Pillsbury "A" Mill.
Minneapolis, Minn.
Hennepin Co.

HABS No. 29-5-A

HABS
MINN
27-MINAP
3-

Reduced Copies of Measured Drawings

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA
District No. 29

Historic American Buildings Survey
Wm. G. Dorr, District Officer
702 Wesley Temple Bldg.
Minneapolis, Minn.

PILLSBURY "A" MILL.
1880
Main St. & 3rd AVE. S.E.
Minneapolis, Minn.

Built by the Pillsbury Flour Mills Co., when Minneapolis was becoming the greatest flour milling city in the World. Parts of earlier buildings are incorporated in this building.

The building is six stories, built of local limestone. The earlier buildings which made Minneapolis famous as a flour milling city have been destroyed by fire, or torn down, and this is the best remaining unit, typical of this type of building and industry.

Wm. D. Dorr
District Officer.

Reviewed by H.C.F. 1936

ADDENDUM TO
PILLSBURY MILLING COMPLEX, PILLSBURY "A" MILL
116 3rd Street Southeast
Minneapolis
Hennepin County
Minnesota

HABS No. MN-29-5-A

HABS
MINN,
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Buildings Survey
National Park Service
Department of the Interior
Washington, D.C. 20013-7127

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

HABS
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27-MINAP,
3-

ARCHITECTURAL DATA FORM

STATE	COUNTY	TOWN OR VICINITY
Minnesota	Hennepin	Minneapolis

HISTORIC NAME OF STRUCTURE *(INCLUDE SOURCE FOR NAME)*	HABS NO.
PILLSBURY "A" MILL	MN-29-5-A

SECONDARY OR COMMON NAMES OF STRUCTURE

COMPLETE ADDRESS *(DESCRIBE LOCATION FOR RURAL SITES)*
116 3rd Avenue, Southeast

DATE OF CONSTRUCTION *(INCLUDE SOURCE)*	ARCHITECT(S) *(INCLUDE SOURCE)*
1881 (National Register nomination)	

SIGNIFICANCE *(ARCHITECTURAL AND HISTORICAL, INCLUDE ORIGINAL USE OF STRUCTURE)*
Symbolizes the role of Minneapolis as the chief flour-milling center of the United States from 1880-1930. The Pillsbury "A" Mill was the largest, most advanced mill in the world at the time of its completion in 1881. It was a masterpiece of industrail design from*

STYLE *(IF APPROPRIATE)*

MATERIAL OF CONSTRUCTION *(INCLUDE STRUCTURAL SYSTEMS)*
Limestone, 8 1/2 feet thich at foundation, its ashlar walls rising to 2 1/2 feet at top.

SHAPE AND DIMENSIONS OF STRUCTURE *(SKETCHED FLOOR PLANS ON SEPARATE PAGES ARE ACCEPTABLE)*
rectaugular, 175 ft. wide and 115 ft. deep, 6 stories high with basement

EXTERIOR FEATURES OF NOTE
limestone ashlar walls with rounded arched window heads (and windows on the top story), belt course below top story

INTERIOR FEATURES OF NOTE *(DESCRIBE FLOOR PLANS, IF NOT SKETCHED)*

MAJOR ALTERATIONS AND ADDITIONS WITH DATES
In 1912 the interior was repaired, replacing the wooden columns and beams with steel ones. Concrete butresses to stop movement of walls due to vibrations added in 1913. Use of water power to drive mill replaced with electricity in 1950's.

PRESENT CONDITION AND USE
good condition, flour production ceased in "A" mill in 1853, used as flour storage.

OTHER INFORMATION AS APPROPRIATE
*which a standard of all other mills of its time were measured. The production from this mill made Pillsbury the undisputed leader in the flour milling industry.

SOURCES OF INFORMATION *(INCLUDING LISTING ON NATIONAL REGISTER, STATE REGISTERS, ETC.)*
National Register nomination, Stephen Lissandrello, Historian, Landmarks review project, National Park Service, August 1975.
Catalog of National Historic Landmarks

COMPILER, AFFILIATION	DATE
C. Lavoie, Historian, HABS/HAER	Jan. 1989

ADDENDUM TO
Pillsbury Milling Complex, Pillsbury "A" Mill
301 Main Street Southeast
Minneapolis
Hennepin County
Minnesota

HABS No. MN-29-5-A

HABS
MINN,
27-MINAP,
3-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

Historic American Buildings Survey
National Park Service
Rocky Mountain Regional Office
Department of the Interior
P. O. Box 25287
Denver, Colorado 80225

HABS
MINN,
27-MINAP,
3-

HISTORIC AMERICAN BUILDINGS SURVEY

PILLSBURY MILLING COMPLEX,
PILLSBURY "A" MILL

HABS No. MN-29-5A

Location: 301 Main Street Southeast, Minneapolis, Hennepin County, Minnesota.

USGS Minneapolis South Quadrangle, Universal Transverse Mercator Coordinates: Zone 15; 480100:4981060; 480320:4980940; 480260:4980800; 480040:4980940

Present Owner: The Pillsbury Company
Pillsbury Center
200 South Sixth Street
Minneapolis, Minnesota 55402

Present Occupant: The Pillsbury Company

Present Use: Flour Milling

Significance: This mill is the most imposing structure on Main Street. Still operative the mill more than any other building symbolizes the role of Minneapolis as a major U.S. Flour Milling Center from 1880-1930.

PART I. HISTORICAL INFORMATION

A. Physical History:

1. Date of erection: Built in 1880-81.

2. Architect: LeRoy S. Buffington.

3. Original and subsequent owners: Charles A. Pillsbury & Company, now The Pillsbury Company.

4. Contractor: George McMullen.

5. Original plans and construction: The Pillsbury "A" Mill was designed to contain two milling units, each with entirely separate equipment and operating crew. The first to be completed was the east unit, but much of the equipment was delivered and set in place in the west unit while finishing touches were applied on the opposite side.

   On June 15, 1880, the foundation was begun and just five months later, in late October, the building was ready for roofing.

6. Alterations and Additions: In 1920, when installation of a new waterwheel required replacement of several beams, it had been noted that the wooden posts and girders were becoming victims of dry rot.

The north and south walls had become badly cracked due to vibrations caused by the vast amount of milling equipment and an attempt was made to temporarily stabilize the movement of the walls by adding 12" x 12" timbers as diagonal braces. In 1913, C.A.P. Turner, a structural engineer decided that the east wall should be stabilized with monolithic reinforced concrete buttresses on the exterior as it sagged 22" out of alignment. Also, the west wall could then be stabilized by steel struts from the east wall.

B. Historical Context:

The year was 1881 and C.A. Pillsbury & Company, under the energetic direction of Charles A. Pillsbury atonished the milling world with the completion of the largest and most modern flour mill in history. The Pillsbury "A" Mill of Minneapolis was the result of one's determination to lead all others in his profession, combined with the talent, drive and loyalty of those who worked for and with him. The "A" Mill was an industrial and architectural masterpiece, a standard from which all others would be measured and against which all others would compete.

PART II. ARCHITECTURAL INFORMATION

A. General Statement:

1. Architectural Character: The Pillsbury "A" Mill is a six-story limestone structure, 175 feet by 115 feet with a full basement. It is one of the few flour mills at St. Anthony Falls that was designed be an architect.

2. Condition of the Fabric: The building is in fair condition because of the vibration of the milling equipment and lack of maintenance.

B. Description of Exterior:

1. Overall Dimensions: The Pillsbury "A" Mill is a rectangular structure 175 feet by 115 feet.

2. Foundations: The foundations are of Platteville limestone.

3. Walls Construction: The exterior wall thickness varies from 8'-0" thick at the basement to 2'-0" thick at the top of the building.

4. Structure System, Framing: Exterior walls are load bearing stone construction with heavy timber framing on the interior.

5. Loading Platform: This is of timber construction which was added after the building was completed.

6. Chimneys: There are six chimneys on the roof of the building.

7. Openings:

   a. Doorways and doors: There are several doors which have been either bricked in or reduced in opening size. Generally doors and door frames are of wood.

   b. Windows: Typical windows are double hung wood sash each with six panes. The windows on the first five floors were originally equipped with iron shutters.

8. Milling Equipment: In 1912, the mill was equipped with 256 sets of rolls, 18 run of stone, 8 cockle machines on the first floor, 8 brush and 8 cockle machines on the second floor, 8 scourers and 8 separators on the third floor, 10 separators and 8 scourers on the fourth floor, 2 separators on the fifth floor, 180 purifiers on the sixth floor and 15 dust collectors in the attic. Most of this equipment has been removed.

9. Roof:

   a. Shape: The roof is flat with a monitor structure. There are two new metal penthouses for machinery. Roofing is of pitch and gravel construction.

   b. Cornice: The bracketed main cornice on the top floor is of stone.

C. Description of Interior:

1. Floor Plans:

   a. Basement: A transformer vault, the water inlets (which are not in use) and an electrical room.

   b. First Floor: Floor mounted small sifter, ceiling hung Nor-Well Hustler sifter manufactured in Fort Scott, Kansas and Amco Pressure Tank.

   c. Second Floor: There are conveyor belts for the movement of flour bags and there is a staff lunch room in the northwest corner.

   d. Third Floor: There are conveyor belts for the movement of flour bags and flour bins on the south side.

   e. Fourth Floor: Flex-Kleen dust collector, Entoleter centrifugal machine, Allis-Chalmers gyration sifter, Barron stone grinder, Richardson scale, Mikro-Pulsame dust collector and a packing bin.

   f. Fifth Floor: Great Western Manufacturing Co. sifter, Great Western Lure dry granular separator, Great Western Manufacturing Co. sifter and an Entoleter centrifugal machine.

   g. Sixth Floor: There are flour bins.

   h. Seventh Floor: There is an electrical room, monitor, elevator penthouse and a Humphrey man lift.

2. Staircase: There was originally a decorative spiral cast iron staircase in the center of the building which has been removed.

D. Site:

1. General Setting: The building is facing Southeast Main Street with frontage on Southeast Third Avenue.

PART III. SOURCES OF INFORMATION

A. Original Achitectural Drawings: Not Available.

B. Early Views: Photographs are on file at the Minnesota Historical Society, 690 Cedar Street, St. Paul, Minnesota as follows:
MH59, MP3.1P, r29 ca 1885, neg. 2528.
" , " ", r30 ca 1886, " 6740.
" , " ", r40 ca 1895, " 152.
" , " ", r48 ca 1890-1900, neg. 4723.
" , " ", r61 ca 1976, neg. 01613, 12a.

C. Bird's Eye View: Minnesota Historical Society files, MH 59, MP1K, neg. 6868-10.ca.1945.

D. Primary and unpublished sources:

Hennepin Government Center, deed book and probate records, Minneapolis, Minnesota.

E. Secondary and published sources:

1. Hennepin County Historical Society, Hennepin County History, Minneapolis, Minnesota, 1981. pp. 4-11.

2. Philip W. Pillsbury, The Pioneering Pillsbury, 1866-1947, The Newcomer Society of England, by Princeton University Press, pp. 1-5.

3. William J. Powell, Pillsbury Best, A Company History From 1869, The Pillsbury Co., Minneapolis, 1985.

4. Pillsbury, Pillsbury Best Flour, Product Profile, 1960, pp. 4.

5. Ervin Jean, The Twin Cities Perceived, University of Minnesota Press, 1976.

6. Professor Donald R. Torbert, Significant Architecture in the History of Minneapolis, Minneapolis, Minnesota, 1969, pp. 64.

7. Kuhlman, Charles B., The Development of the Flour Milling Industry in the United States, Cambridge, Massachusetts, The Riverside Press, 1929, pp. 16.

8. Engineering Record, Vol. 70, No. 5, August 1914, pp. 6.

9. Philip W. Pillsbury, Pillsbury People, Pillsbury Mills Employee Newsmagazine, November 1955 - October 1956, pp. 15.

Prepared by:
Farid Jean Sabongi and
Robert Shilts
University of Minnesota
April 1987

PART IV. PROJECT INFORMATION

This project was prepared as a class project for Architecture 5143, Historic Building Research and Documentation, a class offered in the School of Architecture and Landscape Architecture at the University of Minnesota, Minneapolis, Minnesota. The class project was prepared under the direction of Professor Foster W. Dunwiddie in cooperation with the State Historic Preservation Office of the Minnesota Historical Society, Saint Paul, Minnesota. Historical data was compiled by F.J. Sabongi and Robert Shilts, University of Minnesota, April 1987.

ADDENDUM TO: HABS MN-29-5-A
PILLSBURY MILLING COMPLEX, PILLSBURY "A" MILL *HABS MINN,27-MINAP,3-*
116 Third Avenue/301 Main Street, Southeast
Minneapolis
Hennepin County
Minnesota

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN BUILDINGS SURVEY
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN BUILDINGS SURVEY

ADDENDUM TO PILLSBURY MILLING COMPLEX, PILLSBURY "A" MILL

This report is an addendum to written historical and descriptive data that was previously transmitted to the Library of Congress.

HABS MN-29-5-A

Location: 116 Third Avenue/301 Main Street Southeast, Minneapolis, Hennepin County, Minnesota
Lat: 44.983679 Long: -93.253434

Significance: The Pillsbury A Mill tunnel system is a contributing feature of the St. Anthony Falls Historic District and the Pillsbury A Mill complex. It is significant under National Register of Historic Places (National Register) *Criteria A*, *C*, and *D*. The Pillsbury A Mill was designated as a National Historic Landmark and listed in the National Register in 1975, and the St. Anthony Falls Historic District was listed in the National Register in 1971.

Several previous studies have outlined the historic significance of the Pillsbury A Mill and St. Anthony Falls Historic District. Reports concerning the Pillsbury A Mill include the National Historic Landmark Nomination for the Pillsbury A Mill, completed in 1975; the Pillsbury A Mill National Register Nomination, also written in 1975; and the 1936 and 1987 Historic American Building Survey (HABS) documentation for the Pillsbury A Mill. Reports regarding the St. Anthony Falls Historic District include a National Register Nomination written in 1971 and supplemented in 1991, and the Historic Preservation Certification Application for the East Bank Mill site. Although discussion of the tunnel is limited, it is considered contributing in several reports, and therefore assumed to be a contributing feature of the overall Pillsbury A Mill complex and St. Anthony Falls Historic District.

The Pillsbury A Mill tunnel is significant under National Register *Criterion A* for its role in the historic development of waterpower at St. Anthony Falls. It is part of the St. Anthony Falls Waterpower Area within the St. Anthony Falls Historic District. This section of the district is significant for its contribution to the patterns of waterpower development at the falls.[1] The tunnel played a major role in the history of east bank waterpower development as the largest direct-drive water power project undertaken by the SAFWPC.

The tunnel is also significant under *Criterion A* for its role in supplying water power to the Pillsbury A Mill, a National Historic Landmark significant for its role as an iconic and influential mill in Minneapolis and the U.S. Minneapolis was the flour milling center of the country from 1880 to 1930, and the Pillsbury A Mill contributed greatly to the city's rise to prominence. It was the largest and most productive mill in the world at the time of its construction, and continued to improve efficiency in the following decades. The Pillsbury A Mill defined the east bank of the Mississippi River, and the massive complex was the most prominent member of the milling community along St. Anthony Falls.

The Pillsbury A Mill tunnel is significant under *Criterion C* for engineering as part of the Pillsbury A Mill complex. It is significant as an integral part of the production system of the Pillsbury A Mill. The mill's architecture and record-breaking production capacity made it the largest mill in the country at the time of construction. Pillsbury hired local architect Leroy S. Buffington to design the mill, making it the only major mill designed by an architect rather than an engineer or builder/contractor. The design and form of the mill, with the primary facade on the long side of the building, made it stand out from vernacular mills, compounding the impressiveness of its size with its architectural design. The Pillsbury A Mill set record production numbers of 5,000 barrels of flour per day soon after construction, and doubled these numbers by 1894. Production continued to increase in subsequent years, hitting 14,000 barrels a day in 1921.[2] The tunnel system played a large role in production. The two identical Pillsbury A Mill machinery units were powered by the two turbines, and production was solely based on direct drive waterpower at the time of construction. Though eventually augmented with steam power, the tunnel

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[1] Don Coddington, *St. Anthony Falls Historic District* (Washington, D.C.: National Register of Historic Places, National Park Service, 11 March 1971), 7-1.

[2] Coddington, 7-8, 27; Robert M. Frame, "The Progressive Millers, A Cultural and Intellectual Portrait of the Flour Milling Industry, 1870-1930, Focusing on Minneapolis, Minnesota" (PhD dissertation, University of Minnesota, 1980), 125.

and turbines continued to support the brunt of the production until the level of productivity necessitated greater steam power supplements after the turn of the century.[3] The turbines supplied power to the mill until 1955.

The Pillsbury A Mill tunnel is also significant under Criterion D as an archeological site that could provide information pertaining to waterpower and milling.[4]

The period of significance for the Pillsbury A Mill tunnel is 1881-1955. It begins with the tunnel's construction date, 1881, and concludes in 1955, when tunnel use was discontinued and the tunnel was blocked off.

A. Character-defining features

Character-defining features are prominent or distinctive visual and physical aspects, qualities, or characteristics that contribute significantly to a historic property's physical character. Features may include form, materials, craftsmanship, engineering design, and structural and decorative details. The following character-defining features of the Pillsbury A Mill have been identified:

- Feature 1: The limestone masonry arch construction continuing uninterrupted from the tunnel intake, around the 90-degree curve about 45 feet northeast of the intake, and extending about 450 feet to the Phoenix Flour Mill tailrace. Though briefly interrupted by the Phoenix Flour Mill tailrace, it continues approximately 150 feet past the tailrace to the edge of the Pillsbury A Mill.

- Feature 2: Design of a complete and intact long tunnel structure and water power system with great integrity extending from the intake under the extension of Second Street Southeast, along Main Street Southeast, through the forebay, drop

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[3] "Local and Personal," *Northwestern Miller,* 18 March 1889; *Minneapolis Journal,* 22 February 1901, 2 December 1901; *Minneapolis Tribune,* 6 December 1910; St. Anthony Falls Water Power Company, "Steam Power House for Pillsbury Flour Mills Company," 27 October 1909; "History of Pillsbury Property Expansion Land and Buildings," available at General Mills Archives, Minneapolis.

[4] Coddington, 8-1; "National Park Service Historic Preservation Certification Application-Part 1 Evaluation of Significance: Accessory buildings to the Pillsbury A Mill, East Bank Mills site," n.d.

shafts, turbine pits, and tailraces, and ending under the Pillsbury A Mill at the Mississippi River.

- Feature 3: The unique underground design and construction of the forebay and turbine pits that included twin 1,200-horsepower turbines.

B. Integrity

The integrity of the Pillsbury A Mill tunnel has been evaluated using the seven aspects of integrity defined in *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*. The seven aspects are: location, design, setting, materials, workmanship, feeling, and association. These aspects affect a property's integrity, or "the ability of a property to convey its significance."[5]

(1) Integrity of location

National Register Bulletin 15 defines location as "the place where the historic property was constructed or the place where the historic event occurred." The Pillsbury A Mill tunnel retains integrity of location because all aspects of the underground system, including intake, main tunnel construction, forebay, sluice gates, drop shafts, turbine pits, and tailraces, remain in their original 1881-1882 location.

(2) Integrity of design

National Register Bulletin 15 defines design as "the combination of elements that create the form, plan, space, structure, and style of a property." The layout and design of the tunnel to carry water from the Mississippi River to the turbines remains intact, reflecting the design of the original construction to power the Pillsbury A Mill. With the exception of the removal of the turbines and secondary trash rack, and blocked intake and turbine pit access stairs, the tunnel retains integrity of design. There does not appear to be any other major alterations to the tunnel system.

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[5] National Register of Historic Places, *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: National Register of Historic Places, National Park Service, 1990), 44–45.

(3) Integrity of setting

National Register Bulletin 15 defines setting as "the physical environment of a historic property." Because the tunnel is underground, and the interior of the tunnel is the significant portion of the structure, its setting has remained intact. The portions of the tunnel facing outside still front the Mississippi River; and the forebay, sluice gates, drop shafts, and turbine pits remain within the Pillsbury A Mill structure.

(4) Integrity of materials

National Register Bulletin 15 defines materials as "the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property." The Pillsbury A Mill tunnel retains original materials with the exception of the removal of the turbines (1992) and trash rack (2013), and added roof support below the 1949 railroad spur (1949).

(5) Integrity of workmanship

National Register Bulletin 15 defines workmanship as "the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory." The limestone tunnel structure has not experienced major changes since construction and remains intact.

(6) Integrity of feeling

National Register Bulletin 15 defines feeling as "a property's expression of the aesthetic or historic sense of a particular period of time." The Pillsbury A Mill tunnel retains integrity of feeling as an underground industrial tunnel with little alteration. Though the tunnel has been blocked off from the river and the turbines have been removed, it retains original physical features, such the arched limestone form, connection to the Pillsbury A Mill and Mississippi River, and a small amount of water. These characteristics convey the feeling of an underground industrial tunnel at its time of construction and use.

(7) Integrity of association

National Register Bulletin 15 defines association as "the direct link between an important historic event or person and a historic property." The Pillsbury A Mill tunnel is largely unaltered; it is still connected to the Pillsbury A Mill and only separated from the

Mississippi River by bulkheads at the intake and tailraces. As such, it clearly conveys its original purpose and relationship with the Pillsbury A Mill and the Mississippi River.

Description: The Pillsbury A Mill complex utilized a direct drive water power system for operation. This section begins with a general description of how a direct drive water power system functioned, and then provides a detailed description of the Pillsbury A Mill tunnel, the principal component of the direct drive water power system.

