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Windsor Street Gas Works,
Birmingham
Phase 2

Archaeological Watching Brief

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Windsor Street Gas Works, Phase 2 Archaeological Watching Brief

Windsor Street, Aston, Birmingham

ARCHAEOLOGICAL WATCHING BRIEF

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Windsor Street Gas Works, Phase 2

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SUMMARY

Birmingham Archaeology was commissioned in January and February 2010 by Celtic Technologies Ltd, acting on behalf of the National Grid, to undertake an archaeological watching brief in respect of remediation work at the Windsor Gas Works, Aston, Birmingham. The watching brief was conducted on ground works undertaken by the client and their contractors in order to remove and remediate contaminated ground. The work involved the recording of industrial archaeological remains of both standing structures and below-ground remains of the former gas works.

The watching brief found that remains of the original gas works partially survived in the area of development. Remains of the bases for possible purifiers or alternatively two Lancashire boilers associated with a former stationary steam engine used to power the original works were uncovered. The base of a tower scrubber (southern of a pair) for the purifying of gas was located to the west of this. A further three bases of cyanogens purifiers were also recorded that were the direct replacement of the earlier tower scrubbers. The work has allowed additional understanding of the processes involved within the work to be understood and has enabled the continuation of the chronology of gas works in Birmingham from the Gas Street and Fazeley Street works of the early 19th century through to the later 19th century and 20th century works.

Windsor Street Gas Works

Archaeological Watching Brief, March 2010

1. INTRODUCTION

1.1.1. Birmingham Archaeology was commissioned by Celtic Technologies Ltd. on behalf of the National Grid to undertake an archaeological watching brief during the improvement programme and remediation of former areas of the Gas Works (hereinafter referred to as the site, Planning Application Number . 2009/05016/PA).

1.1.2. This report outlines the results of the watching brief carried out in January and February 2010, and has been prepared in accordance with a Written Scheme of Investigation (Birmingham Archaeology 2010) which was approved by the Local Planning Authority prior to implementation (see Appendix A), in accordance with guidelines laid down in Planning Policy Guidance Note 16 (DoE 1990). The project conformed to the Institute for Archaeologists Standard and Guidance for Archaeological Watching Briefs (IFA 2008).

2. LOCATION AND CONDITION

2.1.1. The site is located off Windsor Street and Lord Street to the east of the Dartmouth Circus (A4540) and Aston Road (A38) interchange (Centred on NGR SP 0819 8816; Fig. 1). The site lies south of the line of the Birmingham and Fazeley Canal. The site consists of a series of derelict (and now demolished) buildings. The phase 2 area of the site is located at its northern edge and runs parallel to the line of the Birmingham and Fazeley Canal (Fig. 2).

2.1.2. The present character of the site is former demolished or partially demolished remains of the gas works and open concrete and tarmac carpark.

3. AIMS AND OBJECTIVES

3.1.1. The principle objective of the work is to record the character, extent, date, state of preservation and the potential significance of any buried remains.

3.1.2. More specific aims were to:

- Understand specific areas of the gas works and how they enabled gas production.
- Examine structures within the gas works and relate them to historic plans in order to further our knowledge of the 19th century gas industry.
- Understand the chronological development of the West Midlands gas industry as outlined by previous work at the Gas Street and Fazeley Works elsewhere in the city.

4. PREVIOUS WORK

4.1.1. The presence of the tanks and gas works were known from historic maps and plans of the area and photographic records located within the Birmingham City Archives. For this reason an archaeological watching brief was undertaken between May and June 2008 on the remains of the Gas Holders (Hepburn and Hewitson 2008). The

current work represents the second piece of work undertaken on the site. Previous work on gas industry in Birmingham has been undertaken at the Gas Street Works (Williams and Donald 1993; Williams and Stoyel 1993; Demidowicz 1993; Linnane 1998; Halsted and Breedon 1999; Halsted 2000; Bellavia 1999) and the Fazeley Street Works. Both the Gas Street works and the Fazeley Street works were identified as sites at risk by the Monument Protection Programme Step 3 Report (Trueman 2000). Although the Windsor Street works are not as early they complete the understanding and development of the coal gas industry in Birmingham.

5. METHODOLOGY

Watching Brief

5.1.1. The proposed development area covered approximately 1,500m². The area was due for excavation to a depth of 2.5 to 3.5m and as such removed the remains of structures associated with the gas works.

5.1.2. Detailed historic mapping of the site had been undertaken by Celtic Technologies Ltd as part of the programme of pre-investigation in order to establish potential areas of contamination (Fig. 2). The plans identified a series of structures within the area due for excavation. These include;

- Cynagon Purifiers (ref no. 39)
- Two tower scrubbers (ref no. 46)
- Tar and Liquor Well (ref no.47; possibly adjacent and will not be affected by development)
- Unknown building (ref no. 66)
- Further series of unknown buildings (ref no. 66) visible in 1876 (Plan for construction of the Main Gas Holder, Fig. 3) but absent by 1917 (Ordnance Survey 2nd Edition, Fig. 8 and 10).

5.1.3. It was therefore proposed to examine these by means of a non-continuous watching brief. Archaeological monitoring of groundworks was undertaken after the initial period of stripping of the ground levels and removal of tarmac layers.

5.1.4. No archaeological excavation was undertaken other than cleaning exposed deposits for better definition. Adequate time was allowed for observation and recording to take place.

5.1.5. Any archaeological features exposed were recorded by written description, drawing and photography. All stratigraphic sequences were recorded, even where no archaeology was present. Features were planned at a scale of 1:20 or 1:50 as appropriate, and sections were drawn of all cut features and significant vertical stratigraphy at a scale of 1:20. A comprehensive written record was maintained using a continuous numbered context system on *pro-forma* cards. Written records and scale plans were supplemented by photographs using black and white monochrome and digital photography.

Historic Building Recording

5.1.6. In addition to the below-ground remains a single standing building (Hopper Building ref no 60, Fig. 2, Plates 9-14) was identified by the client (Celtic Technologies Ltd) and has been condemned and is due for demolition.

5.1.7. Prior to the demolition a programme of historic building recording was undertaken that conforms to a level 2/3 survey (English Heritage 2006a). It involved written notes on the fabric, structure and function of the building, basic plans annotated onto current survey drawings and a photographic survey with suitable scales (where possible) using high quality digital (6 MegaPixel +) and black/ white monochrome film.

6. ARCHAEOLOGICAL WATCHING BRIEF

6.1.1. The archaeological watching brief was conducted in two locations, Area 1 and Area 2. Details of the surviving elements of the gas works as seen on Ordnance Survey Plans were plotted by Celtic Technologies Ltd, and the watching brief targeted to examine these structures.

Area 1

6.1.2. The natural drift geology was reached at a depth of 1.84m below ground level. It consisted of very light-grey silty sand gravel (113). It had been leached by petrochemical residues in places (later removed). Cut into the natural sub-strata were a series of structures associated with the gas works.

6.1.3. In the north-east corner of area A the site was defined by a linear north-south wall of machine-cut red brick (9 x 4 x 3 inch; 112) that ran for *c* 5.0m. On the western side a former structure was defined by a brick surface (110), 0.88m below the current ground level, 3.1 x 3.0m in size. It was constructed of hand-made red brick (9 x 4¼ x 3 inch) laid on-side. To the north of this was a grey-white gravel surface (111) that respected the alignment of the brick surface (see Fig. 3, Plate 3).

6.1.4. On the eastern side of wall 112 were two parallel semi-circular brick structure. These were represented by the remains of brick structure 107, a central pier element 106 and a further structure 104 to the south. All three elements ran parallel to each other and were constructed of hand-made red-brick (9 x 4¼ x 3 inch). There appeared to be no fire-bricks within the construction. Wall 104 abutted the north-south partition wall 112 (see Fig. 3, Plates 1-3). Directly to the west of 106 was a brick-structure 108 that appeared to be part of a later alteration or rebuild. Its function was unclear.

6.1.5. To the east of this structure was a brick drainage network 109, filled with petro-chemical residues so it remained unexcavated.

6.1.6. In the north-western corner of Area 1, the remains of a circular brick structure were uncovered (115). The structure was *c* 6.0m in diameter and survived to a height of 2.60m, slightly lower on the north-eastern side. The walls were constructed in machine-cut red brick (9x4¼x3 inch), and were 0.40m thick. Located centrally within the structure was a rectangular brick pier (114) of machine-cut red brick (9x4¼x3 inch) constructed on a stone-slab base, to a height of 2.30m. This appeared to be a base to support the centrally located scrubber unit (see Fig. 3; Plate 4 and 5).

