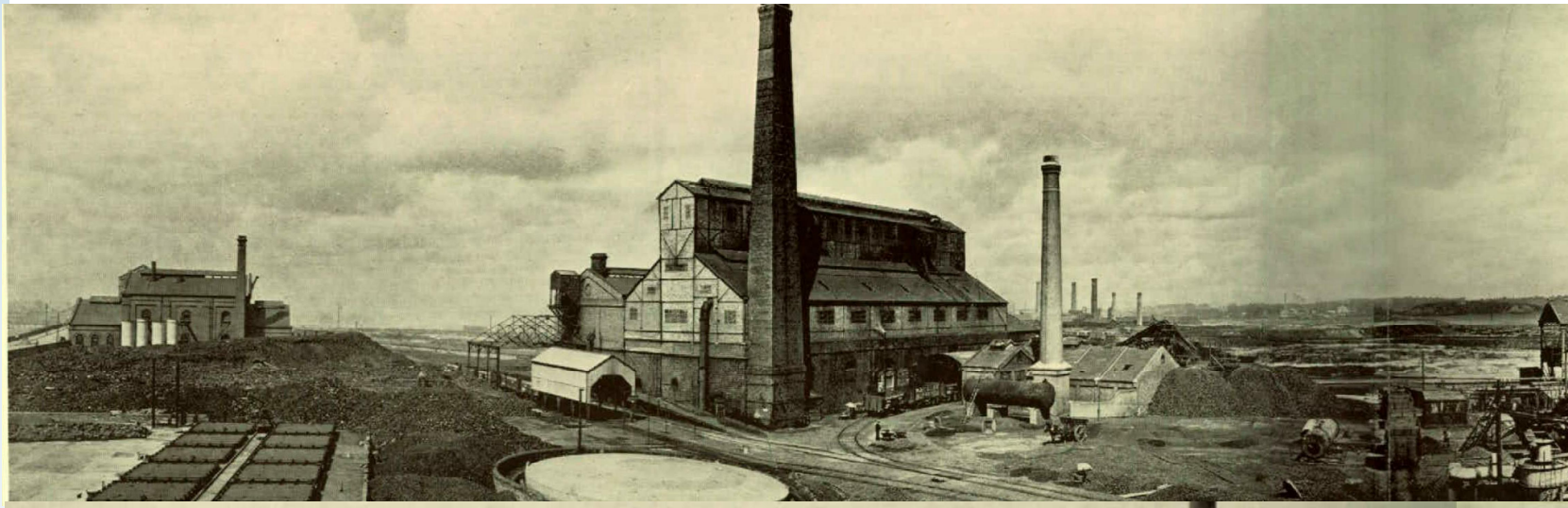
Regeneration & development of former gasworks sites