A. Direct drive water power system

The direct drive water power system has a number of components that, as a system, take advantage of the energy that resulted from water dropping. Such a system has a headrace that carries water horizontally from an intake gate, where water enters from the source at a point that is upriver from where that water source changes elevation. The water is conveyed through the headrace to a vertical drop shaft and through a turbine that operates an intricate system of machinery. After turning the turbine, the water exits the bottom of the drop shaft, flows through the tailrace and re-enters the water source at an elevation below the waterfall.

In the case of the Pillsbury A Mill tunnel system, when it was in operation, the water source was the Mississippi River, and the water entered the headrace at the intake gate located at the East Bank Mill Pond, upriver from St. Anthony Falls. From the intake, water was conveyed through the headrace, located under Main Street Southeast, to the Pillsbury A Mill at the forebay. The headrace also brought water to smaller headraces that served specific mills or auxiliary buildings (e.g. Phoenix Mill and the Pillsbury A Mill Machine Shop). Each mill-specific headrace entered the basement level of a mill where it connected to a vertical drop shaft through a gate, which could be raised or lowered to control the amount of water entering the shaft. The turbine, located in the turbine pit at the bottom of the drop shaft, connected to a drive shaft that extended up through the drop shaft and connected to an intricate system of gears and belts within the mill that transferred the kinetic energy created by the turbine directly to the milling and other equipment. After turning the turbine and exiting the bottom of the drop shaft, the water then flowed out through the tailrace tunnel and emptied into the Mississippi River at an elevation below St. Anthony Falls.[6]

The locations of these various waterpower components associated with the direct drive water power system reflect Minneapolis' particular geology. The headrace is basically located above the layer of limestone bedrock, in the area between the ground surface and limestone bedrock that could be excavated from the surface. The tailraces are below the limestone bedrock, in the layer of relatively soft sandstone that could be excavated by digging horizontally in from the river bluff. The drop shafts extend down through the hard (and difficult to excavate) bedrock layer. See Figure 1 for an illustration of the direct drive water power system.

B. Overview of tunnel system plan and alignment

The Pillsbury A Mill tunnel system was designed and constructed to convey a large, continuous flow of water from the Mississippi River to twin hydraulic turbines located beneath the center of the mill's southwest (front) wall. Water was received at the Mississippi River intake at the tunnel's upriver (northwest) end and conveyed downriver (southeast) through the tunnel headrace to the forebay near the location of the turbines. After passing through the forebay, the flow divided between the two drop shafts, one upriver and one downriver. After passing through the turbines at the bottom of the drop shafts, the water exited directly into two tailraces and returned to the river (see Figure 2 for a site plan of the tunnel system and Figure 3 for a present-day map showing the St. Anthony Falls riverfront along the Mississippi and the location of the Pillsbury A Mill tunnel system).

C. Tunnel headrace

The primary portion of the tunnel, known as the headrace, is a continuous, approximately 600-foot, underground structure beneath Main Street Southeast, that is aligned primarily northwest to southeast. For most of the tunnel headrace's length the alignment parallels

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[6] In Minneapolis's west bank milling district, there was a similar, but more extensive, water power system. There was a main headrace canal with a large gatehouse that controlled the water flow (both of which are still in existence, but buried), from which branched a larger number of mill-specific smaller headraces. There also was a main tailrace that served multiple mills.

the Mississippi River, which is located west/southwest of the tunnel. The northwest end, or tunnel intake, opens onto the river at a point beneath the extension of Second Avenue Southeast. The tunnel headrace then extends about 45 feet northeast, where it curves 90 degrees southeast to an alignment beneath Main Street Southeast. It extends for approximately 450 feet directly beneath Main Street Southeast to the intersection of Third Avenue Southeast and Main Street Southeast.

At the intersection of Third Avenue Southeast and Main Street Southeast, the tunnel headrace turns diagonally northeast on a new alignment adjacent to the southwest wall of the Pillsbury A Mill. It continues straight along the southwest wall of the mill for approximately 110 feet, terminating at the machine shop headrace entrance.

The tunnel is partly cut into existing bedrock, which constitutes the tunnel floor, and partly built-up with sidewall buttresses constructed of limestone block masonry. In some sections the tunnel walls are largely original rock, and in other areas, they are largely built-up limestone masonry.

Yellow brick was randomly placed in voids between bedrock and the built-up limestone masonry along the tunnel walls. The roof of the tunnel is continuous limestone round arch, constructed in two long, unbroken sections. The first arch section extends from the tunnel intake, around the 90-degree curve, to the point where the Phoenix Flour Mill headrace intersects with the tunnel. The arch begins again on the southeast edge of the Phoenix Flour Mill intersection and continues to a point near the southwest corner of the Pillsbury A Mill building. A visible line of keystones extends the full length of each tunnel section. The ends of the two tunnel sections have finished masonry detail with arch rings of voussoir stones. The tunnel is 15 feet, 2 inches wide and 24 feet tall.[7]

The features described below are located along the length of the tunnel headrace, from north (upriver) to south (downriver), and constitute the only notable features in the headrace.

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[7] CNA Consulting Engineers, "Typical Cross-Section Pillsbury A Mill," 19 February 2014.

(1) Tunnel intake

The tunnel intake is located at the extreme upriver end of the tunnel where it opens to the Mississippi River at the location of the old SAFWPC mill pond. The exterior, or river side, of the intake is flanked by short diagonal wingwalls. According to the 1881 tunnel plan, a large pier divides the intake, creating two gateways. When the tunnel system was removed from service, there was either one, extensive bulkhead, or two bulkheads (one that is visible from the exterior and that extends further into the river than the pier at the intake mouth and another one that is visible from the interior of the tunnel) added across the entire entrance to the tunnel system. On the interior side of the intake the concrete bulkhead extends from the floor to the top of the arch, and from wall to wall. A 1-foot by 1-foot opening, now partially closed, is centered in the bulkhead, approximately 5 feet above the floor.

(2) Phoenix Flour Mill headrace intersection

As previously discussed, a portion of the Phoenix Flour Mill headrace, which predated the Pillsbury A Mill tunnel, was incorporated into the Pillsbury A Mill tunnel system. It is aligned perpendicular to the tunnel and intersects with the inland (northeast) side of the Pillsbury A Mill tunnel headrace about 100 feet upriver of Third Avenue Southeast. It extended under Main Street Southeast to the nonextant Phoenix Flour Mill on the northeast corner of Main Street southeast and Third Avenue Southeast. When it was in use, the Phoenix Flour Mill headrace conveyed water through the inland wall of the Pillsbury A Mill tunnel headrace, where it transported water inland to the Phoenix Flour Mill. At the location where the Phoenix Flour Mill headrace was incorporated into the Pillsbury A Mill tunnel, the stone arch of the headrace tunnel terminates on both sides of the tailrace. The Phoenix Flour Mill headrace has a flat roof covered by a rectangular wood plank panel, and the floor is cut slightly deeper in the bedrock than that of the tunnel headrace. The outline of two circular openings to the former Phoenix Flour Mill headrace remain on the inland and riverside (southwest) walls of the Pillsbury A Mill tunnel headrace. The remainder of the headrace, which ran from the east side mill pond to the river side of the Pillsbury A Mill tunnel, was completely blocked off from the Pillsbury A Mill tunnel headrace. The inland and riverside circular openings are nominally 7 feet in diameter and outlined in brick. The inland opening is covered by a deteriorated, circular metal gate that is bolted in place with modern clamps. Timber remnants of the original gate operating mechanism remain on either side of the opening.

The riverside tunnel opening was completely blocked with stone infill at the time of Pillsbury A Mill tunnel construction.

(3) Railroad spur "bridge" imbedded in tunnel roof

The flat tunnel roof that begins at the northwest corner of the Pillsbury A Mill has been reinforced to carry a railroad spur aligned longitudinally directly above the tunnel and along the southwest wall of the mill. In 1949 closely spaced rows of steel I-beams were placed laterally across the top of the tunnel to create the railroad spur "bridge."[8] Some I beams have recently been cut, creating a rectangular opening in the roof to provide access to the tunnel below.

(4) Catch basin lead through the river side wall

A rectangular opening is located high on the river side tunnel wall, opposite the forebay. It appears to have been cut into the stone masonry wall after the tunnel was constructed, and not part of the original masonry wall construction. However, research did not reveal the date this occurred. It reportedly functions as a manhole access tunnel.

(5) Location of nonextant trash rack

A large metal trash rack was located at the downriver edge of the forebay opening, where it originally extended across the width of the tunnel. It was removed in 2013 and remnants of the original metal hardware remain in the tunnel wall.

(6) Headrace bypass

Along the west wall, several feet from the downriver end of the tunnel, the outline of a round tunnel is visible, similar in form to the Phoenix Flour Mill tailrace. It is sealed with a deteriorated circular metal door or gate, similar to the Phoenix Flour Mill tailrace door. Remnants of a gate operating mechanism, including a vertical shaft with central wheel and timbers, remain mounted to the stone masonry tunnel wall above the opening.

(7) Tunnel endwall

A rectangular vertical iron gate is mounted on the endwall, installed to control headrace flow into the machine shop headrace that is located beyond the main tunnel. The tunnel

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[8] Great Northern Railway, "Bridge Over Intake Canal at Pillsbury Flour Mill General Plan," August 1949.

extends beyond the gate into the machine shop headrace, drop shaft, and turbine pit. Remnants of a gate operating mechanism are located on the stone masonry wall above the gate. Remnants of various unidentified pipes and hardware are visible on the inland wall and southeast corner of the tunnel.

D. Forebay

The forebay, located in the middle of the southwest wall of the Pillsbury A Mill, is a very large space, enclosed on three sides and open to the tunnel on the fourth side. The space is approximately 21 feet by 24 feet. The top of the forebay is open to the interior of the mill basement. The forebay directed water flow from the headrace into the two drop shafts. (The upper part of the forebay is visible inside the basement as a rectangular structure of thick, buttressed, stone-masonry walls extending into the basement area from the west wall of the mill.) In the tunnel area, the forebay is accessed through a wide arched opening in the tunnel's inland wall. The lower sections of the arch, beginning at the tunnel floor and extending upwards, are faced with brick, creating battered brick corner piers with rounded corners. The brick is fastened to the stone arch with metal bolts. The back, or northeast, wall of the forebay is also sheathed in brick, which is severely deteriorated and contains remnants of unidentified wall-mounted hardware. A recently installed metal access ladder at the northwest corner extends from the forebay floor to the forebay top and into the interior of the basement.

(1) Sluice gates

On the upriver and downriver walls of the forebay, 6.5-foot by 10-foot metal vertical sliding gates open onto the drop shafts and turbine pits. Each wall has a pair of metal gates and each gate was independently operated. Remnants of the timber beam framework surrounding the gates, and gate operating systems, are visible above each pair of gates. The sluice gate mechanisms extended into the basement of the Pillsbury A Mill through the upper portion of the forebay; however, these mechanisms no longer remain in place.

E. Drop shafts and turbine pits

Beyond the gates, brick archways open onto rooms with drop shafts and turbine pits in the floors. The drop shafts appear to be metal-lined. Though the turbines were removed in 1992, the turbine rings remain in place at the bottom of the turbine pits, above the exits to the tailraces.

(1) Turbine service rooms

Adjacent to each drop shaft and turbine pit is a turbine service room. The rectangular upriver turbine service room is northwest of the upriver turbine pit, and the L-shaped downriver turbine service room is southeast of the downriver turbine pit. These rooms have concrete walls and a deteriorated iron access stairway and ramp leading up to the basement. The turbine service rooms are filled with remnants of original unidentified hardware and metal fittings and debris. The upriver turbine service room opens to the drop shaft turbine pit through a round opening; however, such an opening in the downriver service room is unconfirmed due to debris.

At an unknown date, the basement floor openings to the access stairways and ramps were sealed with corrugated steel panels covered with concrete. In recent years, however, two small rectangular holes were cut through the concrete above each turbine service room to allow limited access from the basement.

F. Tailraces

The two tailraces run diagonally from northwest to southeast under Main Street Southeast and on to the river. The machine shop tailrace empties into the downriver tailrace south of the turbine pit. The upriver tailrace exit at the Mississippi River is blocked by a steel bulkhead with an access door, while the arched downriver tailrace exit is open to the river.

History: In 1881-1882 the St. Anthony Falls Water Power Company constructed the Pillsbury A Mill tunnel system along the east bank of St. Anthony Falls in Minneapolis. The company built the tunnel system to convey water to power the Pillsbury A Mill, the largest and highest producing flour mill of its time. The Pillsbury A Mill, built by C.A. Pillsbury & Company, was the company's flagship mill to substantially increase the company's capacity provided by other mills, including the Pillsbury B Mill on the west bank of the Mississippi River.[9] The Pillsbury A Mill's productivity was due in part to the excellent water power conditions created by St. Anthony Falls. The Mississippi River falls 70 feet at St. Anthony Falls, and the tunnel system took advantage of this energy source by carrying water from the intake at the east bank mill pond approximately 550 feet downriver to the Pillsbury A Mill to power the mill's machinery. The water ran through the tunnel system, down drop shafts, and into turbine pits, where it powered the turbines. The energy created by the turbines was directly transferred to mill equipment. This type of water power is called direct drive water power, so called because the turbines directly powered the mill machinery instead of storing the power as electricity.[10] See Section A of the Description section above for a more detailed description of the direct drive water power system. Figure 3 shows a present-day map that identifies the approximate location of the Pillsbury A Mill and its tunnel system, as well as nearby popular landmarks to facilitate readers' understanding of the St. Anthony Falls and Pillsbury A Mill area.

Due in large part to the importance of the Pillsbury A Mill, C.A. Pillsbury & Company and its successor companies, which were headquartered in Minneapolis, became one of the leading flour milling and food products companies in the United States. In 1975 the Pillsbury A Mill, including the associated tunnel system, was designated as a National Historic Landmark. It is also a contributing feature of the St. Anthony Falls Historic District, which was listed in the National Register of Historic Places (National Register) in 1971.

A. Historical background and context

(1) Early settlement along St. Anthony Falls

St. Anthony Falls is the only natural waterfall along the Mississippi River. The steep river drop created an ideal site for waterpower development, and as early as the 1820s

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[9] Letters were assigned to mills based on the hierarchy in the milling operations; they were not necessarily assigned in a chronological order. The letter "A" was reserved for a company's flagship mill.

[10] Louis C. Hunter, *Waterpower, A History of Industrial Power in the United States, 1780-1930 vol. I,* (Charlottesville, Va.: University Press of Virginia, 1979), 274.

settlers took advantage of the falls to power mill sites.[11] The first settlement near the falls area was Fort Snelling, a government outpost constructed between 1820 and 1823 under the direction of Colonel Josiah Snelling. Fort Snelling is located at the junction of the Minnesota and Mississippi Rivers about 9 miles downriver from St. Anthony Falls. The fort had jurisdiction over the falls and constructed the first saw and grist mills on the west bank by 1823.[12]

In 1837 the U.S. government opened the east bank of the Mississippi for settlement, while the west bank remained under control of Fort Snelling. Franklin Steele purchased land and the adjoining water rights along the falls, and constructed a timber dam, saw mill, and flour mill over the next 20 years. He also platted the town of St. Anthony along the east bank in 1849.[13] Meanwhile, Robert Smith leased the Fort Snelling mills along the west bank of the river in 1848 and purchased the land and water rights when the west bank opened to settlement claims in 1852. In 1854 the town of Minneapolis was founded along the west bank.[14] In subsequent decades, milling districts developed in both St. Anthony and Minneapolis; however, the east and west banks developed along different timelines and utilized different water power distribution approaches.

(2) The development of the Minneapolis Mill Company and St. Anthony Falls Water Power Company

In 1856 Franklin Steele founded the St. Anthony Falls Water Power Company (SAFWPC) on the east bank and Robert Smith founded the Minneapolis Mill Company on the west bank. Each company constructed a mill pond to receive water and supply its own water power system. The two companies cooperated to construct the St. Anthony Dam, which directed part of the river flow into the mill ponds on either side of the river.[15]

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[11] Lucile M. Kane, *The Falls of St. Anthony* (St. Paul: Minnesota Historical Society, 1987), 1-7; Louis C. Hunter, *Waterpower, A History of Industrial Power in the United States, 1780-1930* vol. I (Charlottesville, Va.: University Press of Virginia, 1979), 233.

[12] Minnesota Historical Society, "Timeline," *Mill City Museum*, www.millcitymuseum.org/timeline (accessed 6 February 2014).

[13] Coddington, 8-1; the town of St. Anthony was absorbed into Minneapolis in 1872.

[14] Coddington, 8-1.

[15] Kane, 42-44.

After the dam was constructed, the Minneapolis Mill Company successfully established the Lowell model of water power distribution, which involved construction of a single power canal fed by the mill pond. This allowed for construction of mills on either side of the canal. The company then leased water power usage to mill companies. Each mill company constructed their own headrace and tailrace along the canal.[16] The Minneapolis Mill Company constructed the west side power canal in 1857 and began selling land along the canal to mill companies. By 1869 the waterfront along the canal was crowded with mills.[17]

The east bank developed more slowly. Plagued by internal struggles and financial difficulties, the SAFWPC failed to complete construction of a power canal for several decades. Though the SAFWPC attempted to construct a canal in 1866, work halted after it encountered a cave. This canal was named "Chute's tunnel" after the company manager Richard Chute. It extended from the bluff near Fifth Avenue Southeast to Main Street Southeast, where it ran under Main Street until it ended at the cave. Construction ceased, and for a time SAFWPC allowed a private party to operate Chute's Cave for tourism. Without a power canal, the SAFWPC had to transfer power to mills through a system of ropes and shafts running from turbine installations on the dam. Years later, in 1874, canal construction began again, but instead of completing the power canal, a segment of Chute's tunnel became part of the tailrace for the newly constructed Phoenix Flour Mill.[18]

After several decades of hardship, including lawsuits, debt, and fires, the original SAFWPC owners sold out to Minnesota railroad entrepreneur James J. Hill in 1880.[19] After Hill purchased the SAFWPC, he sought to harness and distribute water power more efficiently and revitalized plans to construct a power canal along the eastern waterfront. However, due to an existing commitment to provide power to the proposed Pillsbury A Mill, the company constructed a shorter tunnel, rather than open canal, directly to the mill

[16] The Lowell model is described in Hunter, 204-227; Kane, 53-54.

[17] Kane, 53-54, 59.

[18] Coddington, 7-56, 57.

[19] Kane, 7-56.

in 1881.[20] This arched limestone tunnel system running beneath Main Street Southeast became known as the Pillsbury A Mill tunnel.[21]

Lacking an accessible canal, the east bank looked very different from the west (see Figure 4). The west bank had a densely developed mill row along the Minneapolis Mill Company power canal, while east bank development remained limited. By 1893 only two flour mills were located on the east bank: the Pillsbury A Mill and the smaller Phoenix Flour Mill. The four-story, limestone Phoenix Flour Mill was built in 1875 by Stamwitz and Schober. Though it pre-dates the Pillsbury A Mill, it was eventually incorporated into the Pillsbury Company and converted to a rye mill.[22] With the exception of these two flourmills, the east bank remained relatively undeveloped. The west bank, by contrast, was crowded with flour mills. The Minneapolis Flouring Mill, Pillsbury B Mill, Excelsior Mill, Northwestern Roller Mill, Pettit Mill, Zenith Mill, and Galaxy Mill were built side by side along the Minneapolis Mill Company canal. Farther inland the Washburn C Roller Mill, Washburn A Mill, and Crown Roller Mill were only a few of the many other milling operations, which included saw mills, a paper mill, and a woolen mill.

The contrast between the east and west banks of St. Anthony Falls reflects the different approaches each company had to water power distribution. The easily accessible west bank power canal constructed by the Minneapolis Mill Company allowed for many mills to operate along the river bank. Across the river, the SAFWPC constructed a tunnel with

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[20] "Local and Personal," *Northwestern Miller*, 11 March 1881. Charles Pillsbury, the founder of the Pillsbury Company, had been involved in Minneapolis milling for 10 years prior to the construction of the Pillsbury A Mill. After investing in several mills independently, Charles formed C.A. Pillsbury & Company in 1871. The company continued to lease and remodel mills over the next decade. Notable Pillsbury mill renovations from the 1870s included the Empire Mill and the Pillsbury B Mill, formerly known as the Alaska Mill. After researching milling techniques and gaining years of experience, Pillsbury constructed the Pillsbury A Mill in 1881. *A History of Pillsbury's "A" Mill,* Minnesota: n.p., n.d.

[21] Kane, 123; most historic resources refer to the Pillsbury A Mill tunnel as a canal, though it is a completely enclosed underground space. The term "canal" was generally used for both east and west water supply systems in historical documents.

[22] Coddington, 7-57.

restricted accessibility dedicated largely to the operation of a single mill. There was little opportunity for other mills to access the power tunnel, resulting in limited industrial growth along the east bank.

(3) The Pillsbury A Mill and Minneapolis milling

The St. Anthony Falls milling industry was originally dominated by saw mills, with a variety of other small industrial facilities present. However, throughout the 1870s and 1880s the saw milling industry slowly moved to north Minneapolis and flour mills came to dominate St. Anthony Falls.[23]

Charles A. Pillsbury was one of the most prominent flour mill entrepreneurs in Minneapolis. He began acquiring mills along the Minneapolis waterfront in 1869 and, with others, promoted new technological innovations that allowed for successful spring wheat milling. Charles formed the C.A. Pillsbury & Company in 1871, and several family members joined his company, including his brother Fredrick and uncle John. The company continued to invest in the industry over the next decade, and in 1880 Charles, Fredrick, and John purchased several east bank parcels along Main Street Southeast and began construction of the mammoth Pillsbury A Mill. The Pillsbury A Mill was intended to be the company's flagship mill. Designed by Minneapolis architect LeRoy S. Buffington, the mill was 175 feet wide and 115 feet deep, with a total height of 187 feet. The construction was completed in 1881 at a cost of $500,000. At this time it was the largest mill in the world, producing 4,000 barrels of flour a day.[24]

As the Minneapolis flour milling industry flourished in the late nineteenth century, it also experienced a period of consolidation. In 1876 there were 17 firms operating 20 mills. By the early twentieth century, only three major corporations owned most of the flour milling operations in Minneapolis: Washburn-Crosby (later General Mills), Pillsbury-Washburn (later the Pillsbury Company), and Northwestern Consolidated Milling. Minneapolis became the center for flour milling in the U.S., and led the industry from 1880 until 1930.[25]

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[23] Kane, 115.