6.1.7. At the southern edge of Area 1 were a series of 3 circular crushed brick and concrete bases (118, 119, and 120) of the cynagon purifiers. The cynagon purifiers were only partially exposed, the remainder was left unexcavated beneath the southern edge of excavation. They were located at a depth of 2.20m below current ground level and were *c* 3.0m in diameter and survived to a height of 0.40m (see Fig. 3; Plates 6 and 7).

6.1.8. Adjacent to the western and central purifiers was a square steel structure (117) 1.5x1.5m and 2.0m deep, with a circular hole in the top. It would appear to have been associated with the cynagon purifiers. A further man-hole and 2 steel pipes running into it appear to also be associated with the cynagon purifiers. The external footprint of the purifiers was enclosed by a curvilinear machine-cut red brick wall (116; 9x4½x3 inch), 1 course thick and surviving to a depth of 2 courses (see Fig. 3; Plates 6 and 7).

6.1.9. Area 1 was covered by a series of deposits, a dark-grey levelling layer of silty sand (103), 0.1m deep, a mixed industrial layer of brick rubble and clinker, contaminated with petrochemicals (105), 1.90m deep, an orange-brown sand and brick layer (102), a crushed stone and brick formation layer (101) and the current tarmac floor surface (100).

Area 2

6.1.10. Excavations in Area 2 were conducted to a similar depth to Area 1 (*c* 2.0m below current ground level). Although depths of rubble material were encountered no significant archaeological remains associated with the Gas Works from any phase were located. The historic plans had suggested that it was unlikely that any significant features would have been located here and this appears to have been the case. The potential remains of purifier plants in the southern side of Area 2 were not uncovered and it appears that these may have been less substantial than other remains in Area 1 (see Fig. 2; Plate 8).

7. HISTORIC BUILDING RECORDING

Coal Hopper, Windsor Street Gas Works, Aston, Birmingham: Remains of a brick-built coal hopper. Dated c 1900-1915. (Plate 9)

7.1.1. The southwestern façade is constructed in hand-made red brick (9 x 4¼ x 3 inch) in the English bond. The remainder of the hopper is constructed predominantly in machine-cut red brick (9 x 4¼ x 3 inch) in the English Garden Wall bond. The quoins are picked out in blue-brick. A single pier was located to the western side of the northwestern façade constructed in machine-cut red brick with blue-brick decoration on the quoins as before. A low plinth of blue brick ran around the base. On the western side was the springer for a redundant and now demolished arch (this suggests that the block to the southwest was possibly arcaded along its length with a series of similar arches).

7.1.2. The principal access to load the hopper would originally have been from the higher level of the gas works located to the south. Access to fill wagons from the hopper was via a double doorway located in the northern façade (see Fig. 5).

7.1.3. Within the northwestern façade was the plain doorway (as above; Plate 10) with a wooden baton door surviving (now boarded-up). At first floor level were a series of iron fittings suggestive of a platform located in a line, with L-form iron beams located within the pier described above. A cast-iron pipe ran along the first floor level, with smaller pipes extending from this, a single stopper tap located in one.

7.1.4. The southwestern façade was plain except for a single low segmental-arched opening to a recess (now partially bricked-up; Plate 11, Plate 13). Within the recess was a small cast-iron hopper, badly eroded but otherwise surviving. A single wall scar on the western side suggested the boundary wall originally rose to the height of the top of the hopper. Two small extant holes in the northwestern side of the façade at first

floor level suggest the pipework on the northern façade (see above) continued to the west.

7.1.5. The northeastern façade was likewise plain except for a single doorway on the southern side (now blocked and boarded access not possible due to asbestos; Plate 12). Iron fittings again suggested a walkway at first floor level. The wall had partially collapsed at the top revealing a cast-iron I-beam supporting a series of four I-beams above and perpendicular to this that formed the roof structure of the hopper. Through the wall collapse the large main hopper was seen to be of iron-construction and trapezoidal in shape (Plate 14).

7.1.6. The interior plan of the coal hopper was not discernable as it had been blocked up and the presence of asbestos prevented access.

Discussion

7.1.7. The hopper is first discernable on the 1917 Ordnance Survey Map as part of the pre-World War I reorganization of the Gas Works and expansion to the north-east. It would appear that the Gas Works operated on two different levels. The upper level was associated with a series of rail lines directly connected to the Windsor Street Wharf and from there to the main line. On the lower level a series of smaller tram lines operated and the hopper may have been associated with transfer of coal to vehicles in the lower yards or transfer to lorries.

8. ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

8.1.1. The following is repeated and amended from the Phase 1 report (Rep No. 1744; Hepburn and Hewitson 2008) concerning the development of the Windsor Street Works;

The History of Coal Gas Production

8.1.2. The earliest mention of gas production from coal occurred in 1688 when John Clayton mentioned experimentation with coal distillation to the Royal Society. In 1791 Phillipe Lebon took out a patent on a 'Thermolampe' that developed gas from wood (WLHC 346.1, 6). However, the first commercial use of gas was by William Murdoch whilst working for Boulton and Watt in 1792, who lit their premises in Redruth, Cornwall. He later lit their premises in Soho, Birmingham by the same technique (WLHC P363.63, 1-2). Initially the gas used was unpurified and was dirty so the technique did not take off. However, by 1812 the first gas company was established, the London Gas Light and Coke Company. By 1815 provincial companies were established with the first in the West Midlands being John Gostlings at the bottom of Gas Street, Birmingham established in 1819 (Shill 1996, 117). By 1882 there were 500 companies operating under a private act of parliament.

8.1.3. Coal gas was initially used solely as a means of street lighting and its success can be directly associated with the health improvement acts of the mid-19th century that sought to improve sanitation but also improve street lighting. The invention of the electric light filament in 1887 brought about serious competition to gas light. However, the invention of the 'Upright Incandescent Burner' by Baron Von Welsbach meant that lighting continued to use gas for several years to come (WLHC P363.63, 5). By this time alternative uses for gas had been developed including cooking, heating, and boilers (WLHC 346.1, 7). The coal gas industry also produced several by-products which were extensively used in the chemical industry. The most plentiful was coke that sold at a higher price than the equivalent coal. Other products included tar, liquor and sulphur as well as a range of chemicals, the most notable being Benzole and Toluol, which were used for explosives in World War One.

8.1.4. The later history of the coal gas industry was defined by its nationalisation after World War Two. This led to the amalgamation of production and the closing of smaller inefficient sites. The discovery of natural gas in the North Sea in the 1960s led to the end of coal gas production in Britain.

The Production of Coal Gas

8.1.5. Coal Gas was produced by the distillation of coal. This was done by the heating of coal in retorts and the subsequent collection of the gas produced by a condenser. The retorts were long tubes into which the coal was placed and heated (WLHC 346.1, 10). William Murdoch initially used vertical, then inclined, and finally horizontal retorts. Horizontal retorts were long cast-iron tubes 18" or 24" in diameter, with a door at the end into which the coal was placed. These were set in beds of five , seven, or nine and were heated by coke-furnaces underneath. The horizontal retorts were 'charged' by hand either through shovelling or the use of a long iron scoop. This was done every six hours in rotation to ensure continuous production. The cast-iron retorts were later replaced by fired-clay retorts. Horizontal retorts continued to be used throughout the 19th century (WLHC 346.1, 11). They were eventually replaced by vertical retorts that allowed continuous production of gas in each retort in the early part of the 20th century along the lines of designs by Woodall and Duckham or Glover and West. These were firmly established by the 1930s (Williams 1981, 62-3).

8.1.6. From the retorts the gas passed from cast-iron pipes through water which sealed the gas and helped remove the tar and liquor. The remainder of the tar and liquor was removed by a series of air-cooled pipes that acted as a condenser. The ammonia was removed by a washer of water sprays. Finally the gas passed through lime to remove hydrogen sulphide. Originally wet lime was used but proved difficult to dispose of, so dry; slaked lime was used until it was eventually replaced by iron-oxide in the 1870s.

8.1.7. From here the gas passed into the gas holders prior to redistribution for gas lighting. In the 19th century these were of a simple design, being a single bell (as opposed to the telescopic bells seen in modern gas holders) that overlay a pool of water sealing the gas (WLHC 346.1, 13).