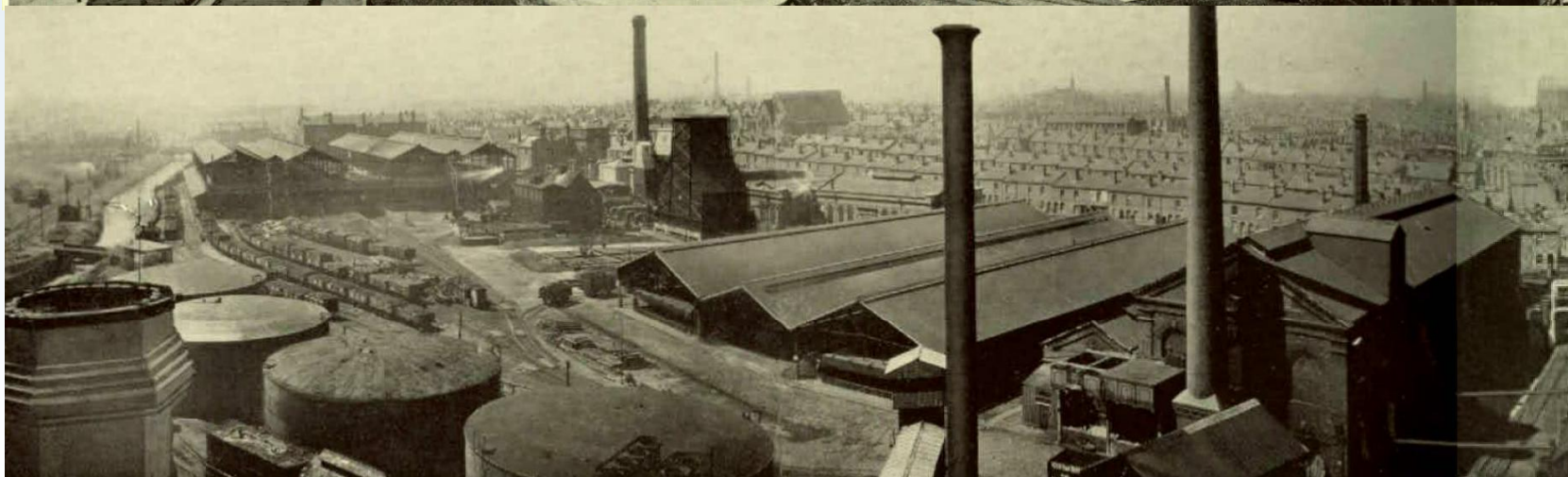
Prof. Russell Thomas

Ground Risk and Remediation – WSP Bristol

Purpose

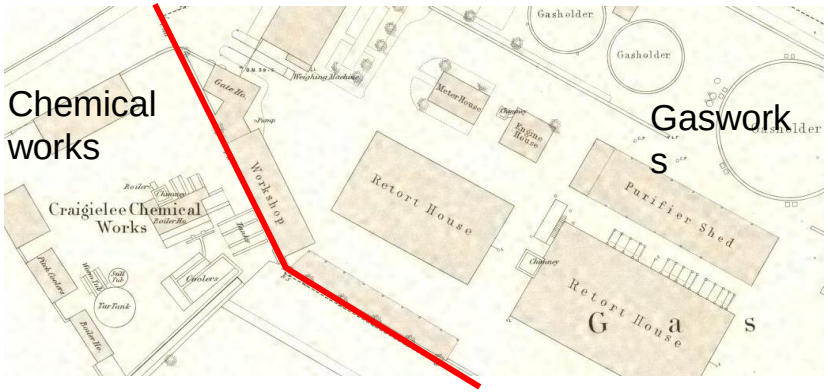
- Brief Description of the History of Gas Manufacture
- Processes used in gas manufacture.
- Key issues when investigating this sites.





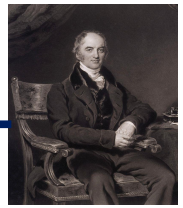
Gas – an Important British Industry

- Gas produced from coal was the first effective form of lighting;
- Old – it predated the railway network , the 1st utility industry.
- Gas lighting improved factory working conditions and safety;
- Street lighting was often introduced to reduced crime rates;
- A strong proponent of employee ownership; and



- The by-products were the feedstock's for the chemical industry, dye manufacture and fuel.
- Associated industries located near-by.

Evolution of the British Gas Industry



Competition from oil gas – 1817-1830

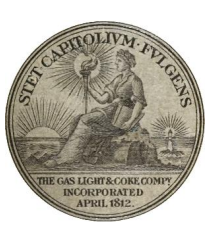
Coalville Urban District Council Gas

The Gas Act 1948

Nationaliation – 1949
Regional Gas Boards

Independence 1812 – 1949
Public and privately owned gas companies

Creation of the Gas Light & Coke Co. 1812



Frederick Winsor: Entrepreneur Behind the Gas light & Coke Co.

Construction of the first factory gasworks 1805/6 onwards

William Murdoch: Inventor of gas lighting

Samuel Clegg: 1st Gas Engineer

The Gas Act 1972 (Centralisation)

BritishGas

British Gas Corporation -1973

The Gas Act 1986

British Gas Plc - 1986

BG plc – 1997
Demerger of British Gas to Centrica and BG plc.

centrica

BG plc

BG Group

Lattice Group - 2000
Demerger of BG plc to the BG Group and Lattice Group.

Lattice
THE INFRASTRUCTURE TECHNOLOGY GROUP

National Grid – 2002. Merger of Lattice Group with National Grid

nationalgrid

Gas Transmission retained

nationalgrid

Sale of Gas Distribution networks : Wales and West, Scotia Gas Networks, Northern gas networks & Most recently Cadent Gas Ltd