[24] A History of Pillsbury's "A" Mill.

[25] Coddington, 8-6. Minnesota Historical Society, "Timeline."

Over these decades, the Pillsbury A Mill remained the largest mill in the world. Production rose to 5,000 barrels a day in the fall of 1882 and 7,000 barrels a day by 1886. By the mid-1890s capacity had reached 9,000 barrels a day, and production increased to 16,113 barrels a day by 1905. The Pillsbury Company achieved this increase in production numbers through updated technology and additions to the mill. As time passed many technological changes increased the productivity of mill machinery. Other improvements included turbine replacement in 1901, and the gradual addition of steam power over the next few decades.[26]

By 1930, however, the era of Minneapolis milling dominance had ended and companies moved their operations to new milling centers in Kansas City, Chicago, and Buffalo, New York. Factors such as changes in regional wheat quality, increased freight rates, and unfavorable tariff policies led to the downturn in the milling industry.[27] Mills gradually closed as the hydroelectric industry expanded along the river. Soon hydroelectric power generation replaced milling as the dominant industry at the falls. As the milling industry moved to other cities, the Pillsbury A Mill remained one of the few mills at the falls. After the Washburn Mill closed in 1975, it was the last operating mill until it closed in 2003.[28]

B. Chronology of Development and Use

(1) Pillsbury A Mill tunnel system construction

Concurrently with construction of the Pillsbury A Mill, the SAFWPC began construction of the tunnel system to bring water to the mill. Because the east bank did not have a

[26] "Improvements to Pillsbury A Mill," *Minneapolis Journal*, 2 December 1901; 8 December 1913; C.A.P. Turner, "Alterations to Pillsbury A Mill," Plans Prepared for the Pillsbury A Mill, 13 February 1912. In 1912 the Pillsbury A Mill required the addition of eight large concrete buttresses, designed by noted engineer C.A.P. Turner, to reinforce the mill's east wall; the structure was shifting due to unexpectedly severe vibrations from turbine activity. During these alterations, a steel skeleton was also built into the plant to minimize vibration effects, replacing the previous timber beam construction.

[27] Coddington, 8-7.

[28] Jim Buchta, "Pillsbury A Mill Renovation Project is Back, on a New Track," *Star Tribune*, 30 October 2013.

power canal, the SAFWPC agreed to construct an underground power tunnel directly to the Pillsbury A Mill. The large mill was designed to be run by twin water turbines, each powering half of the mill's machinery.[29] The Pillsbury A Mill tunnel system carried water from the east bank mill pond to the turbine drop shafts and turbine pits, located below the mill's basement, before channeling it back through two tailraces southwest of the mill. Due to the large scale of the project, the construction of the tunnel system was of great interest to the community, and was well documented by local papers such as the *Minneapolis Tribune* and *Northwestern Miller.*

As construction of the Pillsbury A Mill rapidly progressed, the SAFWPC scrambled to start building the tunnel system in January 1881. Early in January, workmen were already deepening the older tunnel, even before the city council gave official permission to begin construction. The excavation was already 4 feet deep in less than a month, and 10 feet deep a few more weeks later. Construction of the headrace, coffer dam at the tunnel entrance, and tailraces was well under way by mid-February, and the excavation reached 20 feet by mid-March. At that point construction crews reached a bed of limestone, which had to be quarried out to reach the desired depth.[30]

Though the tunnel system construction employed at least 500 men, it caused nearby businesses difficulties. Early in construction, the already operating Phoenix Flour Mill had trouble receiving wheat deliveries because of the torn up streets, causing it to shut down intermittently. As the tunnel system construction progressed, the Phoenix Flour Mill and nearby North Star Grist Mill completely shut down for six to eight weeks due to limited accessibility.

At the end of March, the SAFWPC modified the original plans and widened the tunnel. Plans submitted in February 1881 to the U.S. Engineer Office indicated tunnel measurements would have been 14 feet wide and 24 feet deep. These plans show the

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[29] *A History of Pillsbury's "A" Mill*; the twin turbines were 1,200-horsepower, 55-inch Victor water turbines.

[30] "Local and Personal," *Northwestern Miller,* 7 January 1881, 21 January 1881, 4 February 1881, 18 February 1881, AND 11 March 1881.

masonry arch form of the tunnel and the geologic formations surrounding the tunnel.[31] Although the *Northwestern Miller* reported the tunnel would be widened to 16 feet, 2014 measurements document a final width of 15 feet, 2 inches. The newspaper also reported the tunnel would be about 32 feet deep, though 2014 measurements indicate the tunnel is 24 feet deep, following earlier plans.[32]

As March drew to a close, workers started laying the stone walls of the tunnel, beginning at the end closest to the Pillsbury A Mill. The *Northwestern Miller* reported on the chaos of the construction site: "a great number of teams hauling earth and brick and stone to and from the canal must be added to the hundreds of wood carts and heavily loaded lumber wagons hauling off the freshly cut lumber."[33] In early May, despite setbacks after the river washed away a portion of the coffer dam, the walls and tunnel intake were almost complete and construction of the structure's arch roof began.[34]

In late June arch construction was complete, and the SAFWPC tested the structure by letting a small amount of water through the tunnel. By July 1 the main tunnel and upriver tailrace were finished and the Pillsbury A Mill leased 10 millpowers of water from the

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[31] The full report, written by W.S. Morton, was not located during research at the U.S. Army Corps of Engineers Office Library. W.S. Morton worked for the Corps under Col. Farquahar and Major Allen as an assistant engineer in St. Paul until April 1881, when he formed his own civil engineering firm with V.D. Simar; "Personal," *Engineering News*, 23 April 1881.

[32] *Northwestern Miller*, 1 April 1881; 8 April 1881; *Cross Section of Canal in Process of Construction by the St. Antony Falls Water Power Company*, 19 February 1881, http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10691 (accessed 14 February 2014).

[33] "A Busy Scene," *Minneapolis Tribune*, 6 May 1881.

[34] "Local and Personal," *Northwestern Miller*, 22 February 1881, 1 April 1881, 29 April 1881, 6 May 1881, and 20 May 1881.

SAFWPC. Flour production began a few weeks later.[35] The Phoenix Flour Mill also began using the tunnel. It had previously used a short headrace from the east side mill pond, but after the Pillsbury A Mill tunnel system was complete, it utilized the Pillsbury A Mill tunnel and upriver tailrace.[36]

While tunnel construction was ongoing, the Pillsbury A Mill was constructed in two phases. The mill was designed to run with two independent units of machinery, and each unit was installed during a different phase of construction. During the first phase, the Pillsbury Company constructed the mill building and installed the upriver machinery unit. The SAFWPC finished the main tunnel and upriver tailrace in time for the Pillsbury A Mill to begin production with its upriver unit of the mill machinery.[37]

Though the main tunnel and upriver tailrace were finished in July, construction continued on the second phase, which included the downriver tailrace and installation of the second unit of the mill machinery. Construction had gone without major setbacks up to this point, but in August troubles began stalling the project. The *Northwestern Miller* reported a hole sprung in the finished, upriver tailrace, which shut down the Pillsbury A Mill for several weeks.[38] An assessment of the tunnel's condition revealed the floor of both the turbine pits and the tunnel were too weak. Over the next few months, production at the Pillsbury A Mill and the Phoenix Flour Mill ceased as the SAFWPC fixed the problem by rebuilding the tunnel floor and replacing the original 12-inch plank with

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[35] Kane defines a millpower as "the amount of power that could be derived from 30 cubic feet of water per second used on a twenty-two food head. Theoretically, this volume and head would create seventy-five horsepower," Kane, 55; "Local and Personal," *Northwestern Miller*, 1 July 1881 and 15 July 1881; J.T. Banker, "Location of Center Line of Main St. at Second Ave SE," 8 May 1891, Northern State Power Company Records of Predecessor Companies; Minnesota Title Insurance and Trust Co., "Abstract of Title to Lots 13, 14, 15, and 5 Feet Lot 16 Near Lot 15 of Block 5 St. Anthony Falls."

[36] "Local and Personal," *Northwestern Miller,* 8 April 1881; Kane, 122; Coddington, 7-57.

[37] "Local and Personal," *Northwestern Miller,* 8 April 1881; Kane, 122; Coddington, 7-57.

[38] "Local and Personal," *Northwester Miller,* 12 August 1881.

heavier plank.[39] The turbine pit floor was reconstructed using concrete, timbers, and boiler iron to ensure protection from leakage.[40]

In the fall of 1881, after the tunnel floor was rebuilt, the finished half of the Pillsbury A Mill resumed production, while construction continued on the second unit of the mill machinery and the downriver tailrace. At times throughout 1881 and 1882 construction required the productive half of the Pillsbury A Mill and the Phoenix Flour Mill to shut down.

In January of 1882, as construction continued, the North Star Grist Mill took advantage of the tunnel and constructed a tailrace connecting to the Pillsbury A Mill tailrace. Six months later work on the downriver half of the mill and downriver tailrace was complete. That summer, the Pillsbury A Mill, powered by direct-drive water power through the completed Pillsbury A Mill tunnel system, began full production.[41]

(a) Construction materials

Though little is known about the origins of the stone used to construct the tunnel, stone construction of nearby projects may provide insight. Located just below the falls, the Stone Arch Bridge was designed for James J. Hill by bridge engineer Col. Charles C. Smith and constructed by the Minneapolis Union Railway Company between 1881 and 1883. Smith utilized Kasota limestone and St. Cloud granite to construct the imposing bridge spanning the Mississippi. The granite came from Sauk Rapids, and the limestone was quarried at Mankato, Minnesota, and Stone City, Iowa. Unexposed limestone was quarried on site.[42] These same limestone varieties may have been used in the construction of the Pillsbury A Mill tunnel, which occurred around the same time. A *Northwestern Miller* article detailing construction progress on the tunnel explains, "the excavators are now about 20 feet deep the whole length of the canal, at this depth the

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[39] "Local and Personal," *Northwestern Miller*, 19 September 1881.

[40] "Local and Personal," *Northwestern Miller*, 26 August 1881.

[41] "Local and Personal," *Northwestern Miller,* 18 November 1881 and 2 January 1882; *A History of Pillsbury's "A" Mill.*

[42] Mead & Hunt, "Stone Arch Bridge," Minnesota Historic Property Record, 2006, http://www.dot.state.mn.us/historicbridges/pdf/27004MHPR.pdf (accessed 31 January 2014).

limestone is reached and there will be from five to ten feet of this to be quarried out."[43] Since none of the tunnel was meant to be exposed, and did not need to be constructed of a higher quality material, it is possible the limestone quarried out during excavation was used to construct the tunnel system. The off-site quarries from which materials were obtained for the Stone Arch Bridge are another possible source of limestone, as both structures were built for the same owner, James J. Hill, within one year of each other.

(b) The Pillsbury A Mill tunnel during the peak of Minneapolis milling

As mill productivity increased and water power became less reliable due to seasonal low water levels, the Pillsbury A Mill added auxiliary steam power to supplement direct drive water power. Minneapolis was experiencing a water power shortage at the beginning of 1884, prompting the Pillsbury Company to install auxiliary steam engines in the Pillsbury A Mill by the end of February.[44] Although the Pillsbury A Mill had steam power engines to augment the water power, it still relied primarily on the tunnel for direct drive water power.[45]

In 1887 the Minneapolis Mill Company and SAFWPC both came under the ownership of the Pillsbury-Washburn Flour Mills Company, Ltd. The new owner worked to increase power output to mills and began building a major hydroelectric site at the falls.[46] William De la Barre, engineer for the company, began a series of measures that would promote efficient consumption of the limited water power supply. The company dredged out the east side mill pond, repaired dams, maintained water levels in the mill ponds, and enforced water power lease amounts. Barre's efforts preserved water power availability for the mills.[47]

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[43] "Local and Personal," *Northwestern Miller,* 11 May 1881.

[44] "The Minneapolis Mills in 1884," *Northwestern Miller,* holiday edition 1884-1885; Kane, 119.

[45] *Minneapolis, Minnesota, vol. 2* (New York: Sanborn Map and Publishing Co., 1885), http://sanborn.umi.com.ezproxy.hclib.org/mn/4339/dateid-000001.htm?CCSI=8887n (accessed 25 February 2014).

[46] Kane, 146; *Minneapolis Tribune,* 14 May 1895.

[47] Kane, 146-149.

By the early twentieth century the Pillsbury A Mill required greater power to increase productivity. In 1901 the SAFWPC deepened the downriver tailrace in conjunction with the installation of new 2,500-horsepower, 56-inch Sampson water turbines. However, the new turbines alone did not produce enough power, and later that year the company added a new steam plant to the mill. Over the next decade, steam engines increased power to the Pillsbury A Mill, and in 1909 the SAFWPC constructed a steam powerhouse for the mill. Ten years later steam lines were added to the tunnel.[48]

(c) The decline of water power and Pillsbury A Mill tunnel use

In 1923 the Northern States Power Company acquired the Minneapolis Mill Company and the SAFWPC from the Pillsbury Flour Mills Company, the successor company of Pillsbury-Washburn Flour Mills Company, Ltd., which also owned the Pillsbury A Mill and tunnel system. The Northern States Power Company became the primary supplier of electricity to the Twin Cities and communities in surrounding states, and St. Anthony Falls was an important part of Northern State Power Company's hydroelectric developments. The new owner utilized the falls for electrical power generation, using less and less water to power turbines at the mills. However, the Pillsbury A Mill tunnel system remained in use, bringing direct drive water power to the mill.

Over the next few decades, milling along the falls declined as distribution and consumption patterns, freight rates, and the availability of spring wheat drove millers to construct new mills elsewhere. By 1930 Buffalo, New York, was the flour milling center of the country. However, some large mills continued to operate in Minneapolis, including the Washburn A and Pillsbury A Mills.

The Pillsbury A Mill tunnel underwent a few alterations during the mid-twentieth century. In 1949 plans for a Great Northern Railway rail spur on the southwest side of the Pillsbury A Mill were approved. The railroad spur crossed over the Pillsbury A Mill

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[48] "Local and Personal," *Northwestern Miller,* 18 March 1889; "More Power for Pillsbury A," *Minneapolis Journal,* 22 February 1901;"Improvements Pillsbury A Mill," *Minneapolis Journal,* 2 December 1901; "Electric Mill Power May Supersede Steam," *Minneapolis Tribune,* 6 December 1910; St. Anthony Falls Water Power Company, "Steam Power House for Pillsbury Flour Mills Company," 27 October 1909; "History of Pillsbury Property Expansion Land and Buildings," available at General Mills Archives, Minneapolis.

tunnel, and a portion of the tunnel roof was reinforced with a series of closely spaced metal I-beams to carry the weight. Basic tunnel maintenance continued, and in 1951 a concrete pier was built to reinforce the ledge above the downriver tailrace.[49]

After using direct drive water power for more than 70 years, the Pillsbury A Mill switched completely to electrical grid power in 1955. As the company installed large motors, the tunnel was no longer needed to transport water to the turbines. As a result, the tunnel was blocked off at the river intake, and the upriver tailrace was converted to a storm sewer for the city of Minneapolis. Two years later the SAFWPC officially dissolved, and the separate water power firms on the east and west banks of the river combined to form the St. Anthony Hydro Division of the Northern States Power Company.[50] By the mid-twentieth century few mills remained in operation along the falls. After the Washburn A Mill closed in 1965, the Pillsbury A Mill was the last operating flour mill in the area.

Since the tunnel was no longer in use, only general maintenance activities affected the tunnel during the mid- and late twentieth century. The turbines were not removed until 1992 in preparation for the sale of the Pillsbury A Mill. No further activity or maintenance is recorded until debris removal began in 2013.[51] Presently, the owner of the Pillsbury A Mill complex, which includes the tunnel system, is actively redeveloping the Pillsbury A Mill complex into residential housing units for artists.

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[49] Kane, 171; Great Northern Railway, "Bridge Over Intake Canal at Pillsbury Flour Mill General Plan," August 1949; Office of the Inspector of Buildings, "Permit to Build Outside of Fire Limits No. B324320," 24 October 1951; "A Mill – Minneapolis," timeline available at General Mills Archives, Minneapolis.

[50] Kane, 174; "Archaeology of the Central Minneapolis Riverfront," *The Minnesota Archaeologist* 48 (1989): 109.

[51] Buchta, "Pillsbury A Mill Renovation Project is Back, on a New Track."

(d) Pillsbury A Mill Tunnel construction summary, 1856-2014[52]

1856 Franklin Steele forms the SAFWPC.

1880 James J. Hill acquires the SAFWPC.

1881 The SAFWPC constructs the Pillsbury A Mill tunnel.

1885 First reference to auxiliary steam power usage at Pillsbury A Mill.

1901 The SAFWPC widens the downriver tailrace and installs new 2,500-horsepower, 56-inch Sampson water turbines to replace the original 1,200-horsepower, 55-inch Victor water turbines.

1919 Steam lines and electrical cables are added to the Pillsbury A Mill tunnel.

1951 A concrete pier is constructed to reinforce the ledge over the downriver tailrace.

1955 Water power use is discontinued at the Pillsbury A Mill and a bulkhead is installed at the tunnel intake to block off the tunnel. The downriver tailrace is used as a storm sewer. The Mill is now powered entirely by electricity.

1962 Alterations are made to the tunnel (alterations not specified).

1992 The turbines are removed. Pillsbury A Mill is sold to Archer Daniels Midland.

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[52] Sources consulted to compile the construction history of the Pillsbury A Mill Tunnel include articles from the *Northwestern Miller*, *Minneapolis Journal*, and *Minneapolis Tribune*, Lucile Kane's history, *The Falls of St. Anthony*, City building permits for the tunnel, *Minneapolis, Minnesota, vol. 1,* New York: Sanborn Map and Publishing Co., 1885, the *Minnesota Archeologist* Journal, the St. Anthony Falls Historic District National Register Nomination, the Historic Preservation Certification Application for the East Bank, and various maps.

2003 All production at the Pillsbury A Mill is shut down.

2013 The Pillsbury A Mill is acquired by Dominium after ownership is transferred several times since 1992.

2013-2014 The tunnel is cleaned out in preparation for inspection and evaluation.

Geological Assessment: Based on existing records, the top half of the tunnel lies in soil overburden and the bottom half lies in bedrock as shown in Figure 5.

The Overburden most likely consists of sandy fill and glacially deposited sand and gravels with boulders.

The Platteville Formation is the uppermost bedrock at the site and consists of four members described below and shown in the tunnel section in Figure 5:

- The upper 6- to 8-foot-thick Magnolia member is a fossiliferous, finely crystalline dolomite.
- The middle 4- to 8-foot-thick Hidden Falls member is a massive, argillaceous, finely crystalline dolomite.
- The 10- to 13-foot-thick Mifflin member is a dolomitic limestone with crinkly-bedded shale partings. The tunnel floor lies in this member.
- The thin (10- to 16-inch) basal member, the Pecatonica, is a finely crystalline dolomite.

The unconfined compressive strength of unweathered rock in the Platteville formation typically ranges from 9,000 psi to 35,000 pounds per square inch (psi). The Hidden Falls member generally has the lowest compressive strength in tests on intact core, followed by the Mifflin, Magnolia, and the Pecatonica, respectively. Historical drawings produced by the Corps of Engineers label the upper 8 feet of the Platteville as "disintegrated limestone." This could mean that this rock was weathered enough that it could be excavated without blasting.

The Glenwood Shale separates the basal layer of the Platteville limestone and the underlying St. Peter sandstone. It consists of a series of beds of soft, argillaceous, and sandy shale grading upwards to harder, shaley, dolomitic layers. The contact between the Glenwood and the Platteville limestone is distinct and irregular over a zone of 0 to 2 inches. The lower Glenwood is transitional into the St. Peter sandstone.

The Glenwood shale tends to weaken and slake off when exposed by excavation. It does form a relatively impervious layer so that water in the overlying limestone is commonly perched above it.

Unconfined compressive strength of Glenwood shale has been found to be as high as 7,200 psi. However, considerably weaker shale occurs in layers in the formation.

The St. Peter Sandstone is a low-strength quartz sandstone. Most of the St. Peter sandstone is uniform, white, and friable sandstone and typically contains more than 98 percent silica. The sand grains are nearly all 0.15 to 0.4 millimeters in diameter. The larger grains are rounded, frosted, and pitted, while the smaller grains are more angular and form interlocking aggregates. Minor amounts of clay minerals and carbonates provide some cementing strength, but most of the strength is believed due to compaction and interlocking.

Water moving along a sandstone joint can erode the friable sandstone, and, where the loosened sand can migrate, voids may develop. Voids have been known to form near or next to lined tunnels and within hundreds of feet of river bluffs and buried valleys.

The unconfined compressive strength of the St. Peter sandstone typically ranges from 0 psi to 500 psi. However, nodules or concretions have been found with compressive strengths as high as 14,600 psi.

A. Partial geologic history of St. Anthony Falls

Over a period of 10,000 years, St. Anthony Falls has retreated from the confluence of the Minnesota and Mississippi Rivers to its present location. This retreat was stopped in the 1800s when construction of a dam at St. Anthony Falls began. Before dam construction, retreat of St. Anthony Falls was controlled by the stratigraphy of the bedrock units. As water flowed over the edge of the relatively hard Platteville Formation, it eroded the softer St. Peter sandstone below. This erosion caused the Platteville to be undercut. When the undercutting reached vertical fractures in the Platteville, rock blocks would fall and St. Anthony Falls retreated upriver.[53]

B. Tunnel stone masonry

The tunnel is constructed of rock masonry walls, arched roof, and a bedrock floor. The quarried stone blocks mined from the Platteville Formation, probably in nearby quarries.