8.1.8. A typical mid 19th-century gasworks would comprise a gas retort house with a series of outbuildings designed for the purification process. There would then be several gas holders close to the main buildings. Especially in the West Midlands, the typical location of the gasworks would be close to the canal network usually on an adjacent plot of land (as seen at the Windsor Street works). This allowed ease of distribution of coal in particular. Coal initially came from local sources but the poor quality of South Staffordshire coal meant that by the mid 19th-century gasworks looked further afield (Shill 1996, 117). The by-products from the industry may not have been sold locally and the canal allowed easy distribution. However, it was not uncommon to have a chemical plant associated with the gasworks (WLHC 346.1, 7).

The Development of the Windsor Street Works

8.1.9. The Windsor Street Works in Aston, which opened in 1848, were a replacement for the Gas Street works. Following its takeover by the Birmingham Corporation in 1870 Windsor Street underwent several phases of expansion and rebuilding, most notably in 1880 and 1887. Expansion in the early 1880s resulted in the construction of a retort house, purification plant, and several new gasholders on an adjacent 16 acre plot. In fact the level of clearance was so significant that the existing retort house and gasholders were pulled down and replaced by a new carbonisation plant (Shill 2006, 66). Birmingham Co. was supplying 2,327.6 million cu ft of gas to provide

mainly for Birmingham's street lighting; by 1911 they were supplying 7,693.6 million cu ft of gas a year to the city's homes, businesses, and industries.

8.1.10. In the 20th century the Birmingham Corpoartion at the Windsor Street Works also made and sold gas meters. By 1919 another four ranges of vertical retorts were built, completely replacing the earlier horizontal retort system (Shill 2006, 65) in 1937 they built a purpose built three-storey office and repair shop that faced onto both Windsor Street and Lord Street. In 1949 the British gas industry was nationalised, and Windsor Street was taken over by the West Midlands Gas Board. The 1960s saw a decline in the coal carbonising industry, due to the discovery of sources of natural gas, Windsor Street was the last working coal gas works in Birmingham (*ibid*, 56), production ceased in February 1974.

The Cartographic Development of the Phase 2 area

8.1.11. The early development of the northern area of the site is unclear. Although the canal branch leading from the Birmingham and Fazeley Canal has been constructed by the mid-1850s (Fig. 6 and 7) it is unclear when the Gas Works are predominantly laid out in the northern area. The undated engineering plan of the works clearly shows a series of buildings are laid out to the north of the bank of three gasometers (Phase 1 investigations). These are labelled Condensers, Purifiers and [Wash??] Unit. To the north area two circular structures form a twin scrubber tower and a further isolated circular structure possibly also a scrubber tower. A large isolated rectangular block on the map adjacent to the scrubbers is described as the engine house. To the south of this is a further small block possibly the boi[lers?]. Two canal basins extend from the Birmingham and Fazeley, beside which are three retort houses, the most easterly connected with the Engine House. The design of the retort house would appear to be at variance to others of the same period in the West Midlands in that they are long and thin as opposed to a almost square building but this may reflect the load-bearing capacity of roof designs at the time (eg Walsall *c* 1850; Hewitson 2005a and b).

8.1.12. A plan of 1876 depicts the expansion of the gas works to the east with the outline for the initial construction of the first of the large gasometers which date to this period (Fig. 8). Already constructed and suggesting an approximate date for the earlier plan are two parallel banks of purifiers and washers. They are longer and thinner, possibly with the retorts housed externally in horizontal banks. The area north of these structures is not depicted.

8.1.13. The first edition Ordnance Survey Map (1884, Fig. 9) does not display any buildings within the area of the site between the canal and the gasometers but the retort houses adjacent to the canal basins still exist. This may suggest the engine house has been demolished and redeveloped. By this time the fourth gasometer, located east of the bank and uncovered in the 2008 watching brief is visible. Both the large gasometer constructed *c* 1876 and two further gasometers to the east are also depicted. In addition two large blocks have been constructed to the east of the canal basins. Plans dated from 1880-1885 (kindly donated by National Grid and Celtic Technologies Ltd.) depict the rearrangement of the purification banks and this probably represents the more southerly of the two blocks. A meter and washer block are also built in these years but again it is unclear which block these are and it may be they are not depicted on the Ordnance Survey map. The northern structure adjacent to the canal represents a new retort house replacing the earlier retort houses to the west.

8.1.14. Large-scale redevelopment of the Windsor Street works in the early part of the 20th century resulted in reorganisation of the works and the addition of a direct link not

only to the canal, but also by tramways to the railway network (Fig. 10). Within the immediate area of the excavations the twin tower scrubber and the other circular structure [tower scrubber?] survive suggesting that the 1st edition had merely failed to mark these structures previously. To the north of these a new rectangular structure is depicted with tram links to it. This is depicted on plans as either a Carbonated Water Gas Plant or a Power House (see Figure 11 and 12). The south of the area of excavation depicts a series of blocks running parallel and to the west of the purifier blocks. One of these blocks is known to relate to the 'Compressor House', 'Exhauster and Electric Power House' and the 'Boiler House'. Next to the compressor house is a cooling tower (*c* 1913). This suggests the transition from steam power to gas/ electric power occurred in the early part of the 20th century probably directly replacing the stationary steam engine in the previous engine house (section 8.1.6). The adjacent block is known to have housed the Meter, Washer and Pump House strongly suggesting the area was part of the power source for the entire plant.

8.1.15. To the east of the excavations expansion of the tram system occurs to serve the large blocks presumably associated with the purifiers (A-D and E-F) and a new retort house in the location of the second retort house. This corresponds with a change in technology from the horizontal retorts of the 19th century to the automatic vertical retorts developed in the early 20th century.

8.1.16. The final period of alteration sees the majority of the smaller gas holders discontinued and replaced by a new meter house in the southern part of the site. Within Area 1 a bank of three 'cynagon purifiers' is constructed. This is a later development undertaken by 1923. The 'cynagon purifiers' are designed to remove impurities including hydrogen sulphide, carbon dioxide and hydrogen cyanide.

9. DISCUSSION

9.1.1. The watching brief on the excavations revealed at least one part of what probably relates to the earliest phases of the works after its establishment in 1849. Previous work had located the earliest gas holder bases towards the southeast (Hewitson and Hepburn 2008), but no evidence for subsidiary structures was located.

9.1.2. The structure located in the northeast corner of Area 1 is of unclear function. Two possibilities exist, that it related to the former engine house depicted to the north (see Fig. 7) or that it was a later extension and adaptation of the purification system housed to the south (see Fig. 8).

9.1.3. The two semi-circular long brick structures may relate to brick construction holders for two Lancashire boilers. Stationary steam engines would require boilers to provide the steam to power the pistons. Initially these were haystack or wagon types but were later superseded by Cornish and Lancashire boilers. Lancashire boilers consisted of two parallel furnace tubes and were invented by William Fairburn of Lancashire in 1844 (Hayes 2001, 27-8). A typical Lancashire boiler would be 8 feet (2.4m) in diameter by 30 feet (9.1m) long, this compares with the slightly narrower examples of 7 feet (*c* 2.1m) diameter and a minimum of 25 feet (*c* 8.0m) excavated here. The example of the Lancashire boiler bases adds to the body of evidence provided by the excavations at the Cambridge Street works in Birmingham (Mitchell and Hewitson *forthcoming*). Here the boilers were adapted from earlier examples, but the date *c* 1850s is comparable for a transition to the Lancashire type.

9.1.4. The second possibility is that these structures relate to part of the cooling system associated with the purifiers. Later examples are depicted in banks of two and the 1876 plan (Fig. 8) suggest these extend into the Phase 2 area.

9.1.5. The remains of a solid brick surface to the west of the boiler bases may relate to a base for a further structure. No retaining steel or iron pins exist and these can only be assumed to have been salvaged for scrap metal. There was no evidence for wheel trenches or bases to suggest an engine house. This may suggest the structure was not an engine house but this cannot be discounted.