WALES&WEST UTILITIES

SGN

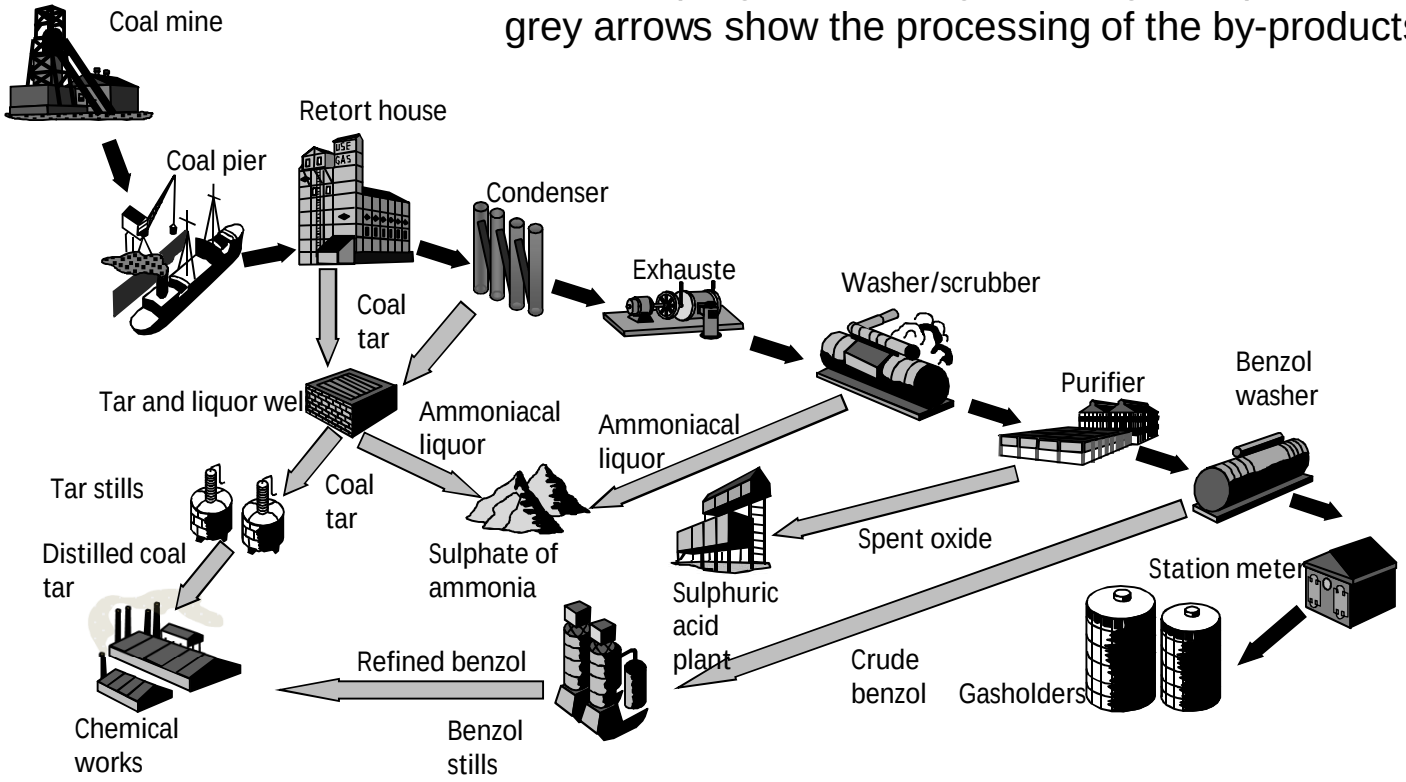
Northern Gas Networks

nationalgrid → Cadent
Your Gas Network

wsp

Gasworks Process Flow Schematic

The manufacture of gas from coal. The black arrows show the progress of the gas through the plant and the grey arrows show the processing of the by-products.

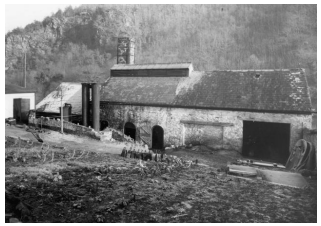


Retort House

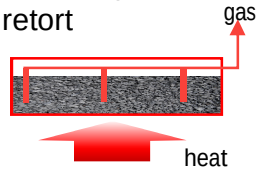
Gas was manufactured from the thermal decomposition of coal in an oxygen free environment in a vessel called a retort. It's composition was approximately:

Non combustible components	**Coal gas**	**Natural gas**
Carbon dioxide	2.0%	0.6%
Oxygen	0.5%	---
Nitrogen	5.5%	2.7%
Combustible components		
Carbon Monoxide	7.5%	---
Hydrogen	51.8%	---
Methane	27.0%	90%
Other Hydrocarbons (Ethane, Propane, Butane, Benzene and others).	4.7%	6.7%

Different Gas Manufacturing Processes

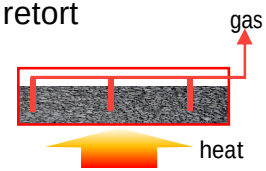


- Low temp. horizontal retort

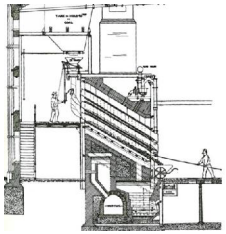


- Tars rich in phenols and paraffins.

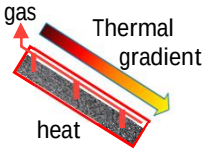
- High temp. horizontal retort



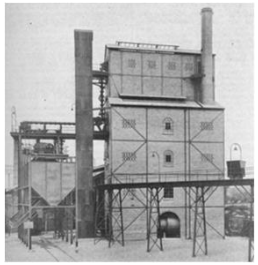
- Tars rich in benzene & naphthalene.



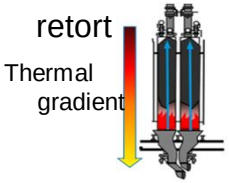
- Inclined retort



- Tars varying composition.

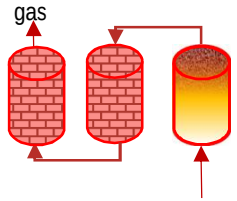


- Continuous Vertical retort



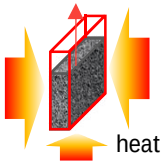
- Tars varying composition.