The thicker stone masonry units were mined from the Hidden Falls member. The massive nature of this dolomite allowed the creation of these larger units. However, this is the weakest member of Platteville and it has a relatively higher clay mineral content than the rest of the formation, which leads to faster deterioration due to freeze/thaw and other weathering forces.

The thinner stone masonry units are from the Mifflin member. These are easily identified by the crinkly bedding of lighter dolomite and darker shale layers. The closely spaced shale layers limited the thickness of these units. The shale layers tend to weather faster, accentuating the contrast with the dolomite layers.

Hydraulic Assessment: **A. River pool levels**

The invert elevation of the tunnel is located at approximately elevation 782 feet. The normal pool elevation above the upper dam is 799 feet. Therefore, the tunnel floor is approximately 17 feet below river level. The downstream normal pool elevation between

[53] Thomas Madigan, "The Geology of the MNRRA Corridor" in John O. Anfinson, *River of History: A Historic Resources Study of the Mississippi National River and Recreation Area* (St. Paul: Army Corps of Engineers, 2003), 23.

the two dams is 750 feet, resulting in a hydraulic head of approximately 49 feet for the A Mill hydraulic structures.

Structural Assessment: The Pillsbury A Mill water power structure complex consists of a number of different components including the following:

- Tunnel (headrace)
- Tunnel intake
- Forebay
- Upriver drop shaft
- Upriver turbine service room
- Upriver tailrace
- Downriver drop shaft
- Downriver turbine service room
- Downriver tailrace

Photographs of the components are shown in Figures 6 through 68. See Figure 2 for the Tunnel Level Site Plan, which provides a graphical diagram of the Pillsbury A Mill tunnel level power structure complex. For a more detailed discussion about the structural condition of the tunnel system and each the components identified above, see the report entitled "Pillsbury A Mill Tunnel Historic and Engineering Condition Study" prepared for the City of Minneapolis (May 2014), and available from the Minnesota Historical Society Library, St. Paul, Minnesota. Drawings prepared for the Study are attached and included in the Field Records for reference.

The tunnel structure was predominantly constructed of limestone locally quarried from the Mifflin and Hidden Falls members of the Platteville Limestone formation. The upper 8 to 10 feet of weathered limestone were excavated with the invert (floor) of the tunnel bearing in the Mifflin member. The limestone blocks were laid in a squared-stone (or ashlar) fashion. Based on the thickness of tunnel buttresses, the stone masonry behind the facing stones was likely from rubble masonry.

In January and April 2014, the tunnel system was visually inspected for signs of distress and deterioration. The lower 6 feet of the tunnel walls were routinely sounded to locate areas of delaminating stone and unbonded brick masonry. Due to the extreme thickness of the walls, drilling through the walls was attempted, but not be completed, with standard handheld hammer drills. The entire tunnel surface was photographed using digital photography. The photographs were then used to map the observed distress and deterioration. The tunnel structure walls were stationed every 25 feet to aid in determining the location of structural features, intersecting utilities and areas of deterioration. Drawings included with this narrative illustrate the condition assessment for the tunnel structure.

In general, the tunnel system is in fair condition overall. No evidence of bulging walls or extensive cracking in the walls was observed. The main structural issues throughout the tunnel system are missing mortar, deteriorating stonework due to freeze-thaw conditions, drummy (debonded) brick infills, and groundwater infiltration.

For more details about the structural assessment of the tunnel system, see the "Pillsbury A Mill Tunnel Historic and Engineering Condition Study."

Archaeological Fieldwork Plan: Due to the significance of the Pillsbury A Mill and associated tunnel system, industrial archaeologists developed an archaeological fieldwork plan in conjunction with the development of the "Pillsbury A Mill Historic and Engineering Condition Study," prepared for the City of Minneapolis, dated May 2014. The archaeological fieldwork plan was developed by examining extant structural elements as well as the more subtle modifications to the structure. The plan highlights areas within the tunnel that appear to have archaeological research potential or are otherwise unique. The plan also includes recommendations regarding treatment of potentially significant features if they need to be disturbed. It is summarized here, and for more details about the archaeological fieldwork plan, see the "Pillsbury A Mill Historic and Engineering Condition Study."

In January 2014, an archaeologist visited the site to assess the Pillsbury A Mill tunnel system and identify areas that appeared to have research potential or were otherwise unique. Six specific areas as well as several general tunnel features appear to have potential significance or research potential (see Figure 69). These areas include the machine shop headrace, forebay, manhole access, arch, Phoenix Mill headrace, and tunnel entrance and bulkhead area. The overall integrity of the tunnel walls, ceiling, and floor are also significant in that, as a whole, the tunnel retains significant integrity of design, setting, feeling, material, and workmanship.

The archaeological assessment resulted in several recommendations. If alterations need to occur in any of these archaeologically sensitive areas, an industrial archaeologist or historian should first be consulted. In addition to the tunnel proper, the Pillsbury A Mill water power system included other components such as drop shafts and turbine pits as well as numerous associated rooms and machinery. Because the historical significance of the tunnel depends on its integrity, adding components or removing historical elements can alter or diminish the tunnel's historic integrity. Thus, it is recommended that structural aspects, features, or artifacts associated with the tunnel not be removed or modified without first evaluating the action's impact on the historic fabric of the system.

From an industrial archaeology perspective, the most important consideration is to ensure that the development plans adhere as closely as possible to the historical aspects of the site. A faithful representation of a structure's original construction should be an important part of that plan. However, for the industrial archaeologist it is equally important to document the evolution of a system or process, provided those changes occurred within the site's period of significance.

In its current state the Pillsbury A Mill tunnel retains a good deal of research potential relative to both original construction and to changes through time. The tunnel also exhibits evidence of a number of changes made after the period of mill operation, but those changes tend to simply clutter or obfuscate rather than add to the interpretive potential. Examples of post-operational modifications are seen in the forms of addition (placement of an access ladder), subtraction (removal of a trash rack and a substantial section of the tunnel roof), and alteration (the historically unsympathetic replacement of the cap covering the Phoenix Mill headrace).

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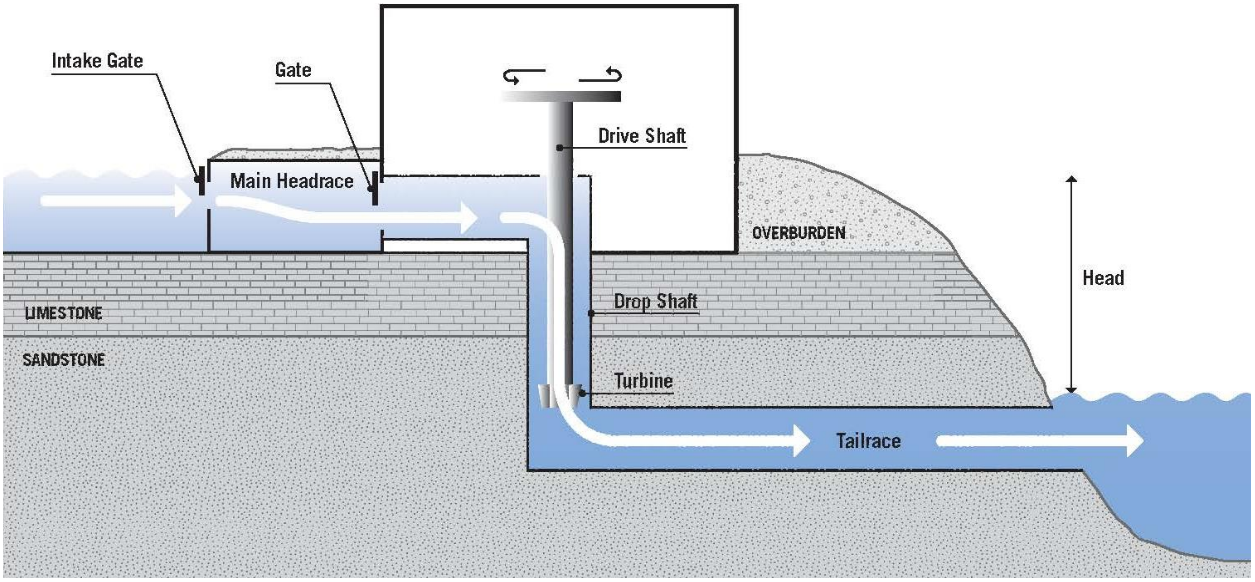


Figure 1. Illustration of the Pillsbury A Mill direct drive water power system. Prepared for the purposes of this Study.

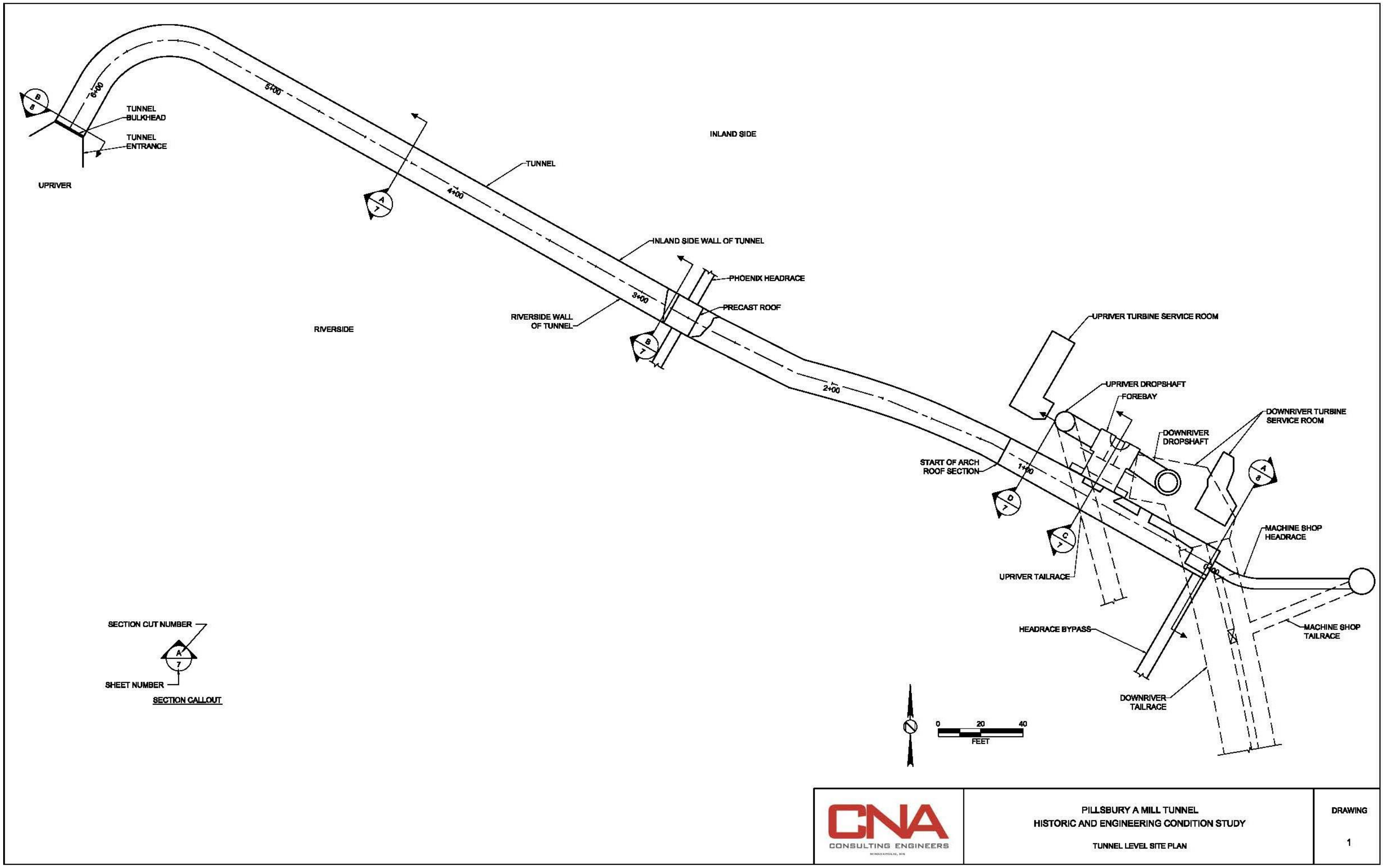


Figure 2. Pillsbury A Mill "Tunnel Level Site Plan" drawing, prepared by CNA Consulting Engineers for the purposes of this Study, 28 May 2014.

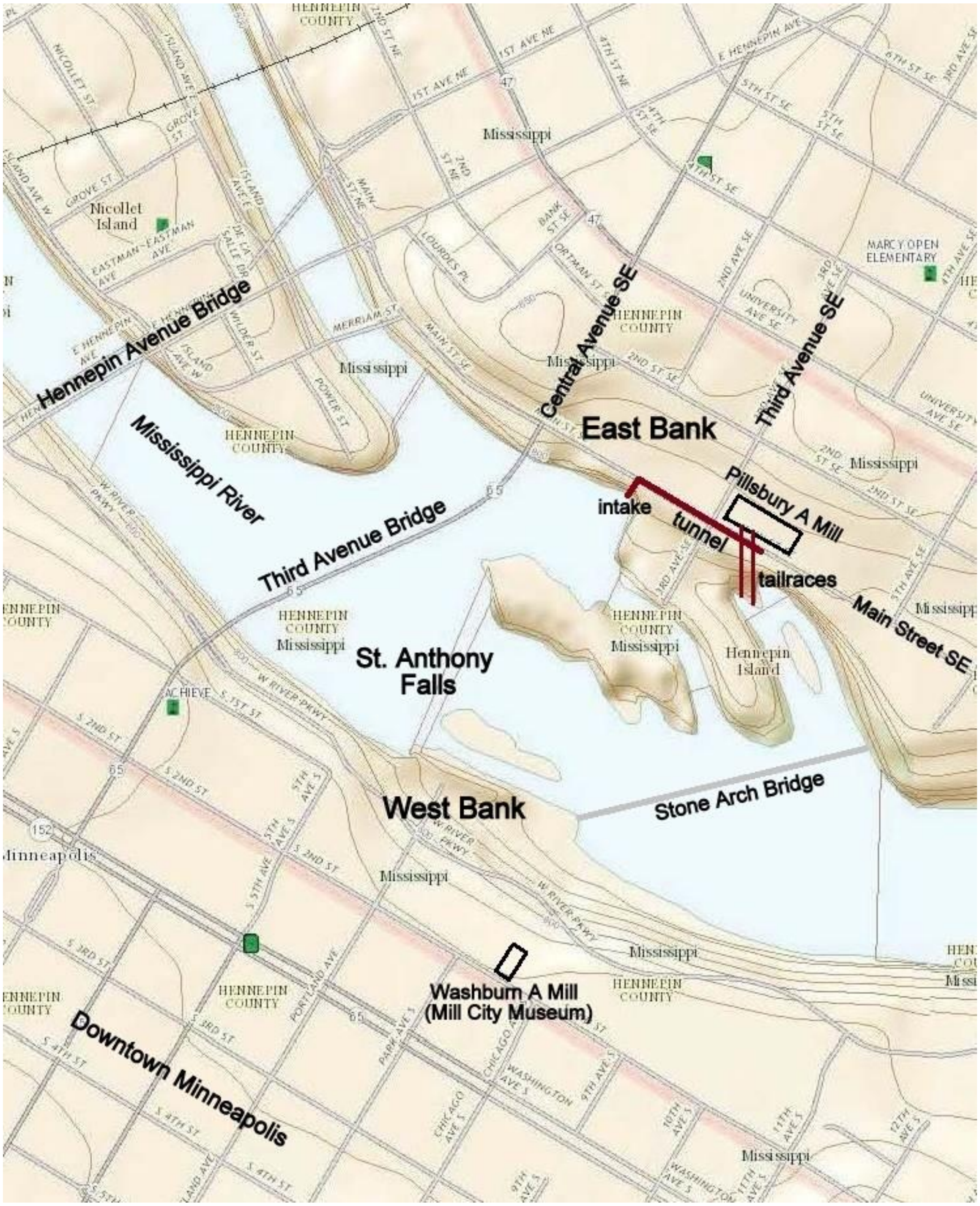


Figure 3. Present-day map showing the St. Anthony Falls riverfront along the Mississippi River. The approximate location of the Pillsbury A Mill tunnel system is outlined along the east bank of St. Anthony Falls. Adapted by Mead & Hunt, Inc. from the USGS National Map website http://viewer.nationalmap.gov/viewer/ (accessed 5/27/2014).

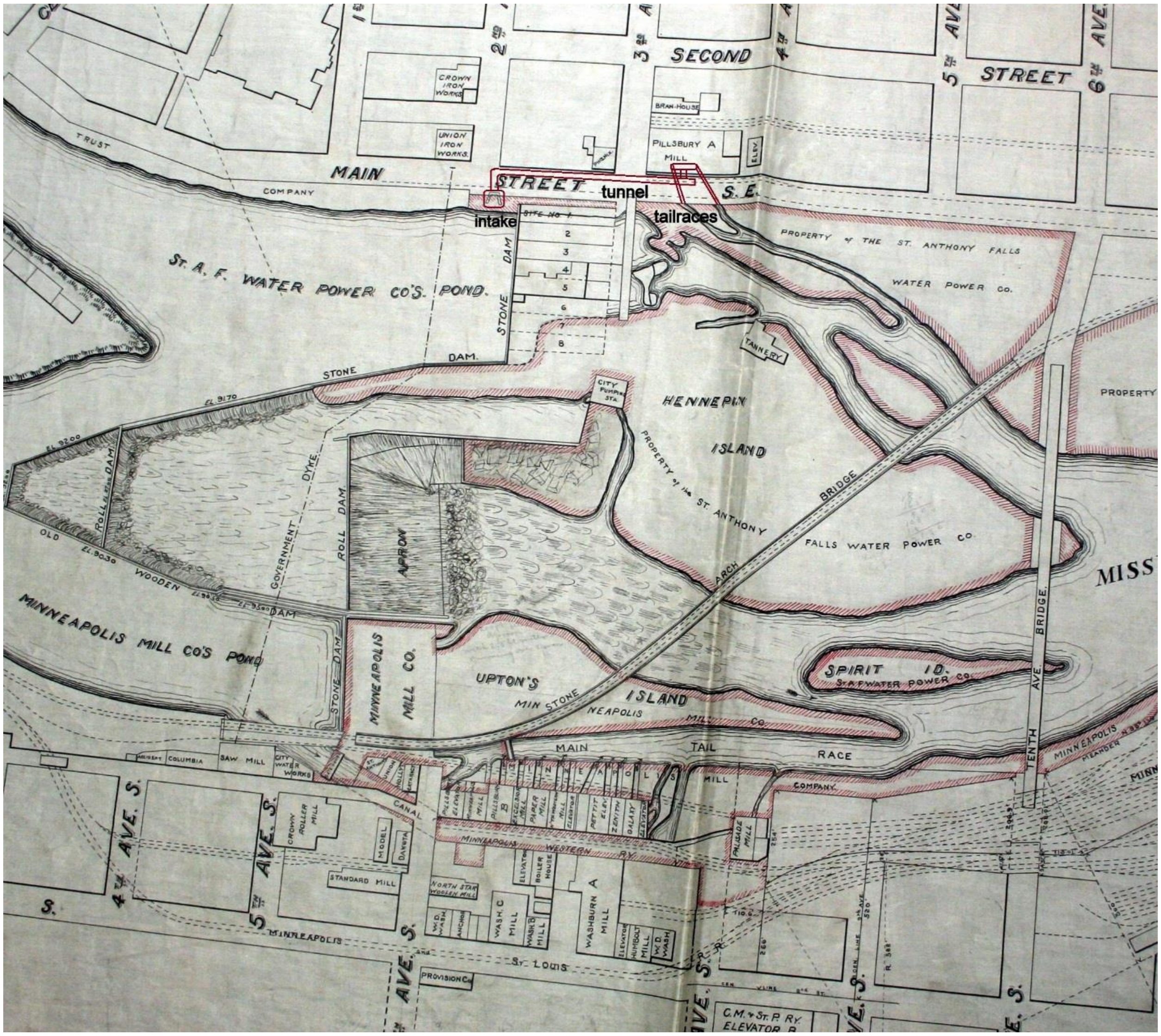


Figure 4. Adapted 1893 map of St. Anthony Falls, showing the development along the east and west banks of the river. An outline of the Pillsbury A Mill Tunnel has been added to the map. "Map Showing Location of Property of the St. Anthony Falls Water Power Co. and the Minneapolis Mill Co." 1893. Available at the U.S. Army Corps of Engineers library, St. Paul, Minn.