9.1.6. The large circular base in the northwestern corner of Area 1 has been suggested to relate to a scrubber tower. It is certainly too large to be a chimney base and the absence of any obvious evidence for flues would appear to discount this structure type. Scrubber towers were purification units designed to remove the noxious sulphur compounds in raw 'coal gas'. Initially this was done by dry or the more offensive wet liming before the development of iron-oxide began to be used for gas purification from about the 1850s (Williams 1981, 16, fig. 2; an example from Nine Elms is reproduced here as Fig. 13). The tower scrubber was a vertical unit through which the gas would pass through a substrate of iron-oxide and the sulphur compounds would combine to form iron sulphide. This would slowly convert back to iron oxide on exposure to air. If this was a base for a scrubber tower it probably relates to one of a pair that were located here with the other lying outside the excavated area to the north of the site.

9.1.7. The other possibility as suggested for another of the circular structures is a tar and liquor well, the location however lends itself more to the Tower Scrubber given depictions on plans of the new Water Gas Purifier. Tar and liquor were a valuable by-product of the Coal Gas industry as they could be reused for a variety of materials including *naphtha* and *creosote* for water-proofing/ preserving and from the late-1850s a variety of organic chemicals. The value of coal tar increased to such a point that it was worth around a £1 a tonne for essentially a waste product by 1900 (Williams 1981, 18). The gas holders located in the Phase 1 investigations are known to have converted to tar/ liquor tanks once the new gas holders in the southeast of the site were established in the 1880s.

9.1.8. The final three circular structures located in Area 1 were the bases of three Cyanogen Gas Purifiers that are historically attested with plans from their construction in the 1920s. Cyanogen Gas Purifiers aim to remove impurities including hydrogen sulphide, caron dioxide and hydrogen cyanide from the gas by passing it through ferrous oxide. They represent more advanced version of the earlier scrubber towers, that must have been superseded by them.

10. CONCLUSIONS

10.1.1. Examination of the mid-19th century plan and understanding of the coal gas purification process suggest that the process of coal gas can now be defined for the earliest gas work at Windsor Street. The first Gas Works developed by 1849 was laid out and aligned along Lord Street. However, coal was initially imported from the canal wharf directly into the three retort houses where the initial liquor was extracted. This then passed through the twin-scrubber tower, one of which was uncovered in Area 1. Here the gas was separated and tar liquor removed. The Tar Liquor was stored in adjacent tar liquor vat located adjacent to the canal where it could be directly distributed back onto available tar boats and sold on to tar processors. The remaining gas then passed to two banks of condensers and the wash halls before passing to the centrally located purifiers to remove the harmful ammonia and sulphur and cyanide compounds. The gas would eventually be passed to the series of gas holders that were located in the south-western corner of the site, three of which were recorded in Phase 1 of the watching brief (Hepburn and Hewitson 2008).

10.1.2. It is clear that the power source for the industry was still the reliable steam engine, the Lancashire boilers of which were uncovered in Area 1. The probable use of the engines was as a power source for the pump house. The pump house would be required to deliver the gas under pressure to the gasholders, prior to delivery to the grid. Later versions of the pump house would have either been electric or more probably gas powered like examples seen at the Granton Gas Works (Sproat 2005, 39).

10.1.3. By the 1880s a radical alteration of the gas works occurred and this involved the realignment of the gas works so the structures followed the line of the Birmingham and Fazeley Canal. This appears to be as a result off increased demand for town gas. The construction of an entirely new major Retort House, a bank of new coal gas purifiers to the south of this. The scrubber towers appear to have survived (although not depicted on cartographic sources).

10.1.4. By the early 19th century the whole complex has been connected to the railway system by a series of lines and the focus of transport has shifted away from the canal. A further Carburated Water Gas (CWG) purifier was established that sought to reuse the former scrubber towers, in addition to this a whole series of new structures were constructed in the centre of the site including a meter house, and exhauster house, a boiler house and a washer house. At this stage the three cynagon gas purifiers located in Area 1 were constructed.

11. ACKNOWLEDGEMENTS

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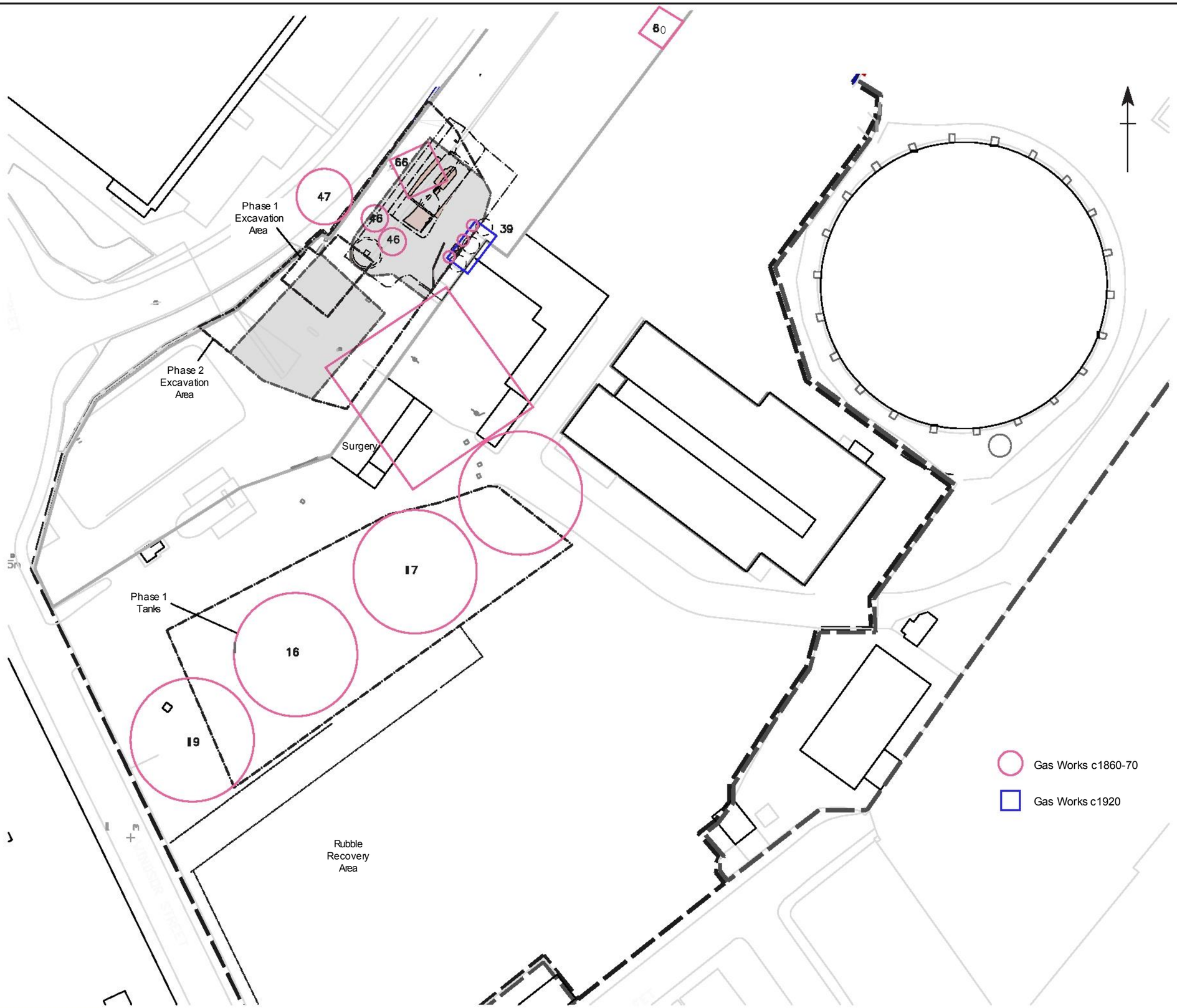
Figure 1: Site Location