- Carb. Water Gas

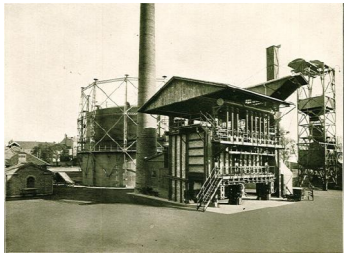


- Oil based tars with coke/coal signature.

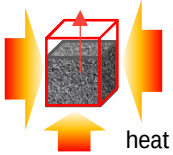
- Coke Oven



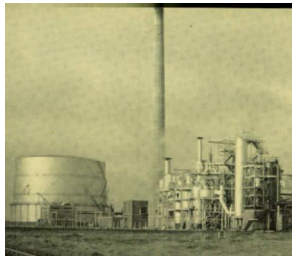
Tars very rich in benzene & naphthalene.



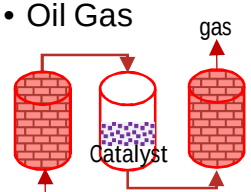
- Chamber Ovens



- Tars rich in benzene & naphthalene.



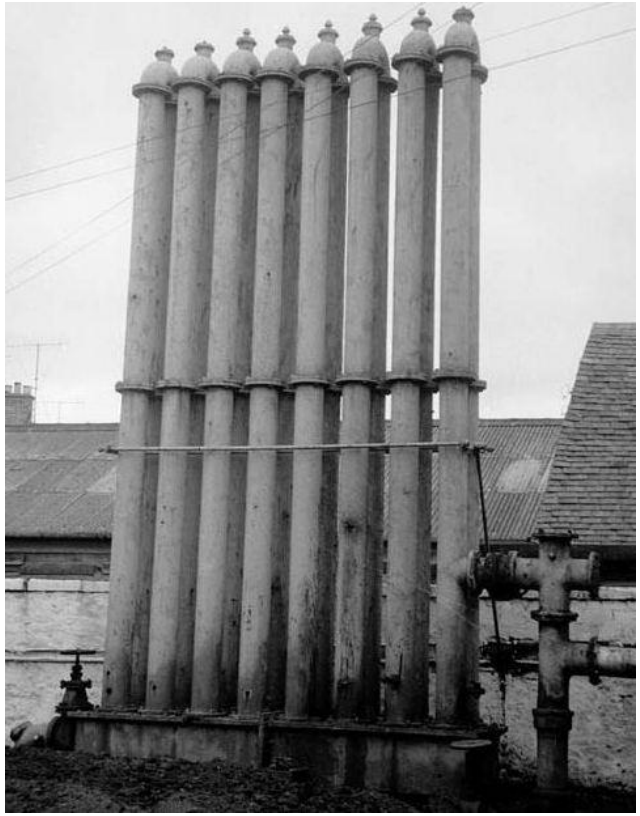
- Oil Gas



- Oil based tars

The Condensers

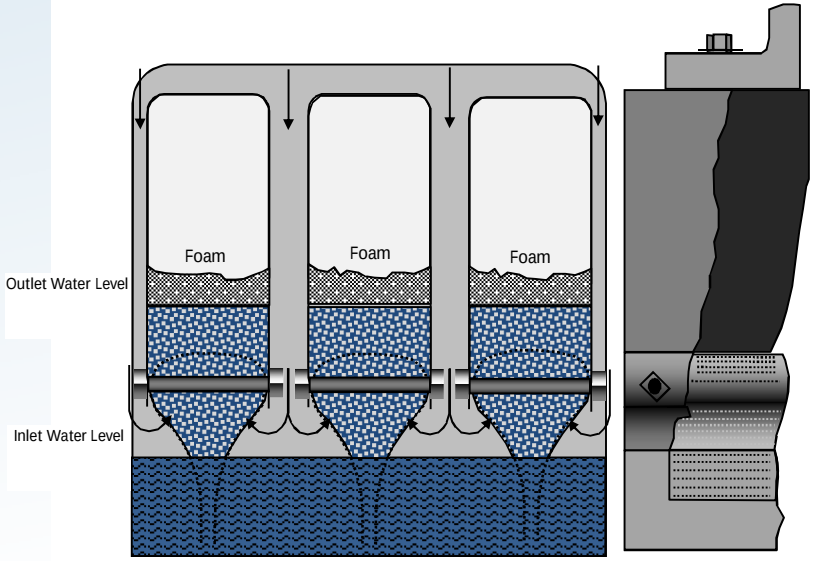
- Cooled the gas and removed coal tar and liquor, which drained to the tar tank.
- Many different designs were employed, three common forms.
- The atmospheric condenser relied on air to cool the gas.
- The annular condenser. Cooled by the atmosphere and water.
- The water tube condenser was cooled by water filled tubes.



Condensers were built above ground

Tar Washers

- Remaining tar, ammonia and phenol were removed from the gas by washers and scrubbers.
- The Livesey washer was designed to remove residual tar, but would remove some phenol and ammonia.
- Gas bubbled through seals or perforated plates and over weirs of liquor.