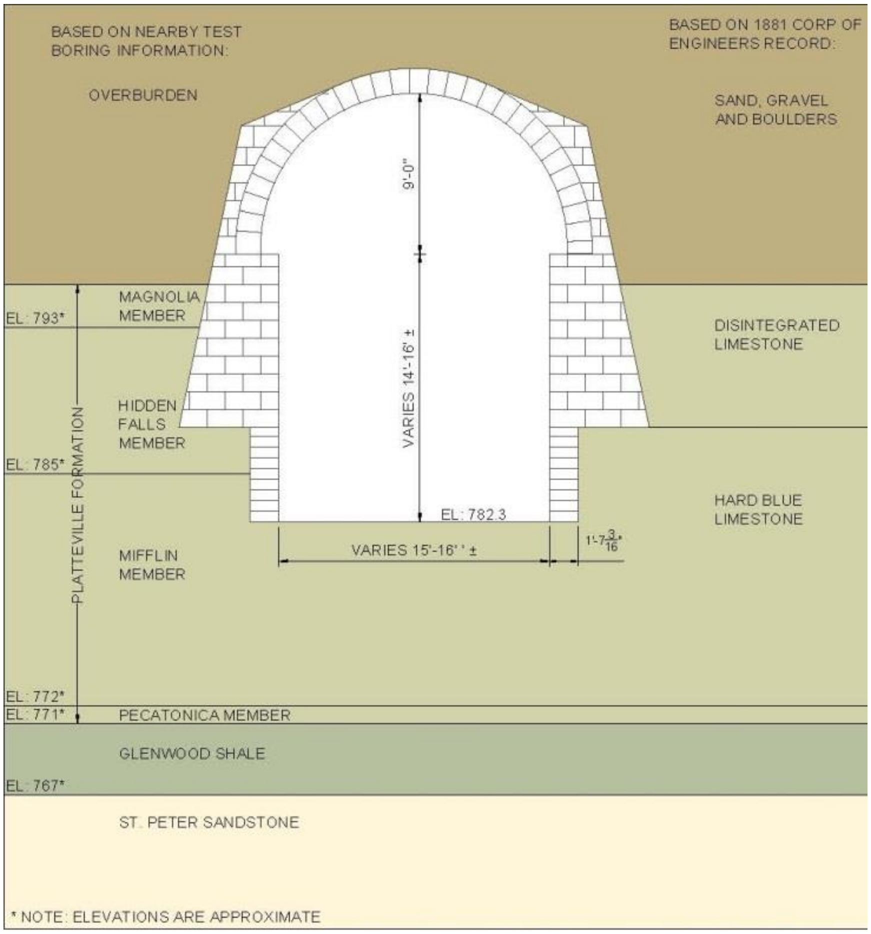


Figure 5. Tunnel construction and geology. Prepared for the purposes of this Study.

Figure 6. Downstream endwall showing headrace bypass (right), and machine shop headrace gate structure. Photograph by CNA Engineers, Inc., January 2014.

Figure 7. Headrace bypass along river side wall at Station 0+02. Photograph by CNA Engineers, Inc., January 2014.

Figure 8. View inside abandoned machine shop headrace. Photograph by CNA Engineers, Inc., January 2014.

Figure 9. Trash screen at Station 0+38 before removal (10/14), looking downstream. Photograph by Daniel Pratt, 2010.

Figure 10. I-beam remnants of cross-tunnel trash screen. Photograph by CNA Engineers, Inc., January 2014.

Figure 11. Catch basin lead through the river side wall at Station 0+57. Photograph by CNA Engineers, Inc., January 2014.

Figure 12. Inland side foundation wall arch into forebay. Photograph by CNA Engineers, Inc., January 2014.

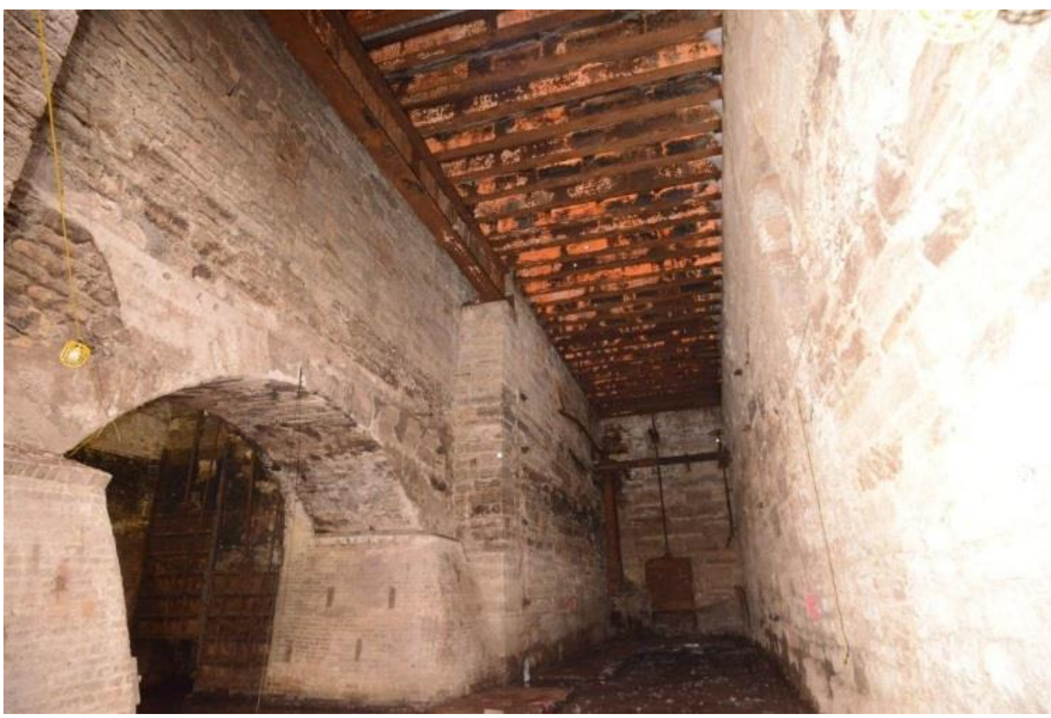


Figure 13. Overview of downstream tunnel section. Photograph by CNA Engineers, Inc., January 2014.

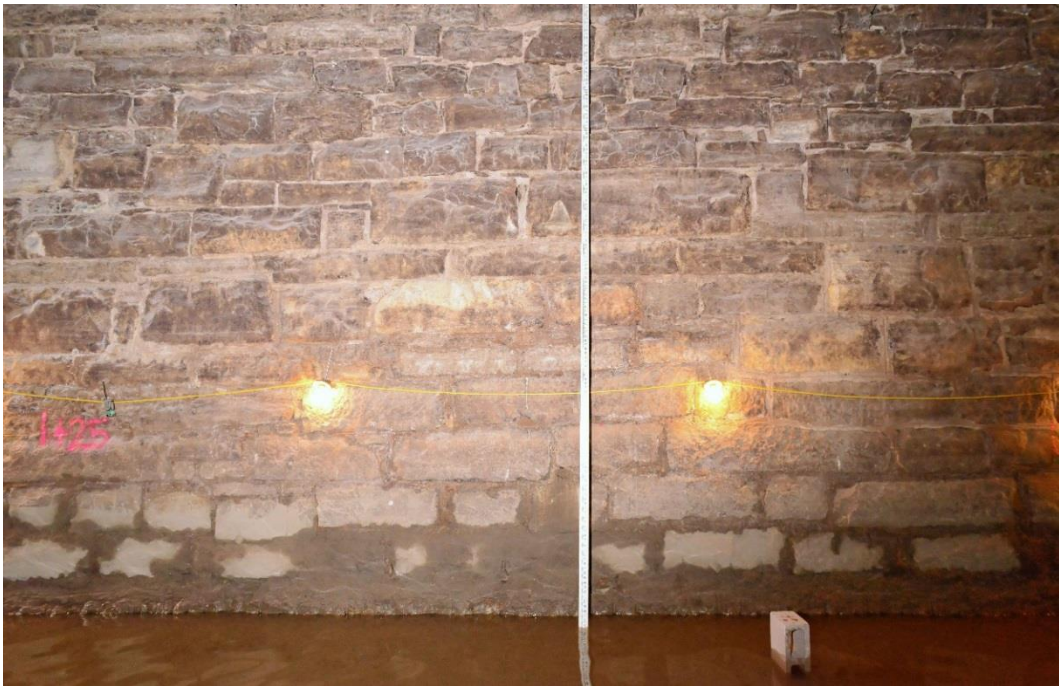


Figure 14. Wall segment in fair condition. Photograph by CNA Engineers, Inc., January 2014.

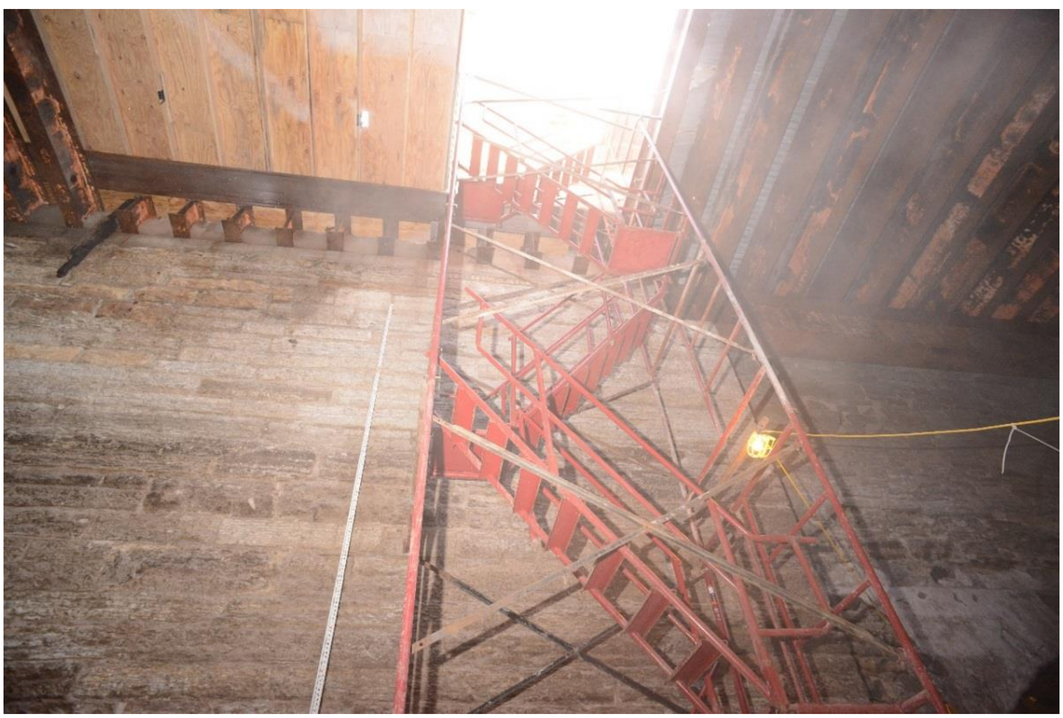


Figure 15. Access stairs and opening. Photograph by CNA Engineers, Inc., January 2014.

Figure 16. Frozen infiltrating groundwater at Station 1+10 on river side wall. Photograph by CNA Engineers, Inc., January 2014.

Figure 17. Brick patch and missing mortar (Station 1+00 to Station 1+25). Photograph by CNA Engineers, Inc., January 2014.

Figure 18. Transition at Station 1+12 from rectangular tunnel to arched tunnel. Photograph by CNA Engineers, Inc., January 2014.

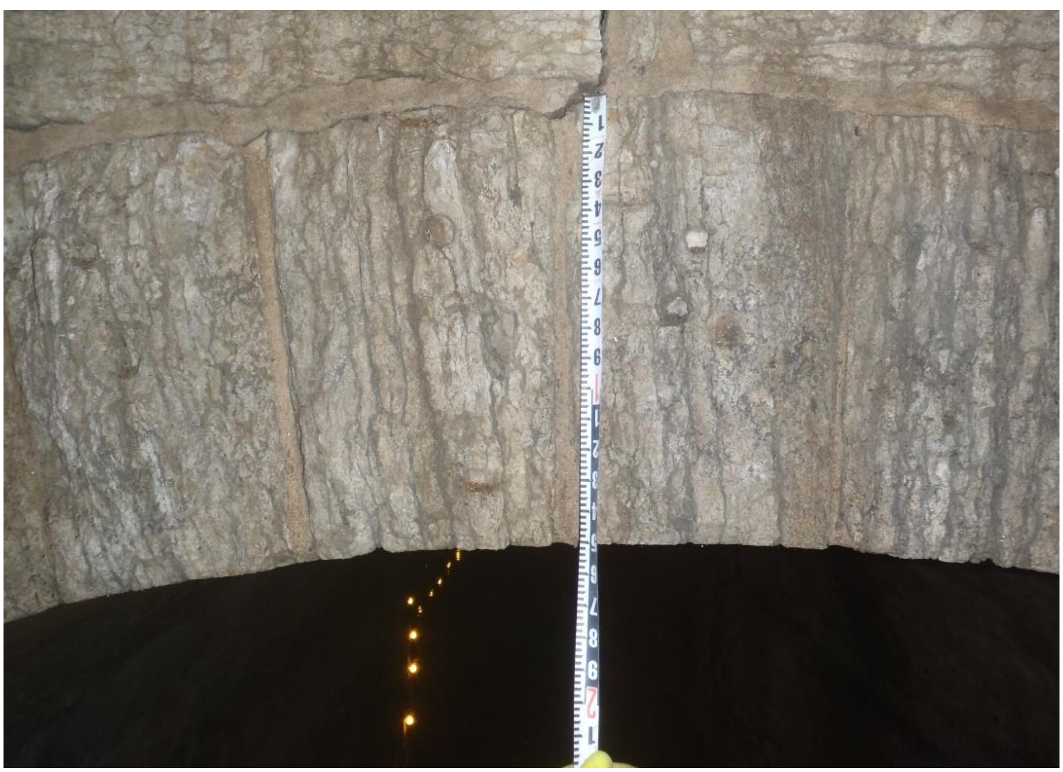


Figure 19. Close-up of the crown at the transition zone to rectangular tunnel. Photograph by CNA Engineers, Inc., January 2014.

Figure 20. Infiltration above brickline, under catch basin at Station 1+35. Photograph by CNA Engineers, Inc., January 2014.

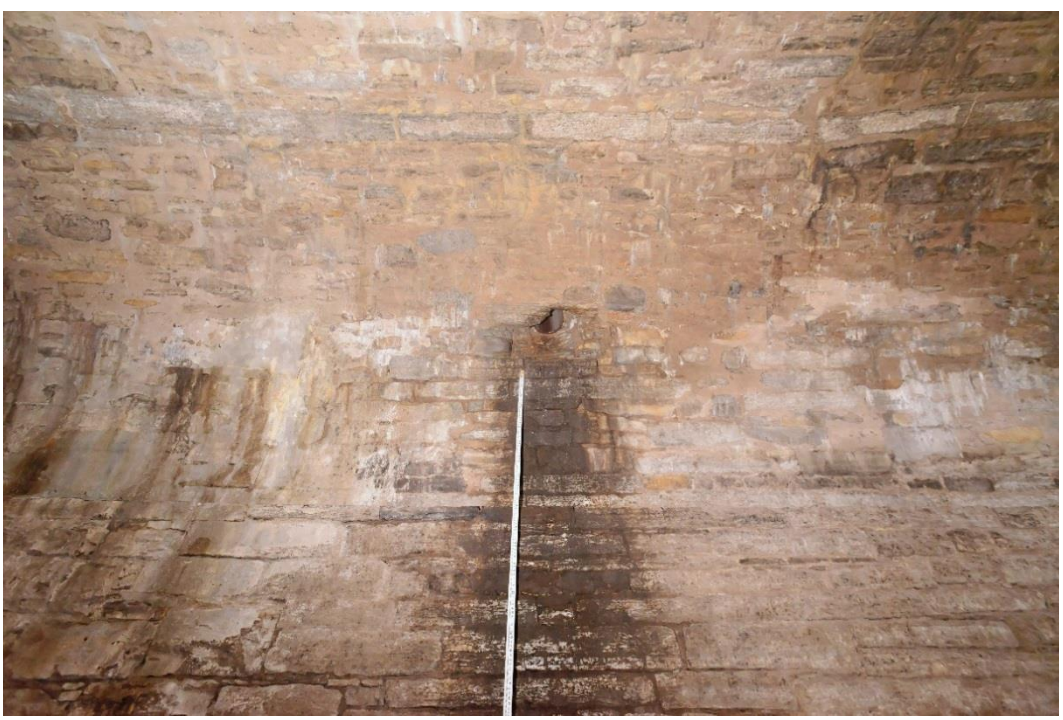


Figure 21. Catch basin connection at Station 1+35 on inland side wall. Photograph by CNA Engineers, Inc., January 2014.

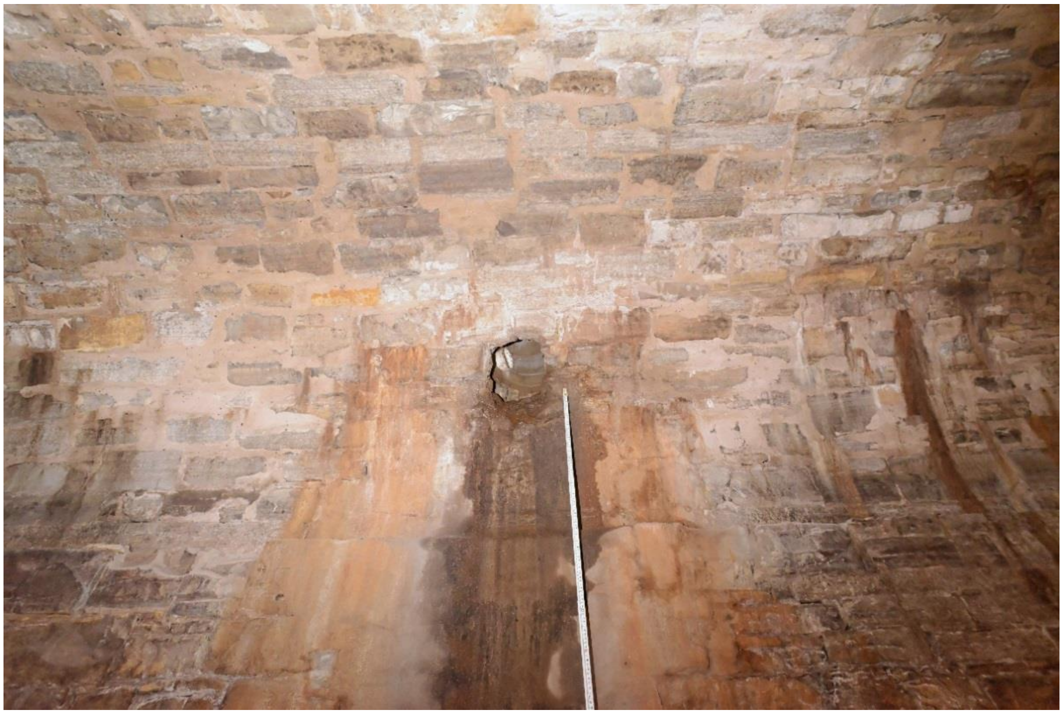


Figure 22. Catch basin at Station 1+86 on inland side wall. Photograph by CNA Engineers, Inc., January 2014.

Figure 23. Close up of catch basin at Station 1+35. Photograph by CNA Engineers, Inc., January 2014.

Figure 24. Close-up showing wall thickness at catch basin Station 1+86. Photograph by CNA Engineers, Inc., January 2014.

Figure 25. Fractured Limestone and missing stone. Photograph by CNA Engineers, Inc., January 2014.

Figure 26. S-curve in arched tunnel. Picture taken from Station 1+75 looking upstream. Photograph by CNA Engineers, Inc., January 2014.

Figure 27. Precast roof section change over Phoenix headrace at Station 2+75. Photograph by CNA Engineers, Inc., January 2014.

Figure 28. Inland side wall of Phoenix headrace intersection. Photograph by CNA Engineers, Inc., January 2014.

Figure 29. Inland side wall of Phoenix headrace intersection before steel gate cover placement. Photograph by CNA Engineers, Inc., January 2014.

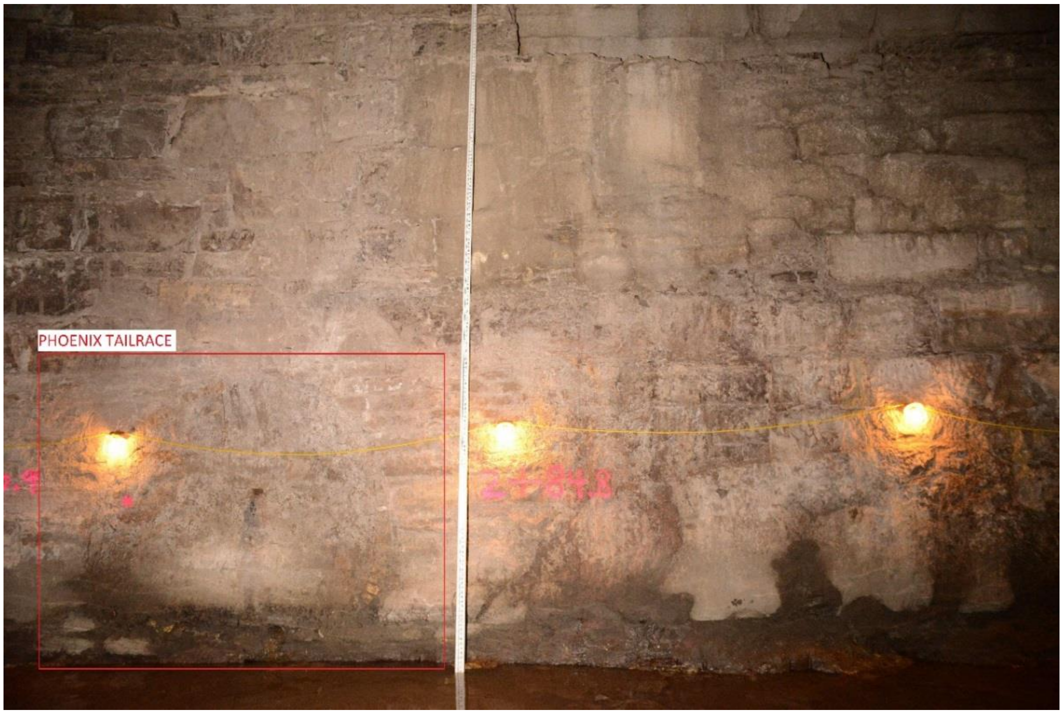


Figure 30. River side wall bulkhead where Phoenix headrace once intersected the tunnel. Photograph by CNA Engineers, Inc., January 2014.