Historical Structures

1. Engine Sheds
2. Chemical Labs
3. Meter House
4. Water Gas Purifiers
5. Weigh Office
6. Workmens Mess Room
7. Carpenters Shop
8. Blacksmiths Shop
9. Fitting Shop
10. Houses (2 No.)
11. Booster House
12. Offices and Stores
13. Governor House
14. Official C.V. Tester
15. Fittings Department
16. Relief Holder
17. Tar and Liquor Tank
18. Meter and Stove Slopes (later offices)
19. Gasholder
20. Industrial Research/High Pressure Gas Labs
21. Borehole Water
22. Meter, Washer and Pump House
23. Cooling Towers
24. Wagon Repair Shed
25. Oxide Gantry
26. Oxide Crane
27. Coal Gas Purifiers
28. Condensers (Liquor Tank)
29. Condensers (Water Tanks)
30. Livesey Washers
31. Tar and Liquor Separating Tanks
32. Liquor Sales Tank
33. Compressor House
34. Exhauster and Electric Power House
35. Boiler House (later paint store)
36. Kirkham Washers
37. CWG Purifiers
38. 'A set' Water Gas Purifiers
39. Cyanogen Purifiers
40. Weighbridge
41. Water Cooler
42. Electricity Substation43
43. MEG Storage Tank
44. Work Foremans House
45. Carburetting Plant
46. Tower Scrubber
47. Tar and Liquor Well
48. Hydraulic Accumulator
49. No.7 Gasholder
50. No.8 Gasholder
51. No.9 Gasholder
52. No.10 Gasholder
53. Condensers Water Tube
54. Chimney
55. Coke Sales
56. Diesel Tank
57. Weighbridges
58. Gasholder
59. Railway Tracks
60. Hopper
61. Technical and Customer Service
62. Admin/Internal Post Office
63. Hall CWT Coke Sales
64. Superheater
65. Condensers
66. Unknown
67. Water Gas Electro Detarrers
68. Oil Tanks
69. CWG Naphalene Washer
70. Benole Washers