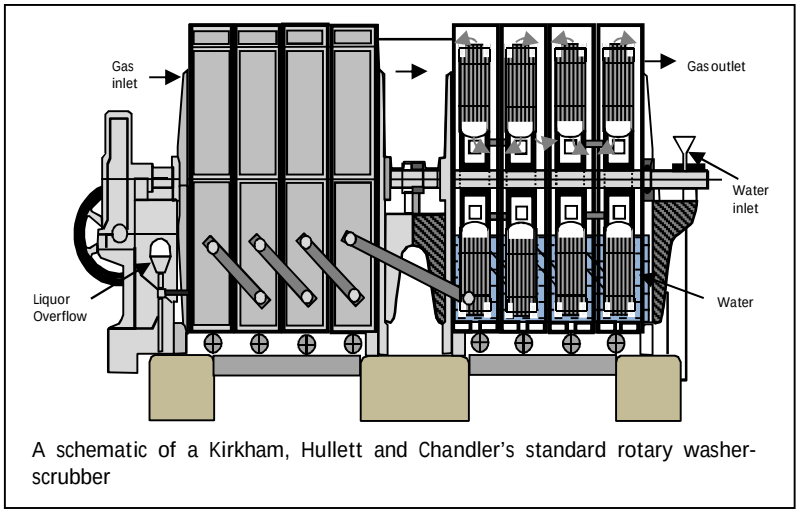
- Tar was caught of the plates and the ammonium and phenol would dissolve in the liquor.
- It drained to the tar and liquor tank by gravity, where it would float on top of the tar.
- Tar extractors carried out the same role.

Scrubbers/ Washer Scrubbers

Tower scrubbers.

- Scrubbers/washer scrubbers – Static or mechanical systems
- Static Scrubbers – Cast iron towers filled with coke, bricks, planks or ceramic rings.
- Gas flowed upward against a spray of cooled water or liquor absorbing the ammonia and phenol.
- Replaced by rotating horizontal or vertical cylinders, containing spinning blades of filter media.

Scrubbers/Washer Scrubbers were built above ground

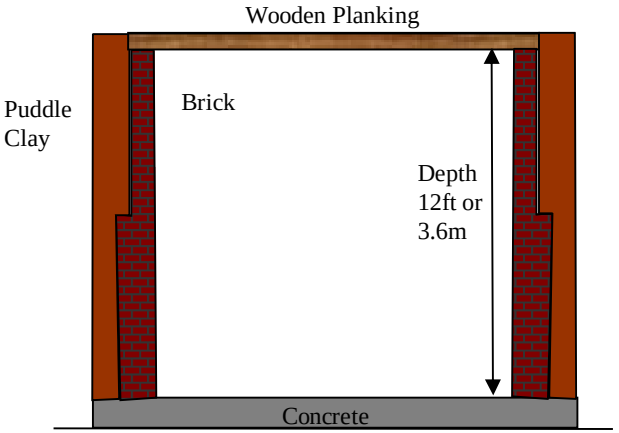


A schematic of a Kirkham, Hullett and Chandler's standard rotary washer-scrubber

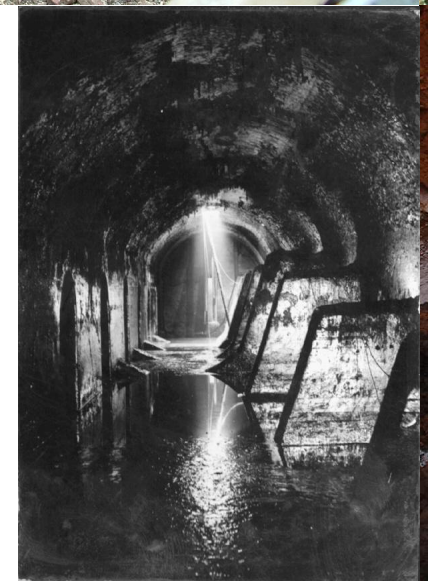
Tar Tanks

- Tar & liquor were stored together in underground tanks.
- Constructed of brick, stone, concrete, cast iron or steel in circular, rectangular or square form, with vaulted roofs.
- The outer facing wall of brick tanks were lined with puddle clay for water proofing.
- Small tanks had wooden covers for protection.
- When too full of solid tar/sludge they would be dug out by hand.

Excavating a circular tar well at a small country gasworks in Norfolk.



Tar Tanks



Dumping of Coal Tars

- Coal tar markets for sale were limited initially.
- It’s value increased as the market for coal tar dyes developed.
- On small gasworks it could be difficult to sell.
- It was run to ground in dump areas forming a thin crust.
- It was dehydrated and mixed with ash to form a poor quality tarmac.