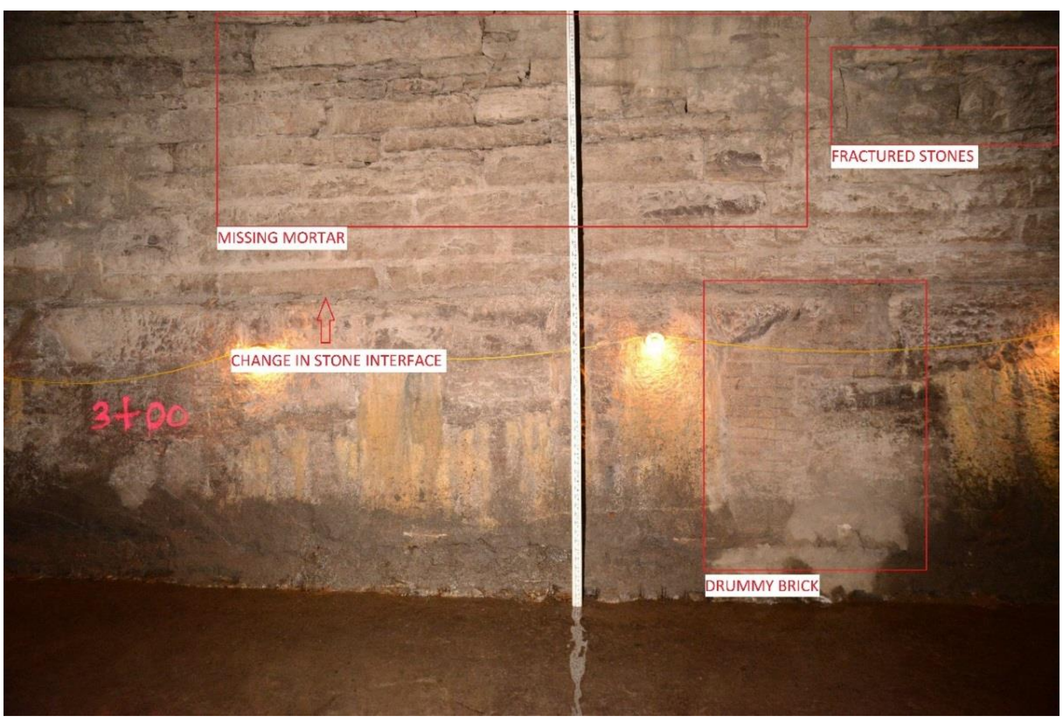


Figure 31. Drummy brick patches, change in stone 7 inches from invert, missing mortar and missing stones. Photograph by CNA Engineers, Inc., January 2014.

Figure 32. Undercutting of stone wall near invert. Photograph by CNA Engineers, Inc., January 2014.

Figure 33. 2-inch pipe penetration at Station 3+45. Photograph by CNA Engineers, Inc., January 2014.

Figure 34. Sanitary intersection near crown of tunnel at Station 4+02, and pipe infiltration at Station 4+13. Photograph by CNA Engineers, Inc., January 2014.

Figure 35. Water infiltration from leaking water pipe. Photograph by CNA Engineers, Inc., January 2014.

Figure 36. Downstream end of broken live sanitary pipe intersecting arch near crown at Station 4+55. Photograph by CNA Engineers, Inc., January 2014.

Figure 37. Upstream end of broken live sanitary pipe on crown of tunnel at Station 4+93. Photograph by CNA Engineers, Inc., January 2014.

Figure 38. Looking upstream from STA 4+97 towards 90-degree bend. Photograph by CNA Engineers, Inc., January 2014.

Figure 39. Shotcrete on river side wall 90-degree bend, and missing ledge. Photograph by CNA Engineers, Inc., January 2014.

Figure 40. Groundwater pipes on inland wall at 90-degree bend. Photograph by CNA Engineers, Inc., January 2014.

Figure 41. Roots penetrating through arch roof in front of bulkhead. Photograph by CNA Engineers, Inc., January 2014.

Figure 42. Headrace bulkhead. Photograph by CNA Engineers, Inc., January 2014.

Figure 43. 8-inch pipe on headrace bulkhead. Photograph by CNA Engineers, Inc., January 2014.

Figure 44. 1-foot by 1-foot steel sliding gate on headrace bulkhead. Photograph by CNA Engineers, Inc., January 2014.

Figure 45. Forebay inland side wall. Photograph by CNA Engineers, Inc., January 2014.

Figure 46. Forebay brick arch and timber roof. Photograph by CNA Engineers, Inc., January 2014.

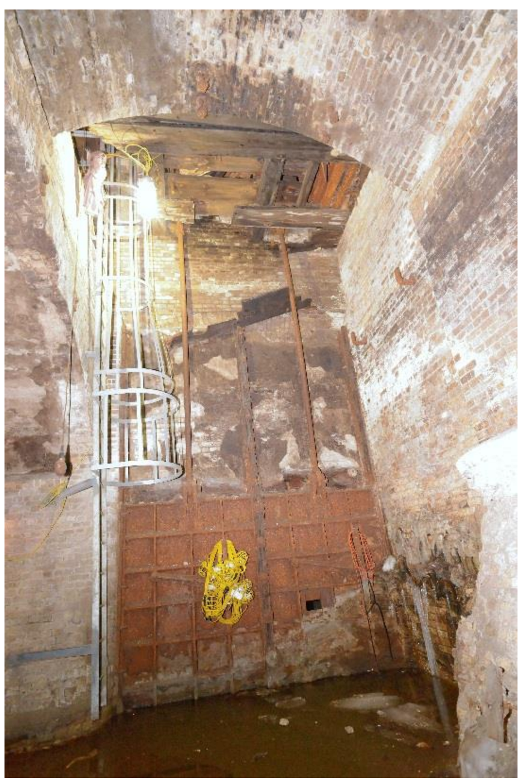


Figure 47. Upstream dropshaft sluice gates. Photograph by CNA Engineers, Inc., January 2014.

Figure 48. Upriver turbine service room. Photograph by CNA Engineers, Inc., January 2014.

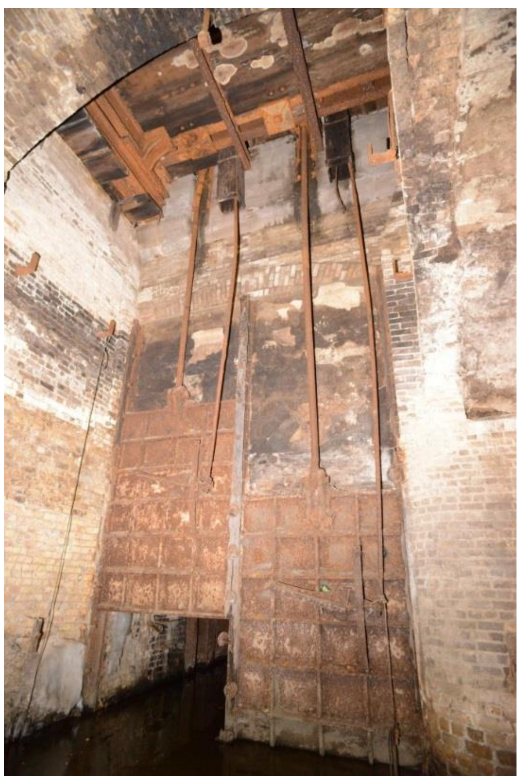


Figure 49. Downstream dropshaft sluice gates. Photograph by CNA Engineers, Inc., January 2014.

Figure 50. Downriver dropshaft in tailrace. (White formations visible are ice.) Photograph by CNA Engineers, Inc., January 2014.

Figure 51. View from tailrace looking up downriver dropshaft. (White formations visible are ice.) Photograph by CNA Engineers, Inc., January 2014.

Figure 52. View from the NW corner of the downriver tailrace. (White formations visible are ice.) Photograph by CNA Engineers, Inc., January 2014.

Figure 53. Debris pile coming from hole in downriver turbine service room. (White formations visible are ice.) Photograph by CNA Engineers, Inc., January 2014.

Figure 54. Downstream turbine service room. Photograph by CNA Engineers, Inc., January 2014.

Figure 55. Downriver tailrace portal. Photograph by Arch^3, LLC., April 2014.

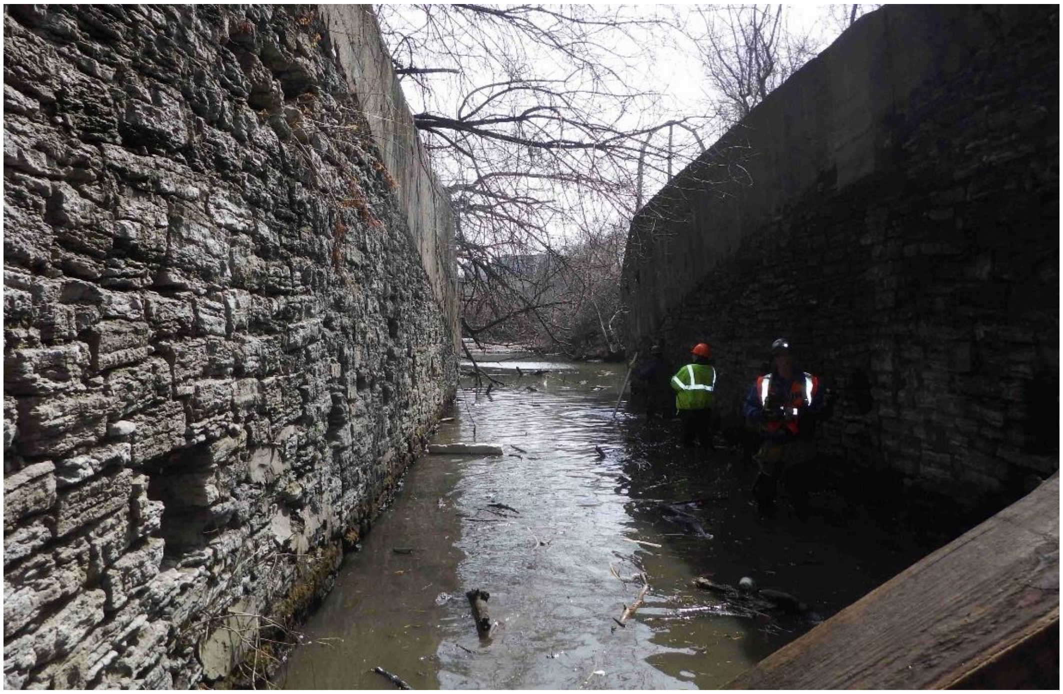


Figure 56. Downriver portal – looking towards Mississippi River from southwest channel. Photograph by Arch[3], LLC., April 2014.

Figure 57. Downriver tailrace – southwest channel portal. Photograph by Arch[3], LLC., April 2014.

Figure 58. Arch at the entrance of the downriver tailrace southwest channel. Photograph by CNA Engineers, Inc., April 2014.

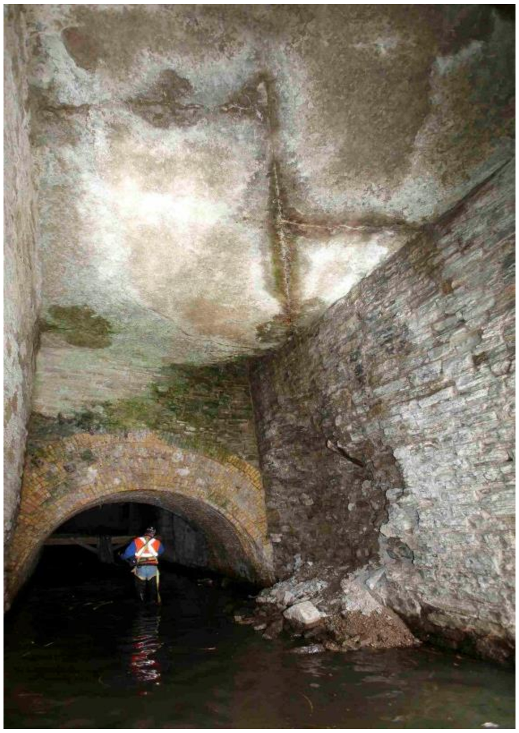


Figure 59. Brick arch in downriver tailrace southwest channel. Photograph by Arch[3], LLC., April 2014.

Figure 60. Downriver tailrace – penetration in interior stone masonry dividing wall. Photograph by Arch^3, LLC., April 2014.

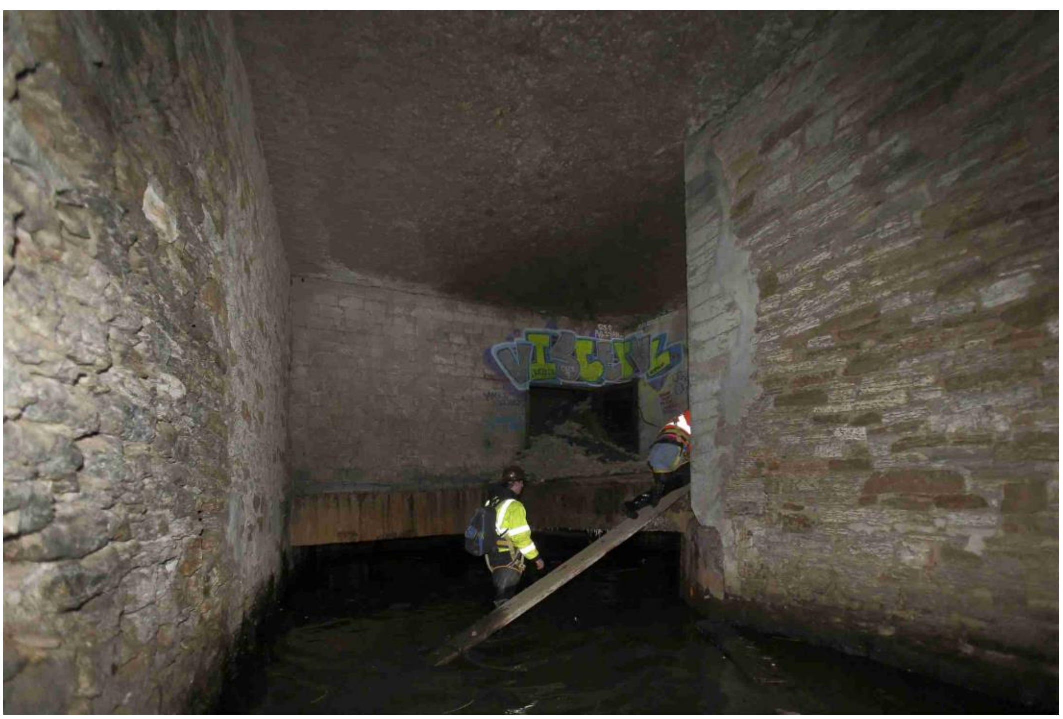


Figure 61. End of the downriver tailrace southwest channel. Photograph by Arch^3, LLC., April 2014.

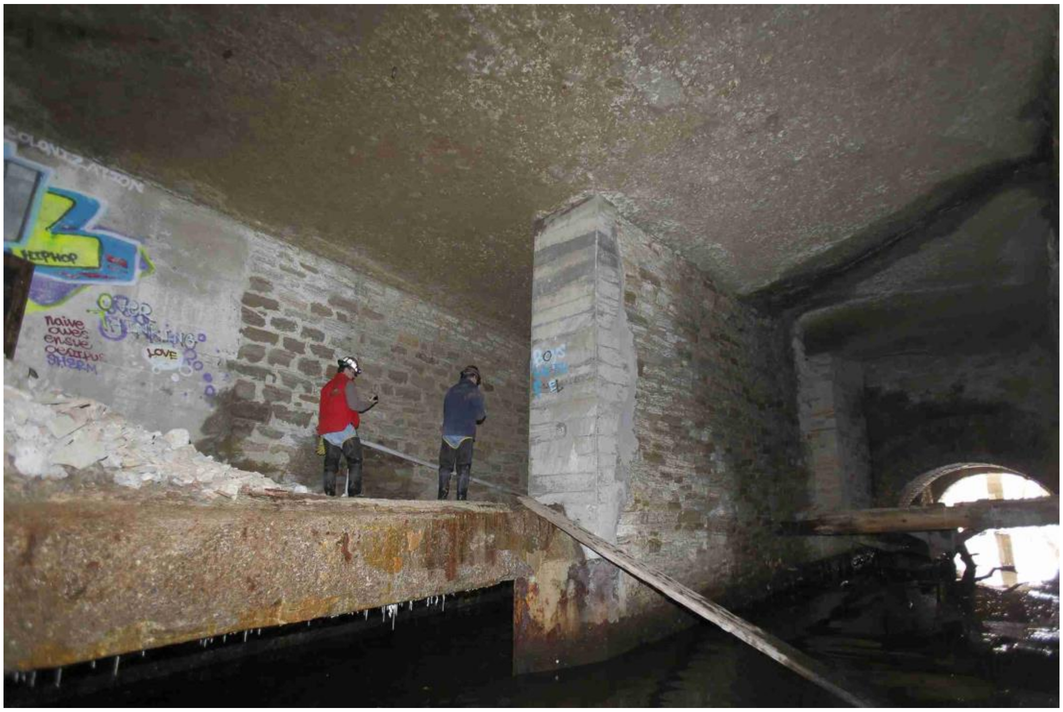


Figure 62. Southeast corner of the southwest downriver tailrace channel looking out towards the river. Photograph by Arch[3], LLC., April 2014.

Figure 63. View beneath elevated platform structure in downstream tailrace. Photograph by Arch[3], LLC., April 2014.

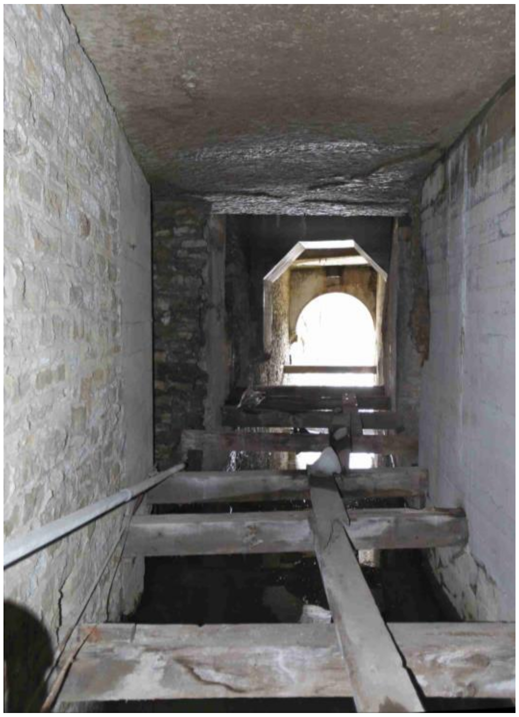


Figure 64. Downriver tailrace northeast channel looking out towards river. Photograph by Arch[3], LLC., April 2014.

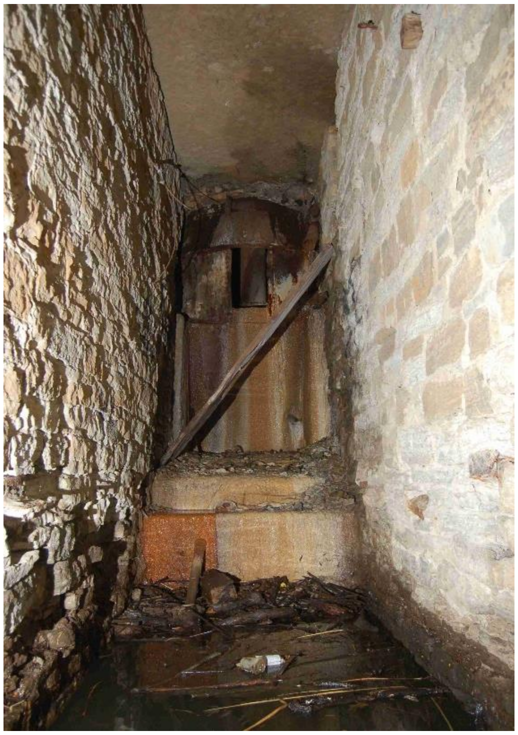


Figure 65. Machine shop dropshaft as seen from Machine shop tailrace tunnel. Photograph by Arch[3], LLC., April 2014.

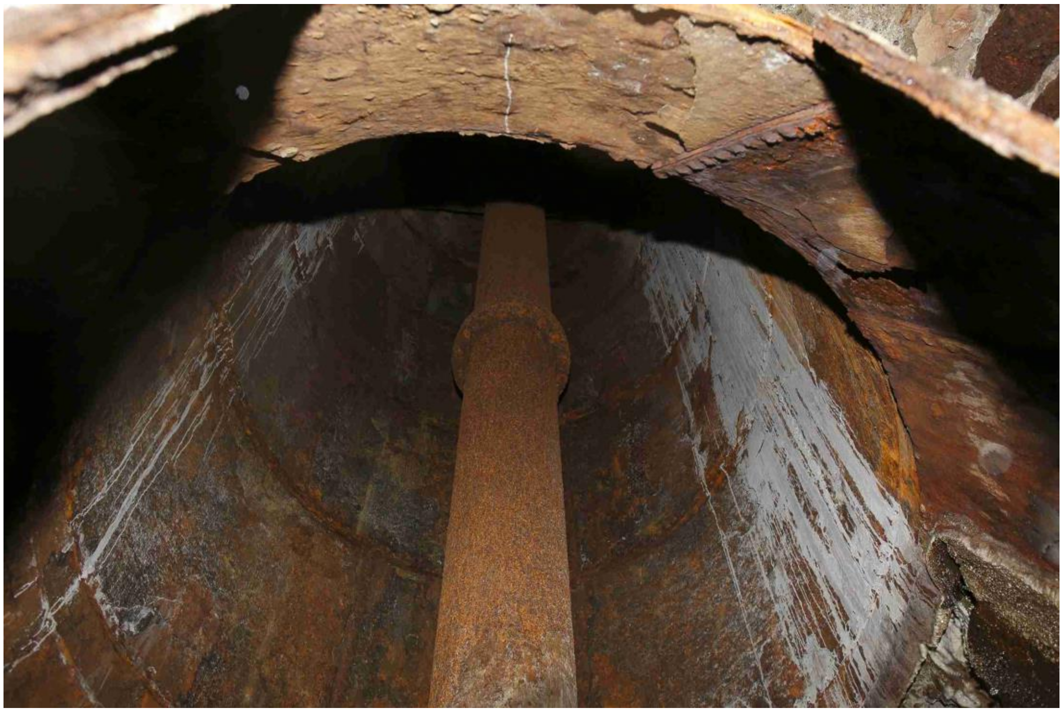


Figure 66. View looking up the Machine shop dropshaft. Photograph by Arch^3, LLC., April 2014.