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Figure 2: Location Areas

Phase 2, Area 1

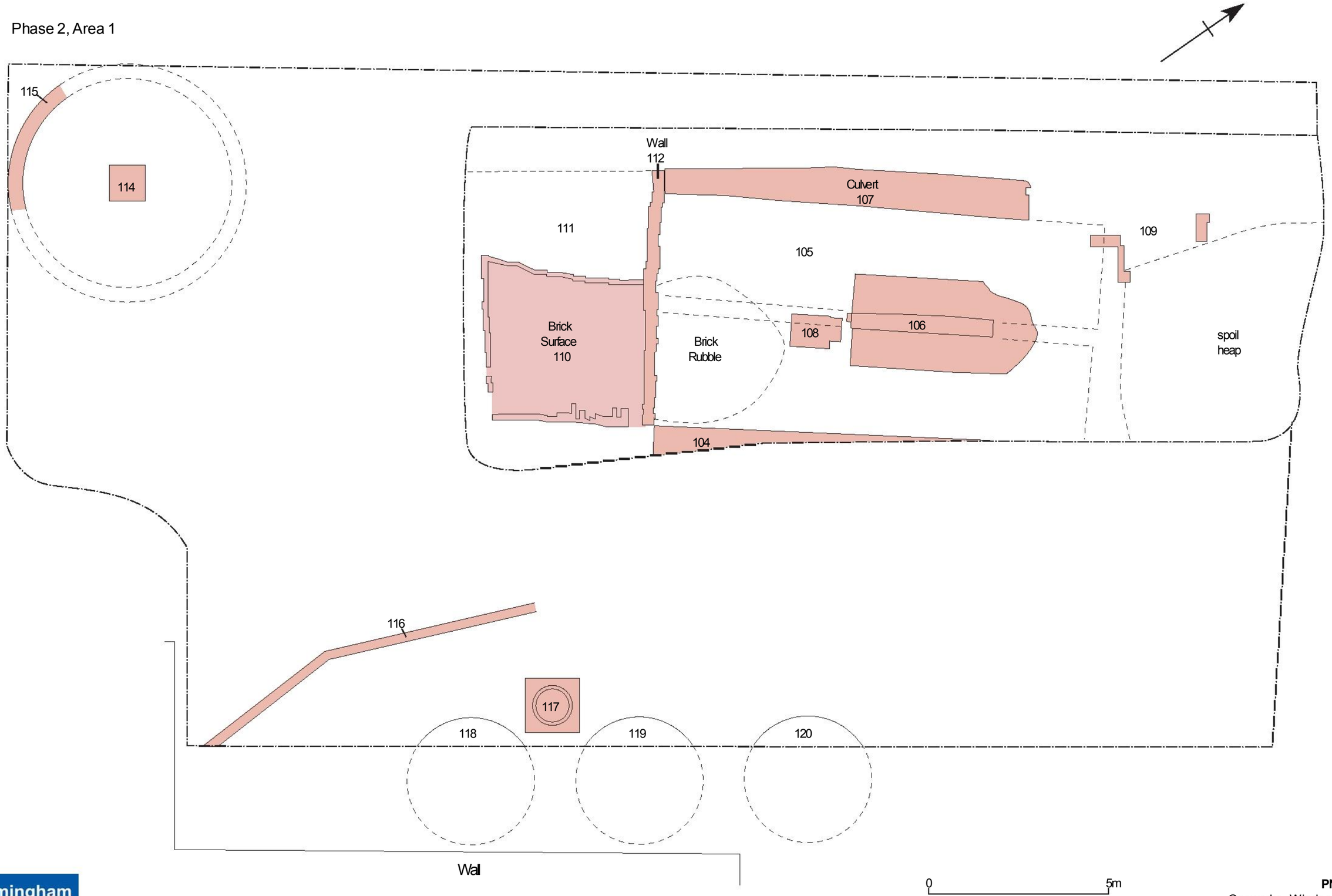

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Figure 3: Trenches

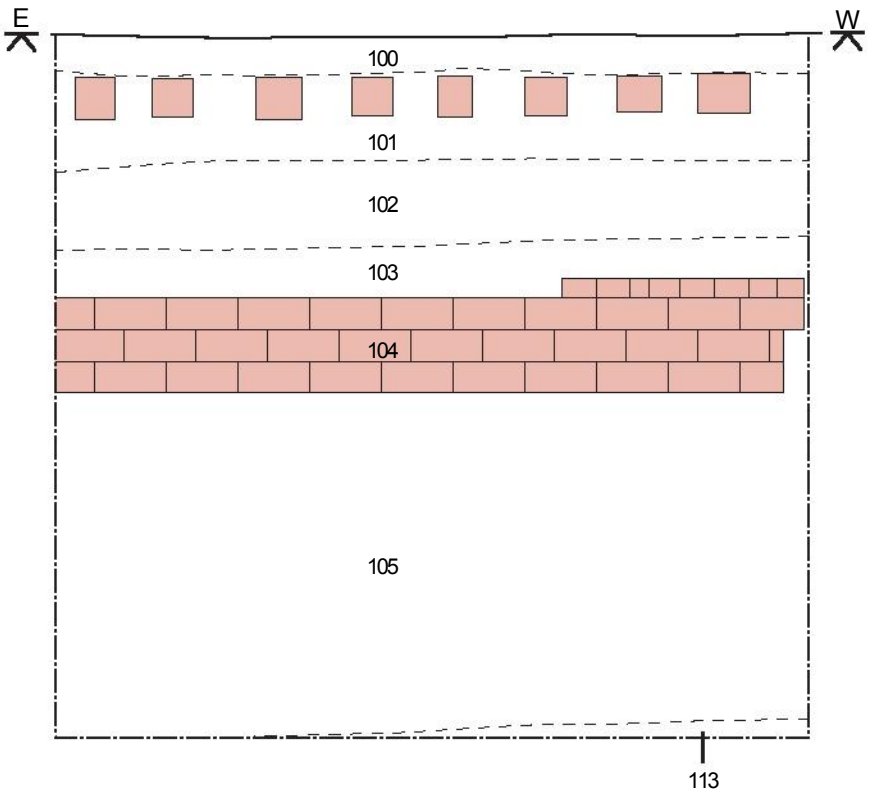

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Figure 4: Section

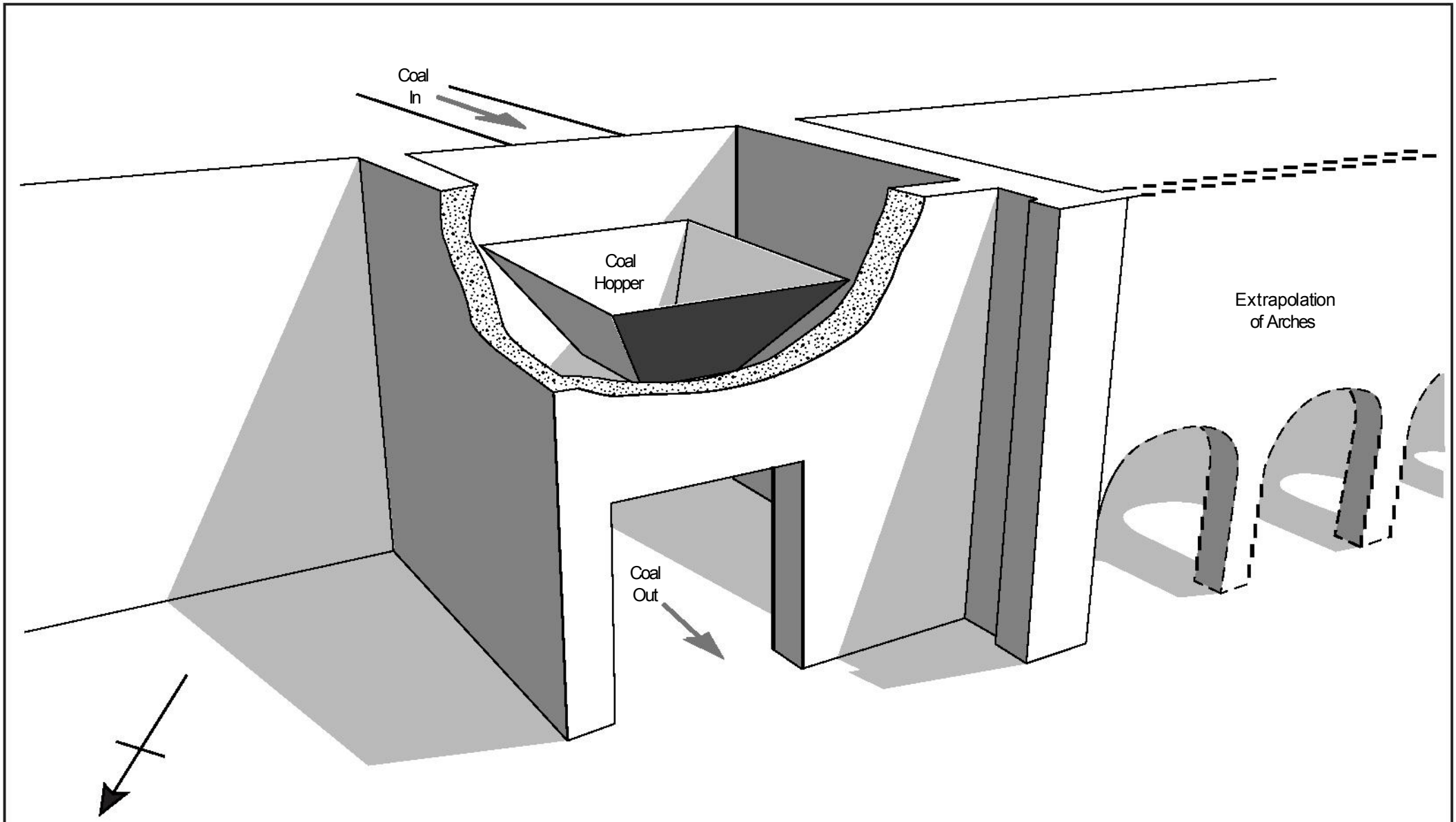

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Figure 5: Isometric