Purification

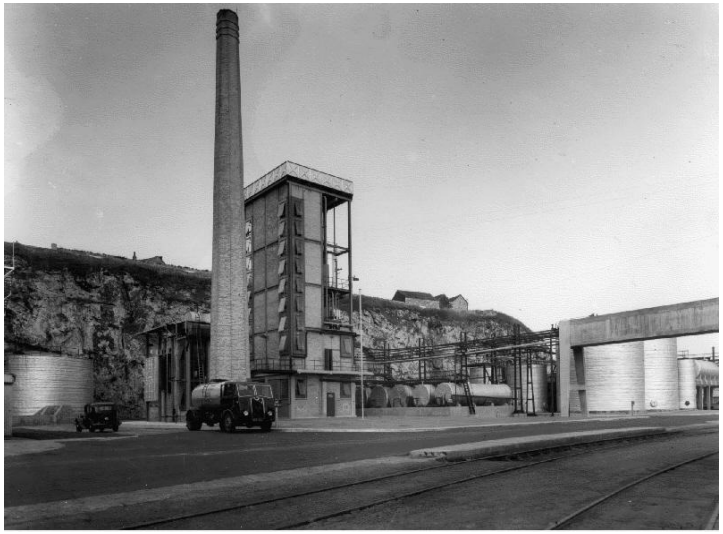
- Hydrogen sulphide and hydrogen cyanide were removed by precipitation.
- The gas was passed through iron boxes filled with slaked lime or iron ore.
- The lime or iron became saturated with sulphur and had to be revivified by exposure to air.
- The oxide/lime became “Spent” when it contained about 50% sulphur & 6% cyanide.
- Foul Lime used as a fertiliser and Spent oxide used for sulphuric acid production.
- Early processes used wet lime – formed waste blue billy
- Later liquid processes developed – Stretford process.

Dumping of Purifier Wastes

- Purifier wastes could become problematic to dispose of.
- On-site dumping common – spent oxide dumping increased as markets disappeared.

Some other Gasworks Structures

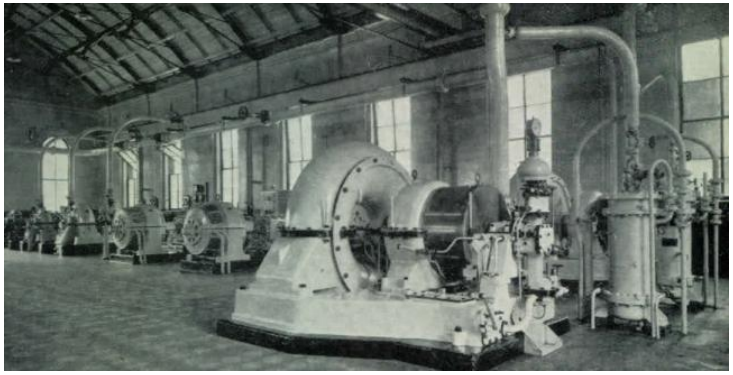
Tar Distillery



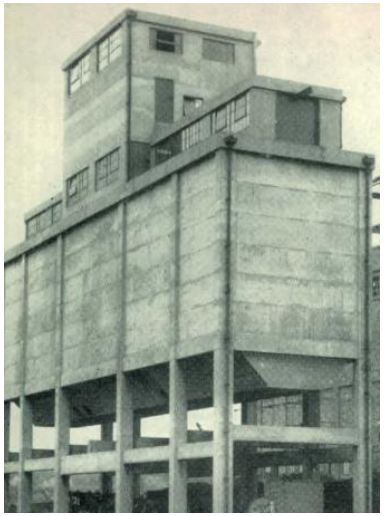
Meter House

Benzole Plant

Exhauster and Booster House



Coke plant



Power House

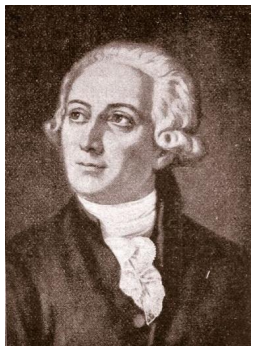
Gasholders

- Used to store purified and metered gas.
- Removed the need for continuous gas production, storage acted as a buffer.
- Consisted of two parts
  - A tank containing water which provided a seal to prevent the gas escaping and acted as a resisting surface to the incoming and exiting gas to make the vessel rise and fall;
  - A vessel closed at the top but open at the base which held the gas
- The weight of the gasholder vessel determined:
    - the pressure to the gas in the mains; and
    - the back pressure on the gas making plant (if no exhauster was used).