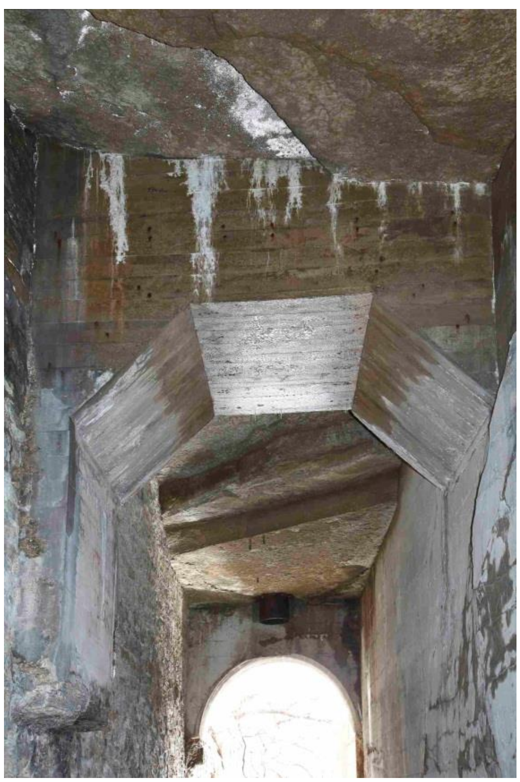


Figure 67. Concrete arch in northeast channel of downriver tailrace. Photograph by Arch^3, LLC., April 2014.

Figure 68. Upriver and Downriver tailrace portals. Photograph by Arch[3], LLC., April 2014.

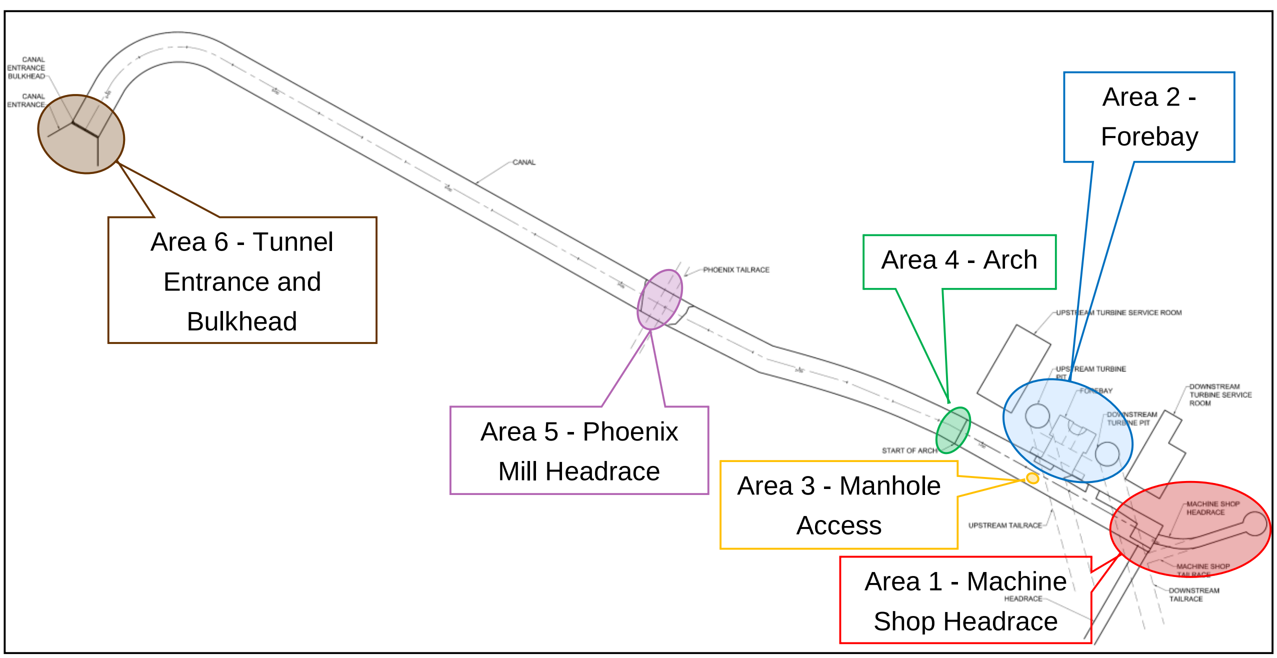
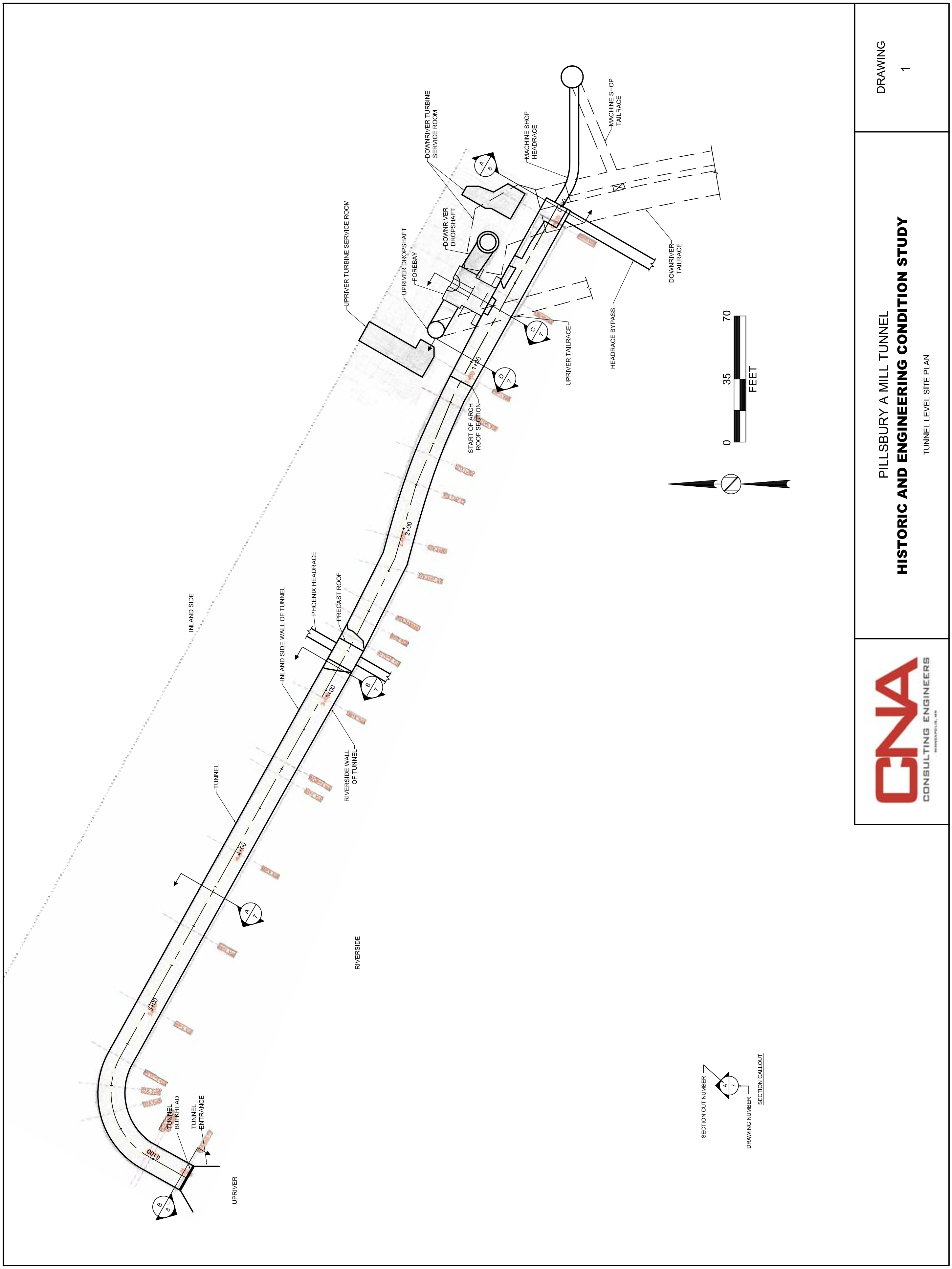
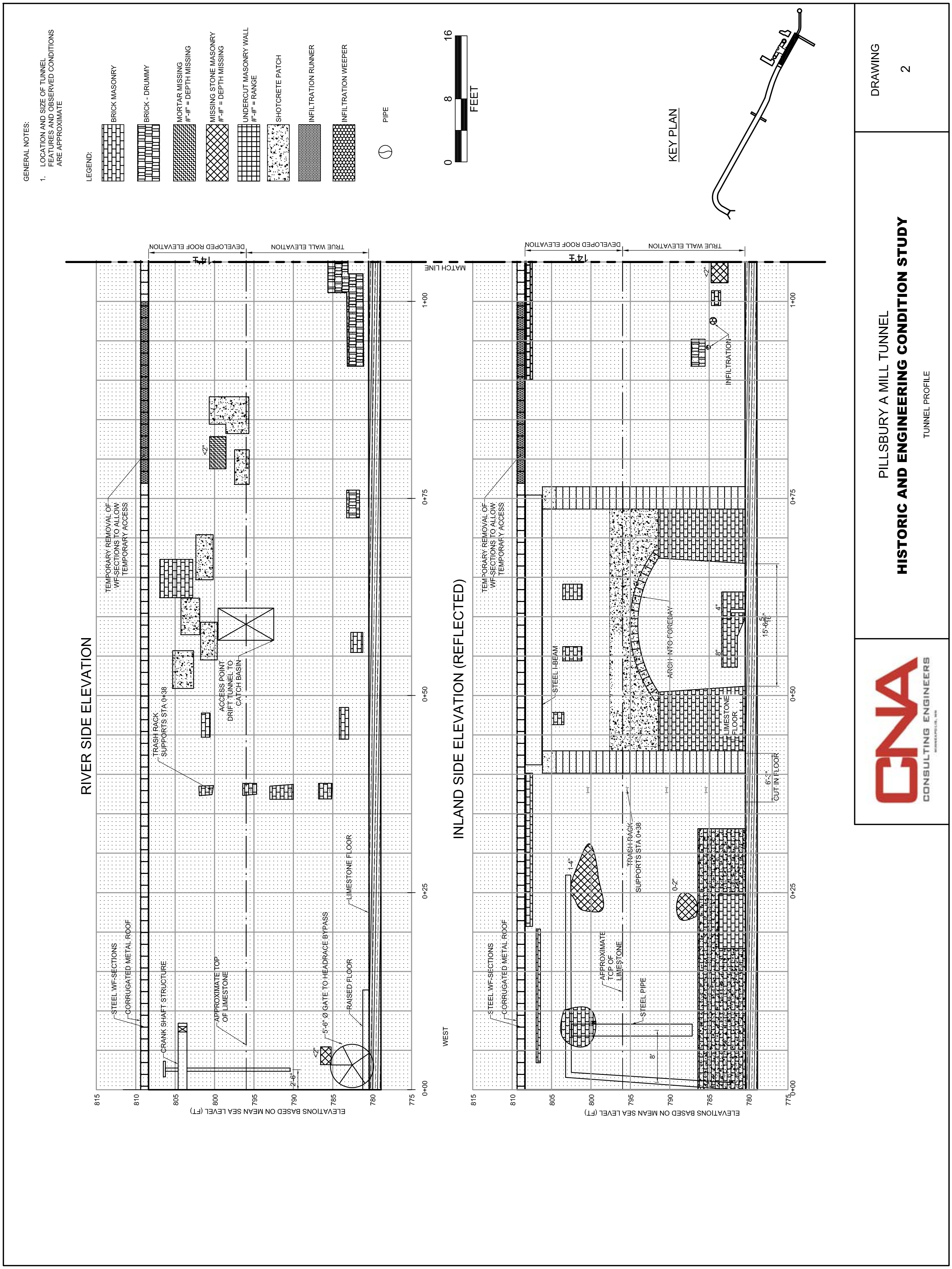
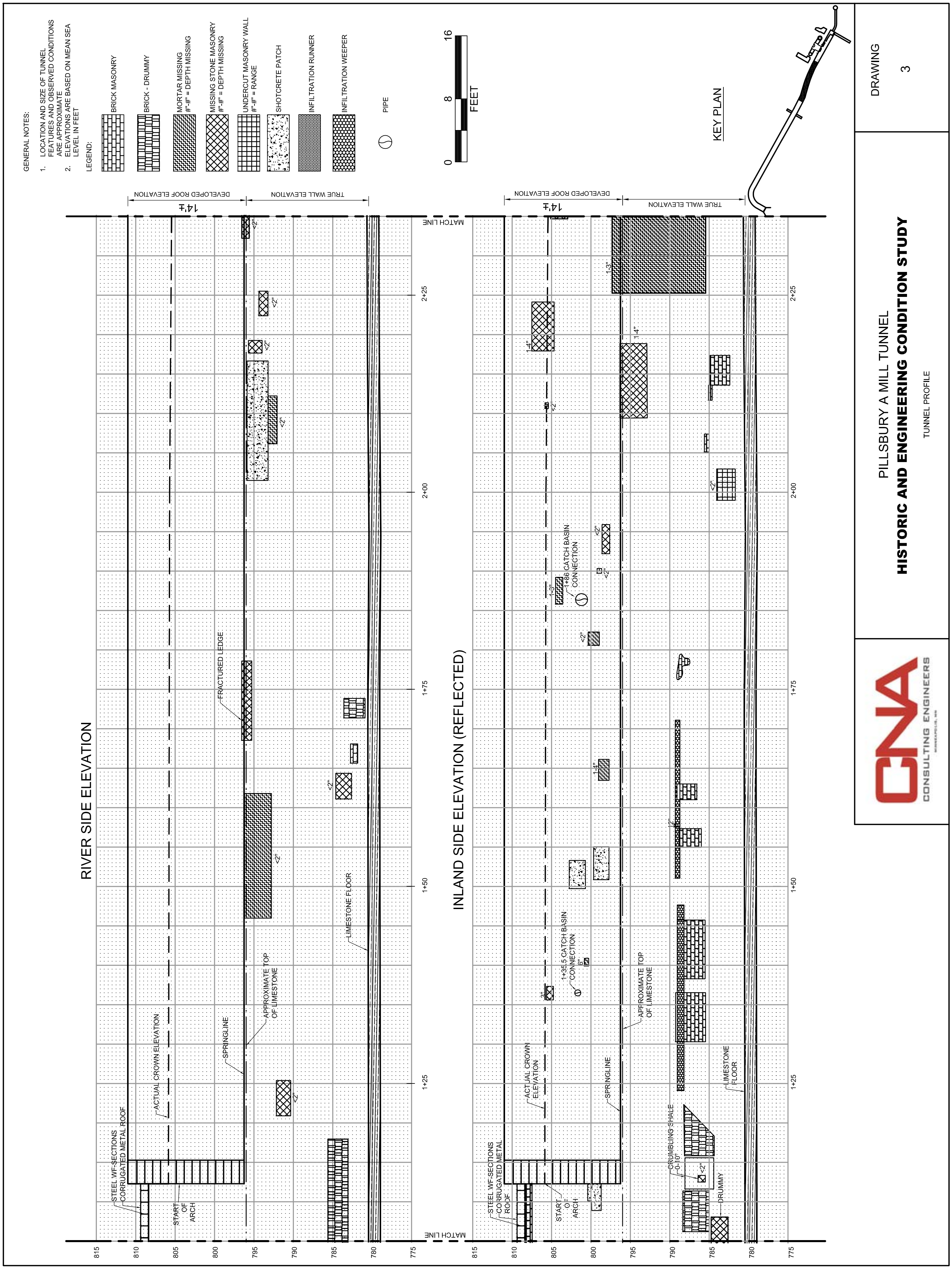


Figure 69. Map showing areas of archaeological interest. Prepared for the purposes of this Study.


DRAWING
1
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL LEVEL SITE PLAN
CNA
CONSULTING ENGINEERS
0
35
70
FEET
MACHINE SHOP TAILRACE
MACHINE SHOP HEADRACE
DOWNRIVER TURBINE SERVICE ROOM
DOWNRIVER DROPSHAFT
UPRIVER DROPSHAFT
FOREBAY
UPRIVER TURBINE SERVICE ROOM
DOWNRIVER TAILRACE
HEADRACE BYPASS
UPRIVER TAILRACE
START OF ARCH ROOF SECTION
PHOENIX HEADRACE
PRECAST ROOF
INLAND SIDE WALL OF TUNNEL
INLAND SIDE
RIVERSIDE WALL OF TUNNEL
TUNNEL
RIVERSIDE
TUNNEL BULKHEAD
TUNNEL ENTRANCE
UPRIVER
1+00
2+00
3+00
4+00
5+00
6+00
SECTION CUT NUMBER
DRAWING NUMBER
SECTION CALLOUT