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Figure 6: 1855 Map

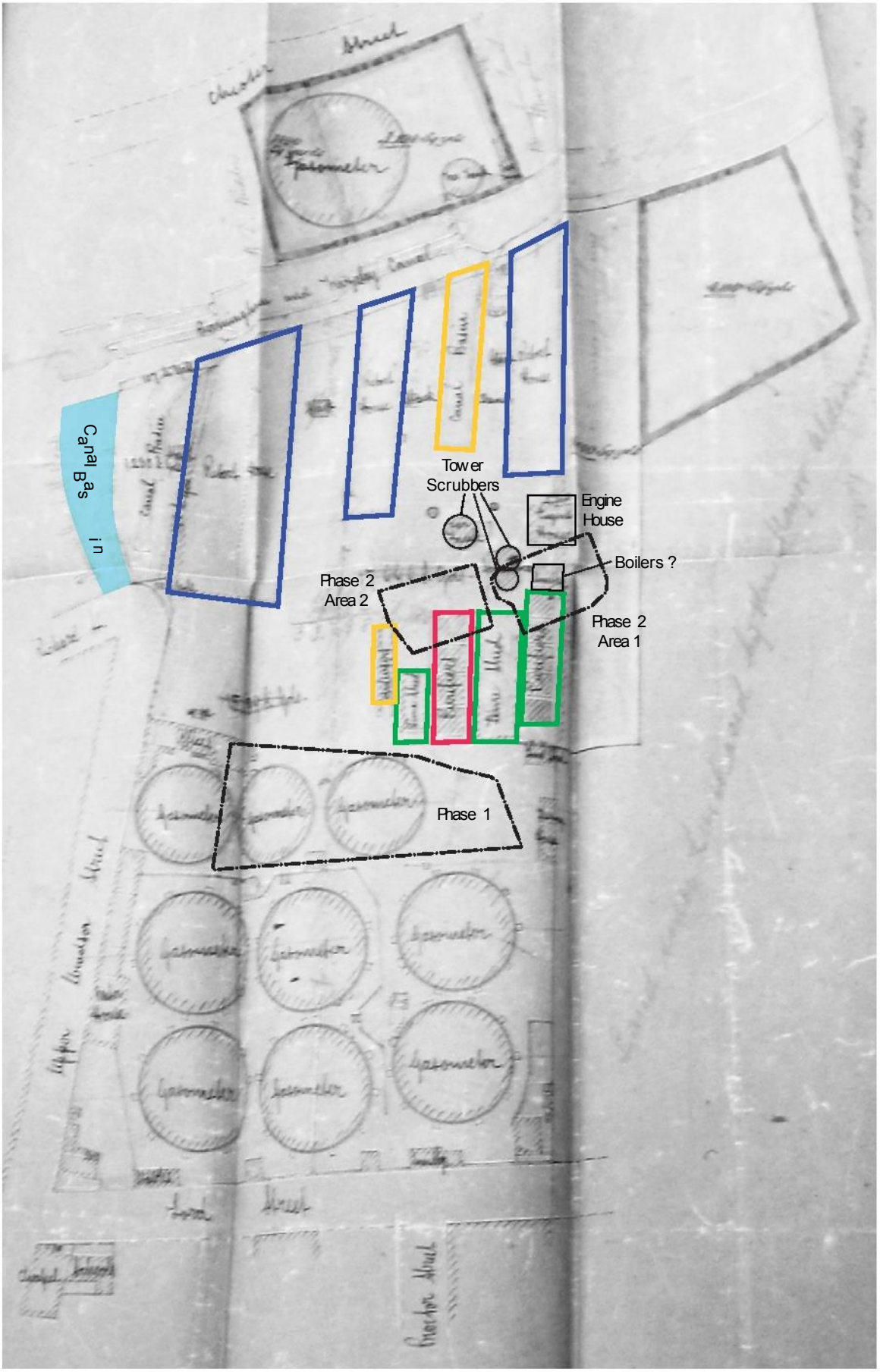

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Figure 7: c1860-70 Map

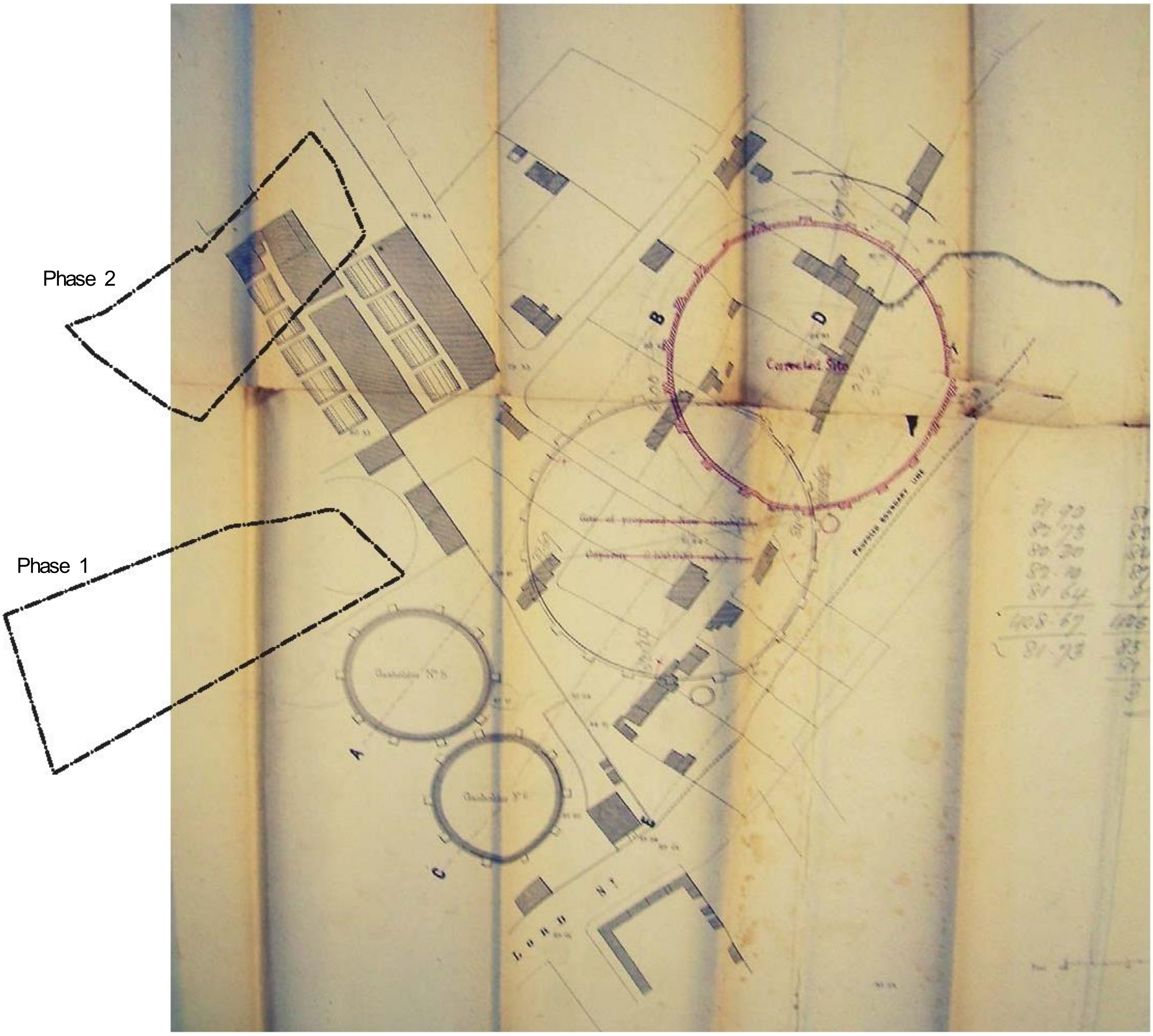

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Figure 8: 1876 Map

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Figure 9: 1884 map

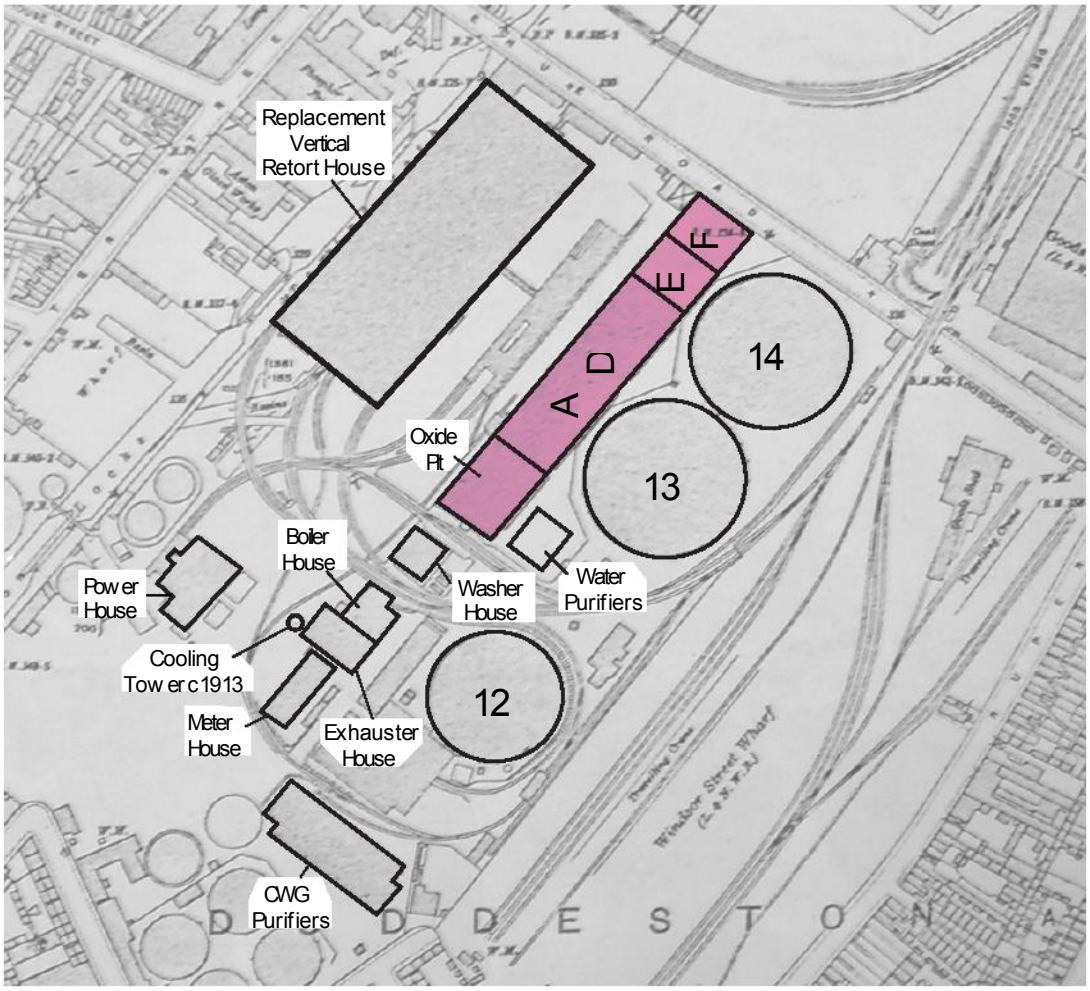