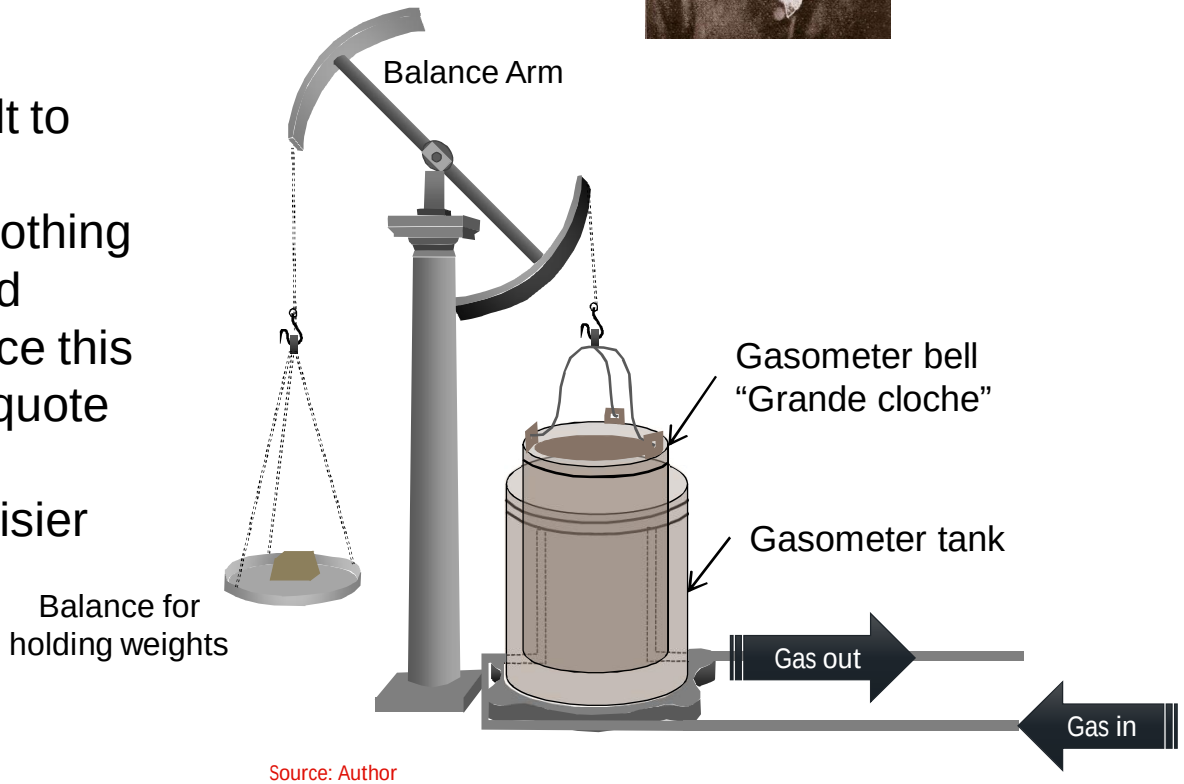
Lavoisier's Gazomètre

Lavoisier devised the gazomètre for experiments in pneumatic chemistry.

"It would be difficult to dispense with the gazomètre since nothing that ingenuity could devise could replace this important device" quote in Kings Treatise accredited to Lavoisier



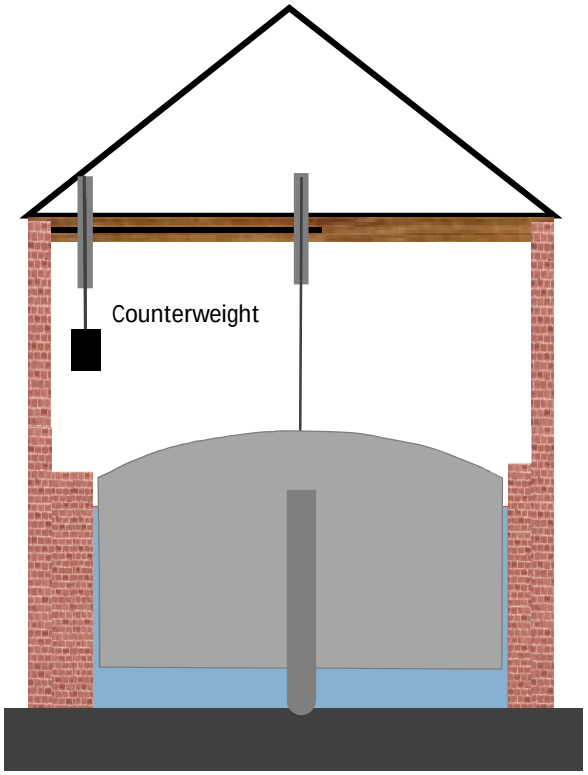
Drawing of Antoine-Laurent Lavoisier.
Source: Wikimédia Commons



