDATION OF SIGNIFICANCE

The significance of a historic property is evaluated in terms of the eligibility criteria established for the National Register of Historic Places. According to the National Register Criteria (36 CFR 60):

> The quality of significance in American history, architecture, archeology, and culture is present in districts, sites, buildings, structures, and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feelings and associations, and
>
> a) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> b) That are associated with the lives of persons significant in our past; or
>
> c) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> d) That have yielded, or may be likely to yield, information important in prehistory or history.

The site of the Virginia Glass Company appears on the basis of the current excavation to be eligible for listing in the National Register of Historic Places. It maintains integrity, and meets three evaluation criteria: A, C, and D.

Criterion A: The Virginia Glass Factory is associated with events that have made a significant contribution to the broad patterns of our history (Criterion A). The factory represents the response of a specific industry to the industrial revolution in the city of Alexandria, Virginia. The archeological remains of the Virginia Glass Factory can be interpreted to demonstrate one aspect of the history of industrialization, from the growth in mechanization that spelled the success of the industry to the demise that resulted from the company's being overtaken by other

firms that built on the technological foundation provided by the Virginia Glass Factory and its employees. The factory also contributes to the story that is the history of the city of Alexandria.

Criterion C: The Virginia Glass Factory embodies the distinctive characteristics of a type, period, or method of construction (Criterion C), an industrial complex during the late-nineteenth and early-twentieth century. The portions of the factory that are intact can provide information on technical engineering regarding the construction and maintenance of early continuous tank furnaces fueled by gas producer technology.

Criterion D: The Virginia Glass Factory has yielded information important in history, meeting the requirements of Criterion D. Because the lowest portions of the factory's ventilation system were filled in rather than being razed, they are in remarkable condition, providing specific details about the construction of the plant that add information to our understanding of this historic factory.

In summary, the Virginia Glass Factory site meets the eligibility criteria for listing in the National Register of Historic Places. It is recommended that it be listed in the National Register.

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