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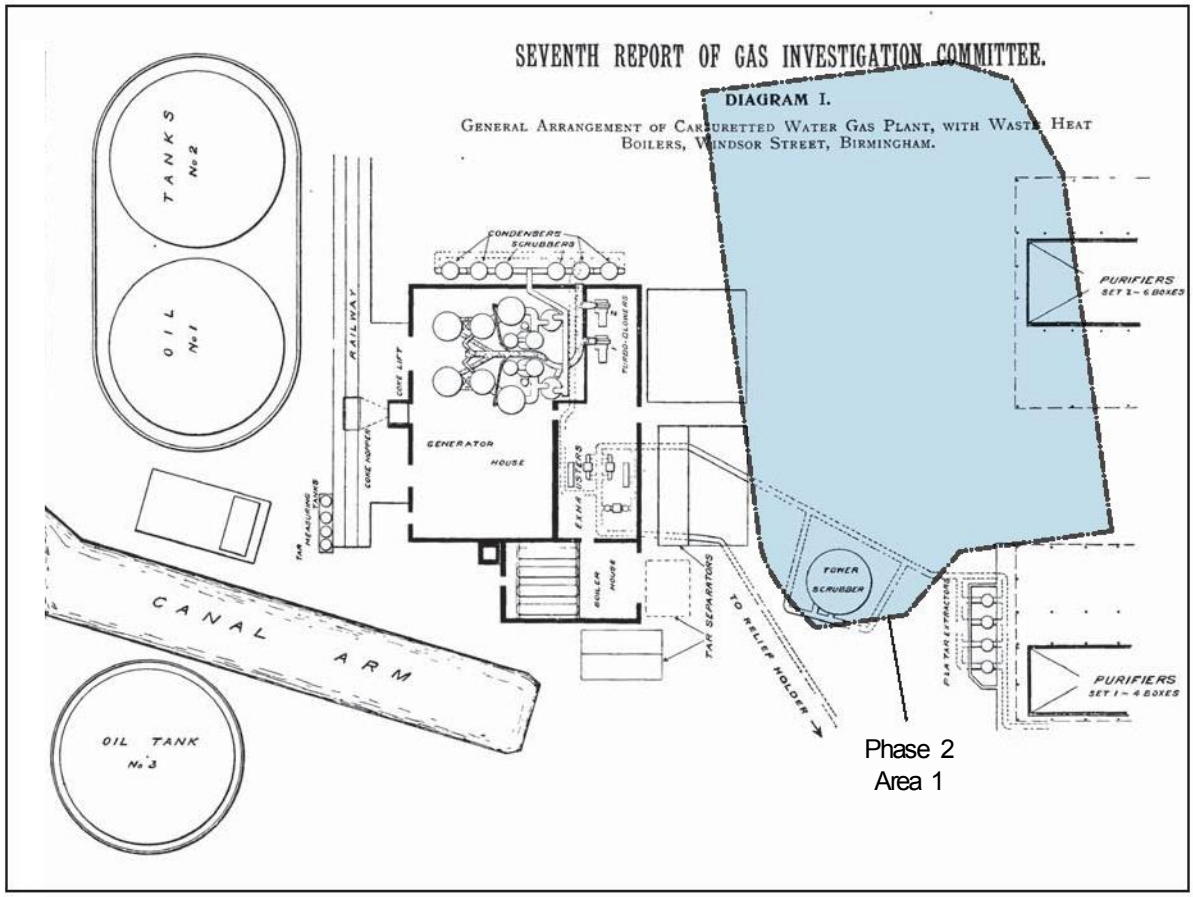
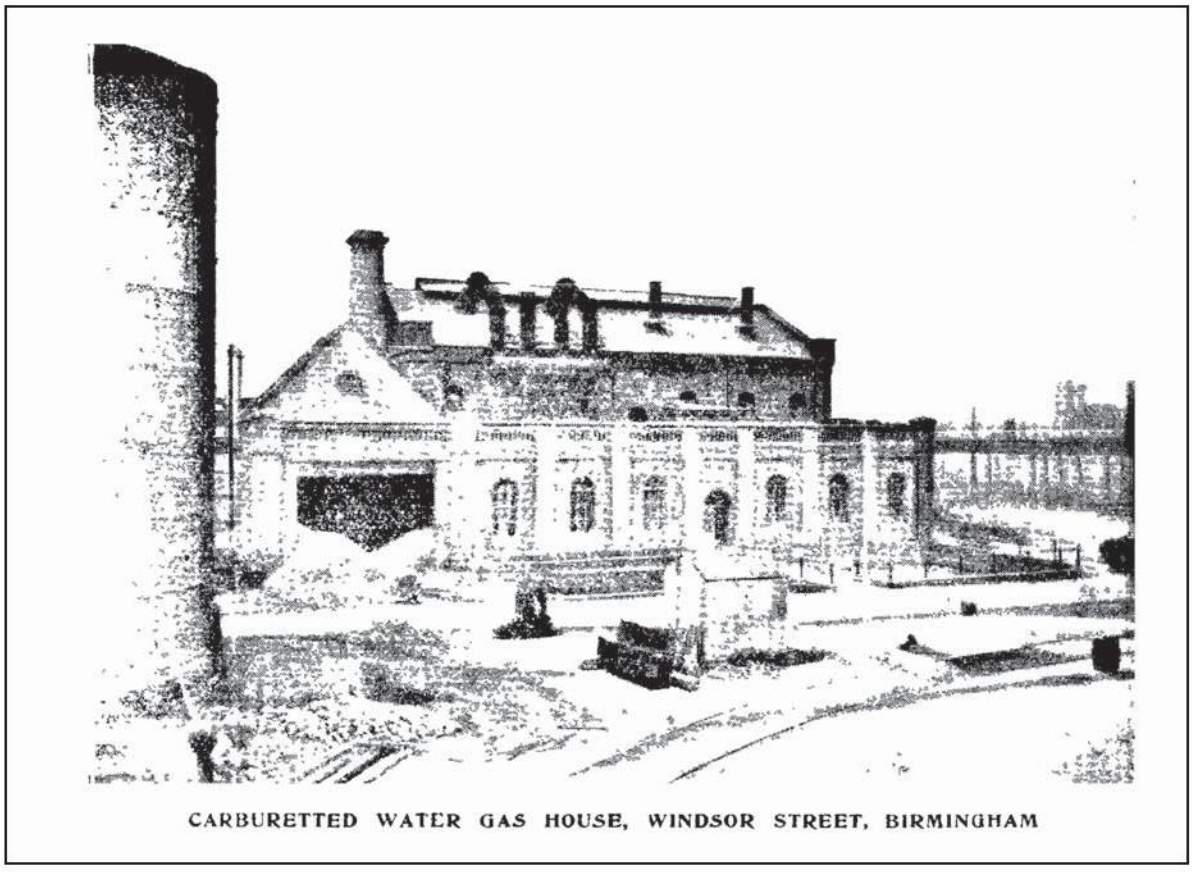
Figure 10: O.S.map 1917





CARBURETTED WATER GAS HOUSE, WINDSOR STREET, BIRMINGHAM

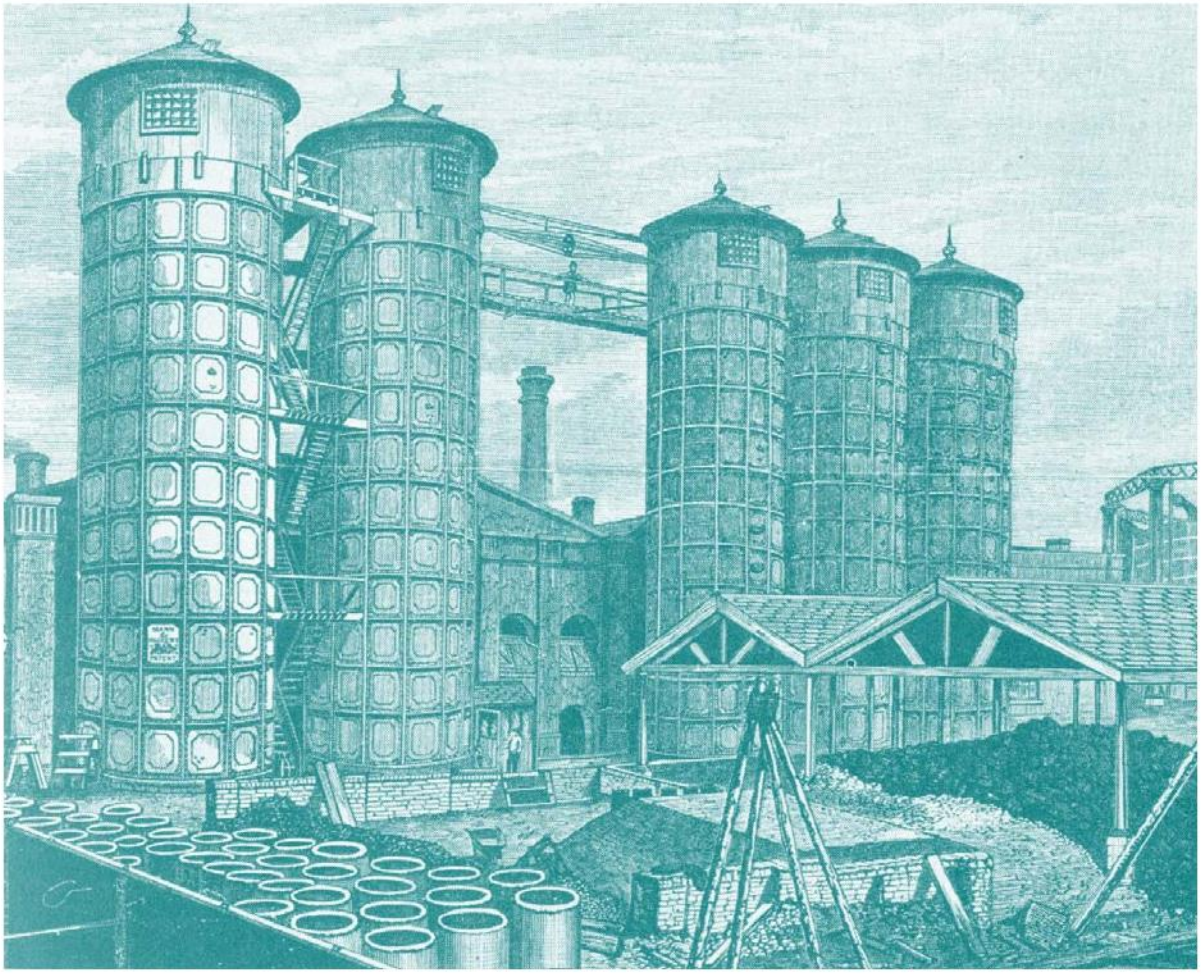


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Figure 13: Scrubbers at Nine Elms c.1870

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Plates 1 - 4


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