GENERAL NOTES:
1. LOCATION AND SIZE OF TUNNEL FEATURES AND OBSERVED CONDITIONS ARE APPROXIMATE
LEGEND:
BRICK MASONRY
BRICK - DRUMMY
MORTAR MISSING #"-#" = DEPTH MISSING
MISSING STONE MASONRY #"-#" = DEPTH MISSING
UNDERCUT MASONRY WALL #"-#" = RANGE
SHOTCRETE PATCH
INFILTRATION RUNNER
INFILTRATION WEEPER
PIPE
0 8 16
FEET
KEY PLAN
RIVER SIDE ELEVATION
INLAND SIDE ELEVATION (REFLECTED)
DEVELOPED ROOF ELEVATION
TRUE WALL ELEVATION
MATCH LINE
STEEL WF-SECTIONS
CORRUGATED METAL ROOF
CRANK SHAFT STRUCTURE
APPROXIMATE TOP OF LIMESTONE
5'-6" Ø GATE TO HEADRACE BYPASS
RAISED FLOOR
LIMESTONE FLOOR
TRASH RACK SUPPORTS STA 0+38
ACCESS POINT DRIFT TUNNEL TO CATCH BASIN
TEMPORARY REMOVAL OF WF-SECTIONS TO ALLOW TEMPORARY ACCESS
STEEL PIPE
STEEL I-BEAM
ARCH INTO FOREBAY
INFILTRATION
CUT IN FLOOR
WEST
ELEVATIONS BASED ON MEAN SEA LEVEL (FT)
0+00 0+25 0+50 0+75 1+00
CNA CONSULTING ENGINEERS
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL PROFILE
DRAWING
2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LEGEND:
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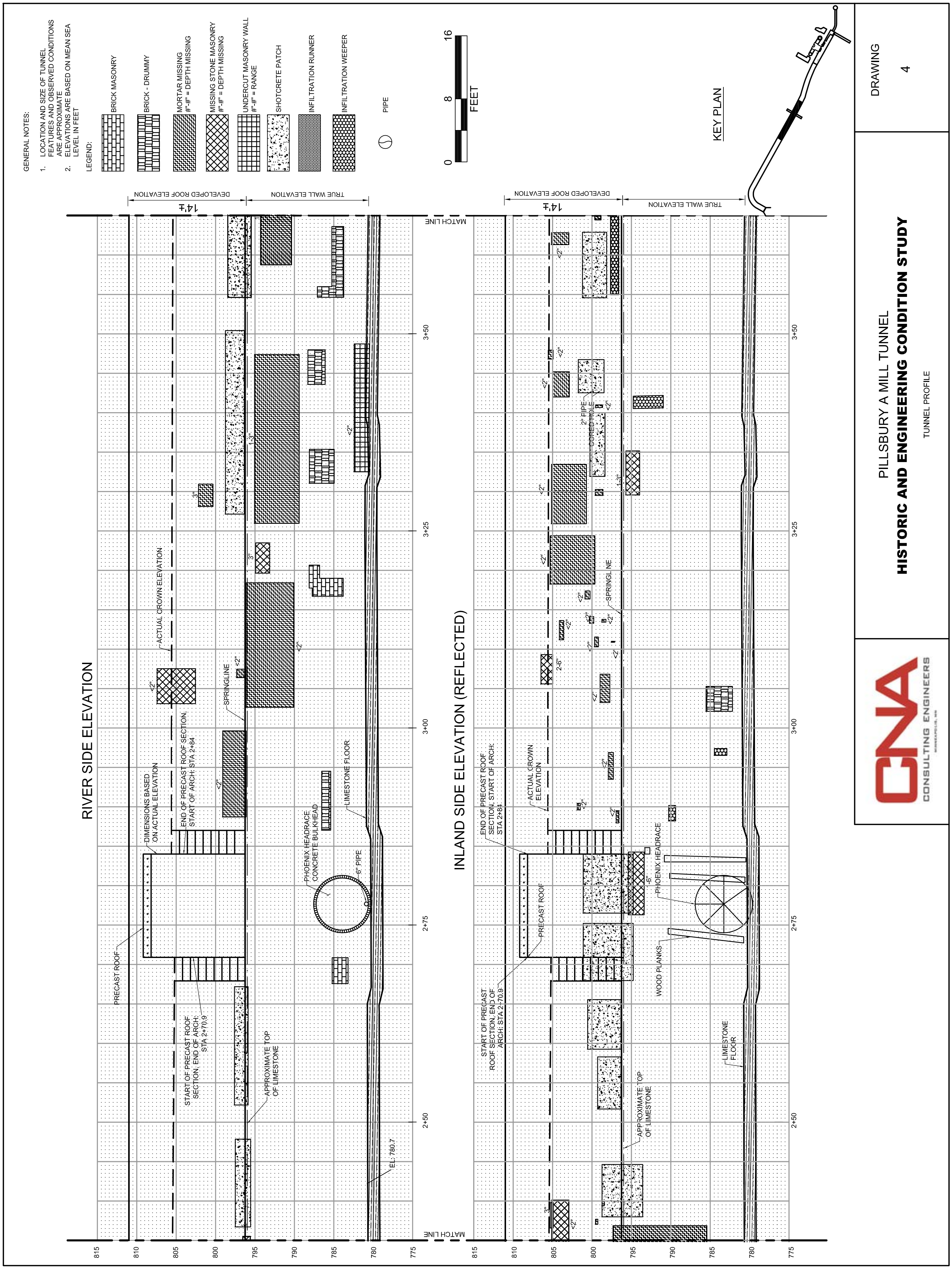
INFILTRATION RUNNER
INFILTRATION WEEPER
PIPE
0 8 16 FEET
KEY PLAN
RIVER SIDE ELEVATION
INLAND SIDE ELEVATION (REFLECTED)
DEVELOPED ROOF ELEVATION
TRUE WALL ELEVATION
MATCH LINE
STEEL WF-SECTIONS
CORRUGATED METAL ROOF
START OF ARCH
ACTUAL CROWN ELEVATION
SPRINGLINE
APPROXIMATE TOP OF LIMESTONE
LIMESTONE FLOOR
FRACTURED LEDGE
1+35.5 CATCH BASIN CONNECTION
1+86 CATCH BASIN CONNECTION
CRUMBLING SHALE 0-10"
DRUMMY
1+25
1+50
1+75
2+00
2+25
815
810
805
800
795
790
785
780
775
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL PROFILE
CNA CONSULTING ENGINEERS
DRAWING
3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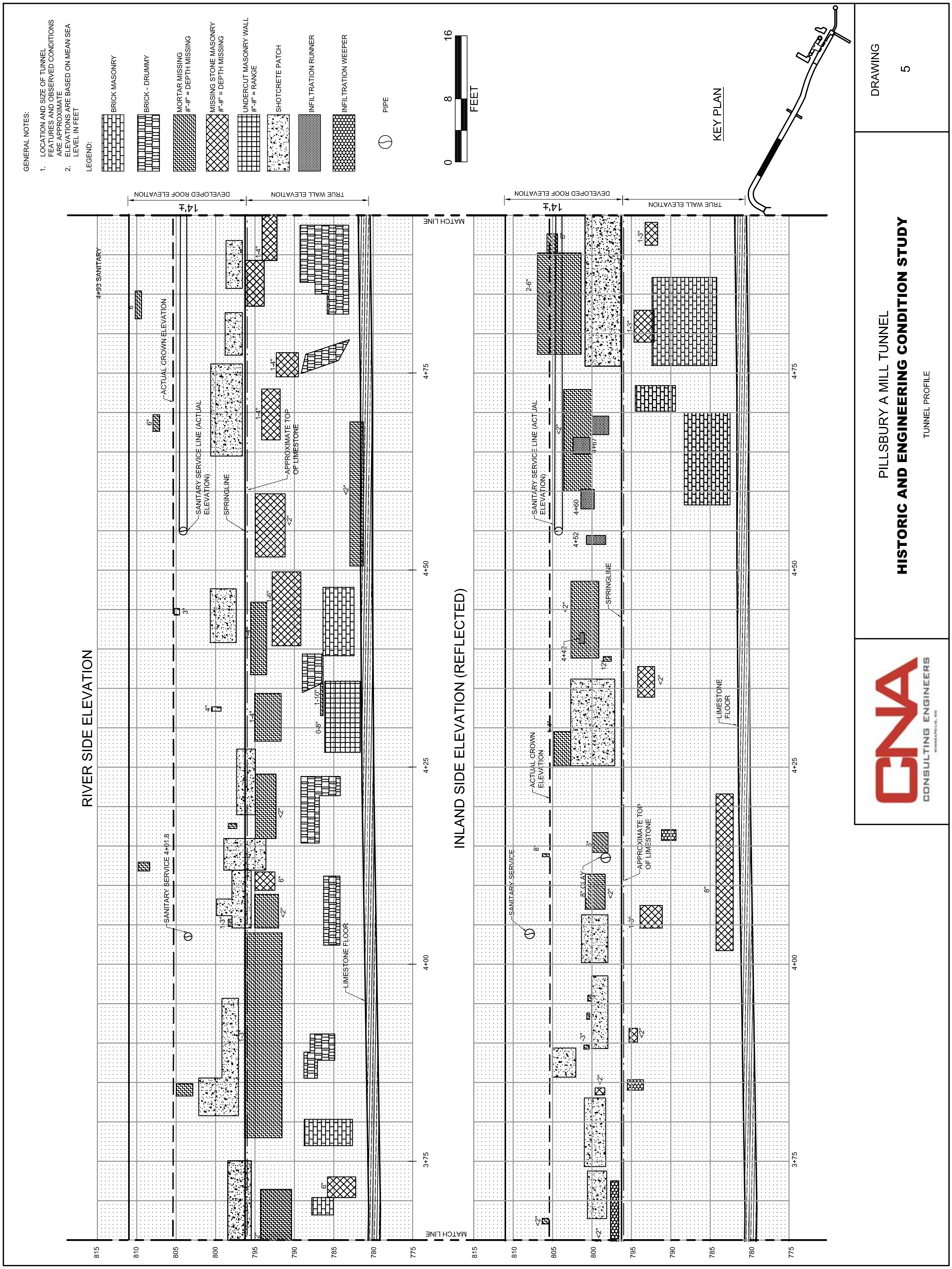
SHOTCRETE PATCH
INFILTRATION RUNNER
INFILTRATION WEEPER
PIPE
0 8 16
FEET
KEY PLAN
RIVER SIDE ELEVATION
INLAND SIDE ELEVATION (REFLECTED)
DEVELOPED ROOF ELEVATION
TRUE WALL ELEVATION
MATCH LINE
PRECAST ROOF
DIMENSIONS BASED ON ACTUAL ELEVATION
END OF PRECAST ROOF SECTION, START OF ARCH: STA 2+84
START OF PRECAST ROOF SECTION, END OF ARCH: STA 2+70.9
ACTUAL CROWN ELEVATION
SPRINGLINE
PHOENIX HEADRACE CONCRETE BULKHEAD
6" PIPE
LIMESTONE FLOOR
APPROXIMATE TOP OF LIMESTONE
EL. 780.7
PHOENIX HEADRACE
WOOD PLANKS
2" PIPE
CORED HOLE
2+50
2+75
3+00
3+25
3+50
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL PROFILE
CNA CONSULTING ENGINEERS
DRAWING
4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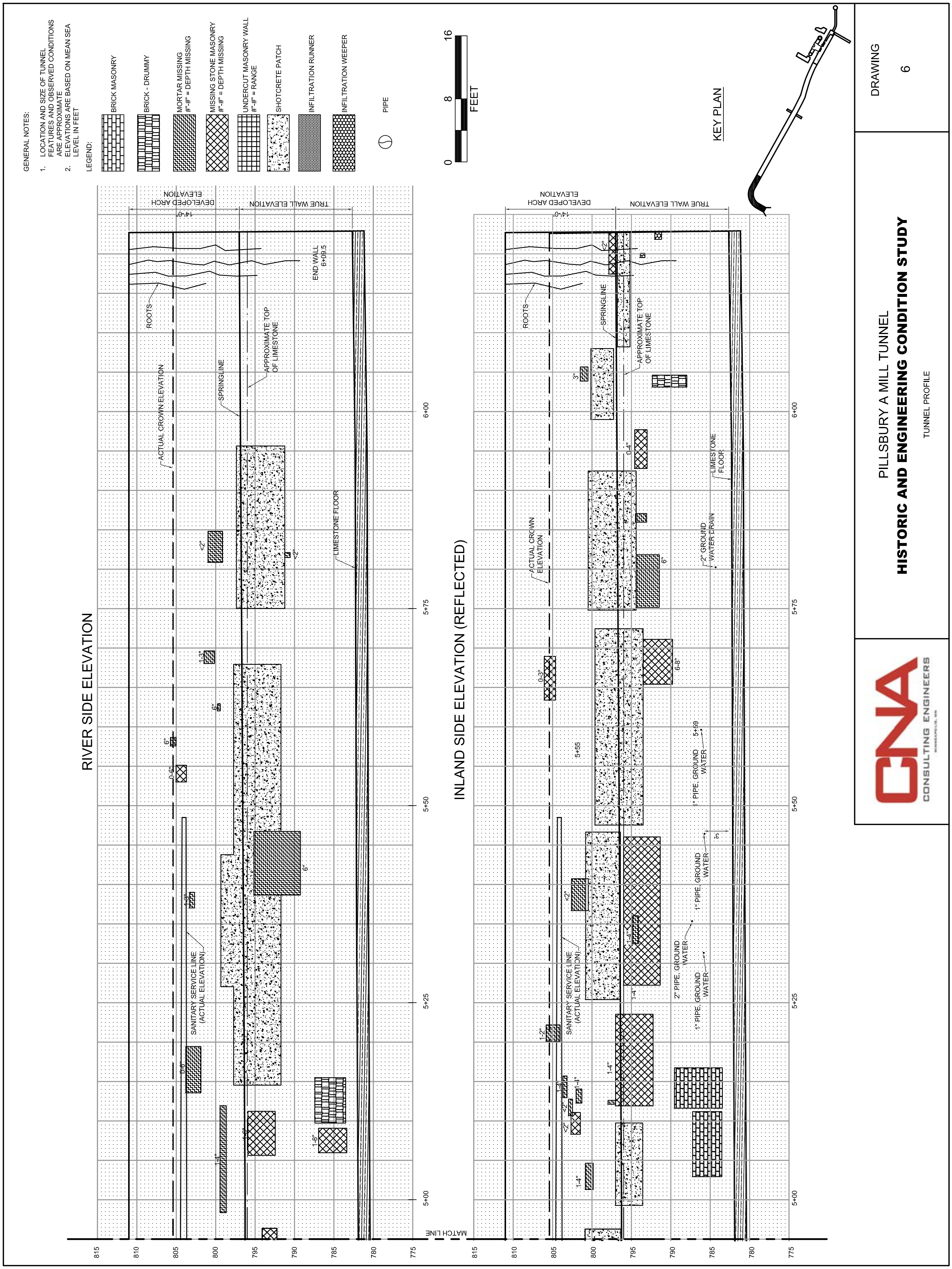
SHOTCRETE PATCH
INFILTRATION RUNNER
INFILTRATION WEEPER
PIPE
0 8 16
FEET
KEY PLAN
RIVER SIDE ELEVATION
INLAND SIDE ELEVATION (REFLECTED)
DEVELOPED ROOF ELEVATION
TRUE WALL ELEVATION
MATCH LINE
ACTUAL CROWN ELEVATION
SANITARY SERVICE LINE (ACTUAL ELEVATION)
SPRINGLINE
APPROXIMATE TOP OF LIMESTONE
LIMESTONE FLOOR
SANITARY SERVICE 4+01.8
4+93 SANITARY
SANITARY SERVICE
3+75
4+00
4+25
4+50
4+75
815
810
805
800
795
790
785
780
775
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL PROFILE
DRAWING
5
CNA
CONSULTING ENGINEERS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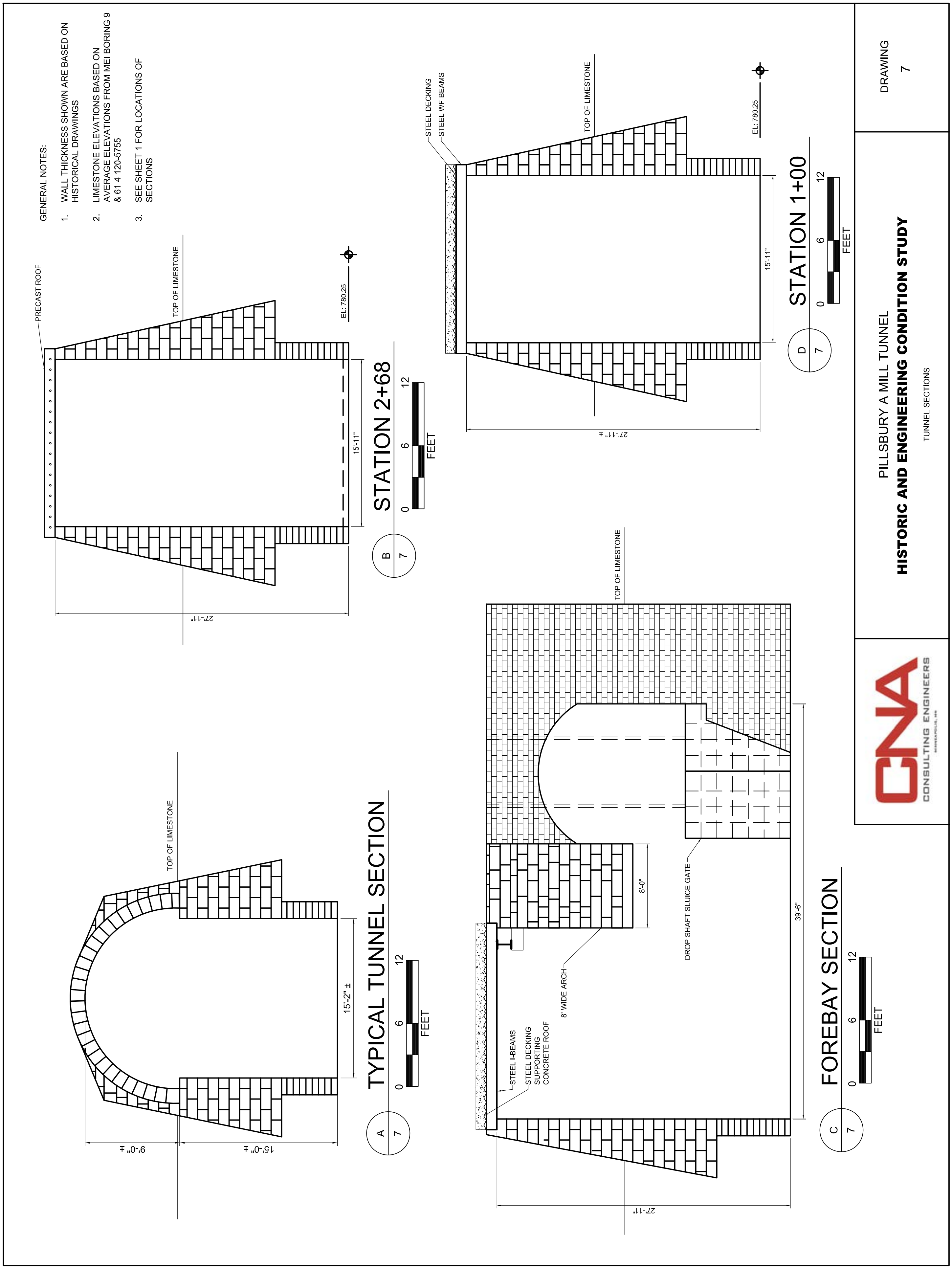
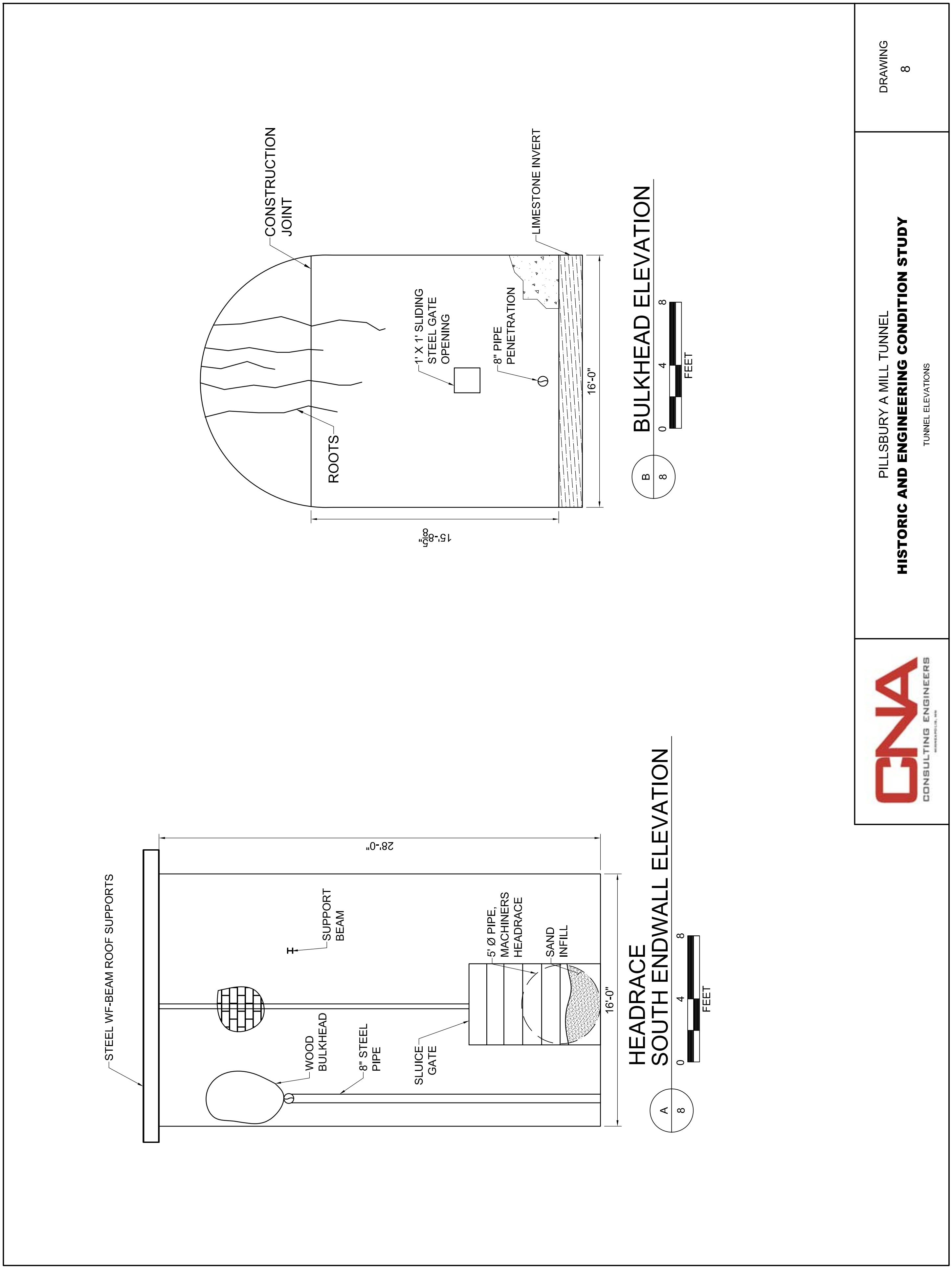
SHOTCRETE PATCH
INFILTRATION RUNNER
INFILTRATION WEEPER
PIPE
0 8 16
FEET
KEY PLAN
RIVER SIDE ELEVATION
INLAND SIDE ELEVATION (REFLECTED)
DEVELOPED ARCH ELEVATION
TRUE WALL ELEVATION
14'-0"
ROOTS
ACTUAL CROWN ELEVATION
SPRINGLINE
APPROXIMATE TOP OF LIMESTONE
END WALL 6+09.5
LIMESTONE FLOOR
SANITARY SERVICE LINE (ACTUAL ELEVATION)
2" GROUND WATER DRAIN
1" PIPE, GROUND WATER
2" PIPE, GROUND WATER
MATCH LINE
5+00
5+25
5+50
5+75
6+00
815
810
805
800
795
790
785
780
775
DRAWING
6
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL PROFILE
CONSULTING ENGINEERS


GENERAL NOTES:
1. WALL THICKNESS SHOWN ARE BASED ON HISTORICAL DRAWINGS
2. LIMESTONE ELEVATIONS BASED ON AVERAGE ELEVATIONS FROM MEI BORING 9 & 61 4 120-5755
3. SEE SHEET 1 FOR LOCATIONS OF SECTIONS
PRECAST ROOF
TOP OF LIMESTONE
EL: 780.25
15'-11"
27'-11"
STATION 2+68
B
7
0
6
12
FEET
STEEL DECKING
STEEL WF-BEAMS
TOP OF LIMESTONE
EL: 780.25
15'-11"
27'-11" ±
STATION 1+00
D
7
0
6
12
FEET
TOP OF LIMESTONE
15'-2" ±
9'-0" ±
15'-0" ±
TYPICAL TUNNEL SECTION
A
7
0
6
12
FEET
TOP OF LIMESTONE
8'-0"
39'-6"
DROP SHAFT SLUICE GATE
8' WIDE ARCH
STEEL I-BEAMS
STEEL DECKING SUPPORTING CONCRETE ROOF
27'-11"
FOREBAY SECTION
C
7
0
6
12
FEET
DRAWING
7
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL SECTIONS
CNA
CONSULTING ENGINEERS


CONSTRUCTION JOINT
LIMESTONE INVERT
1' X 1' SLIDING STEEL GATE OPENING
8" PIPE PENETRATION
ROOTS
16'-0"
15'-8½"
B
8
BULKHEAD ELEVATION
0
4
8
FEET
STEEL WF-BEAM ROOF SUPPORTS
28'-0"
SUPPORT BEAM
5' Ø PIPE, MACHINERS HEADRACE
SAND INFILL
WOOD BULKHEAD
8" STEEL PIPE
SLUICE GATE
16'-0"
A
8
HEADRACE
SOUTH ENDWALL ELEVATION
0
4
8
FEET
CNA
CONSULTING ENGINEERS
PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY
TUNNEL ELEVATIONS
DRAWING
8