Source: Author

Early Gasholders

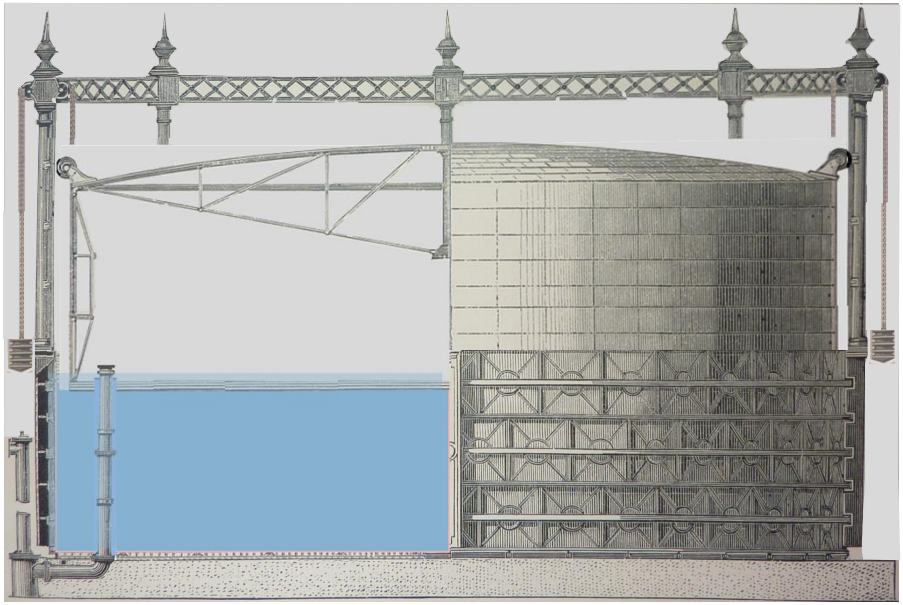
- The gasholders were an integral part of all gasworks.
- Counterweights used in early gasholders.
- An early B&W gasholder for Philips and Lee Mill in Salford is shown right.
- The very early gasholders were built in iron or wooden tanks above ground, guided by chains.
- Below ground brick or stone below ground tanks started to be used in 1818.
- Brick tanks were waterproofed on the outer wall with puddle clay.
- The Royal Society reviewed the safety of gasholders in 1814 and recommended that they were limited to 6000 Ft^3 capacity and housed in strengthened buildings.



Source: Author

Column Guided Gasholders

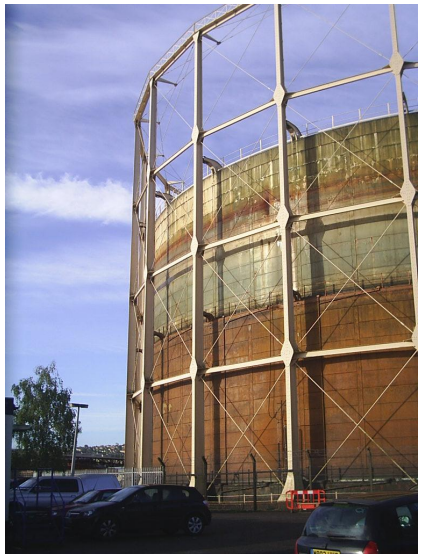
- Early guided gasholders used vertical iron rods attached to the inner sides of the tripod.
- Metal plates with eyelets were attached to the top of the gasholder vessel.
- The tripods were replaced by columns which were connected to ensure rigidity.
- On the inside of these columns, guide rails were attached to ensure the rigid guiding of the lifts.
- Guide wheels were attached to arms extending from the rim of the top of the gasholder lifts.



Source: Author

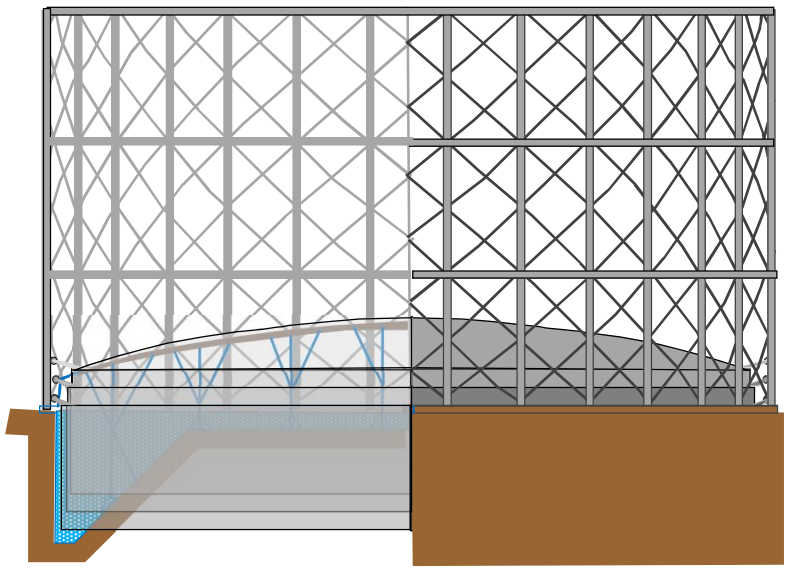
Framed Guided Gasholders

- Heavy cast-iron columns were unsuitable for very high gasholder, as the piers required were large and costly.
- They were superseded by guide framed gasholders which were lighter and built an extensive outer cylinder of structural steel or ironwork.
- An important development was Cutler's patented guide framing.
- Consisted of vertical standards braced by diagonal triangulated framing.



Source: IGEM PHI/ Author/N.Snedker

Telescopic Gasholder

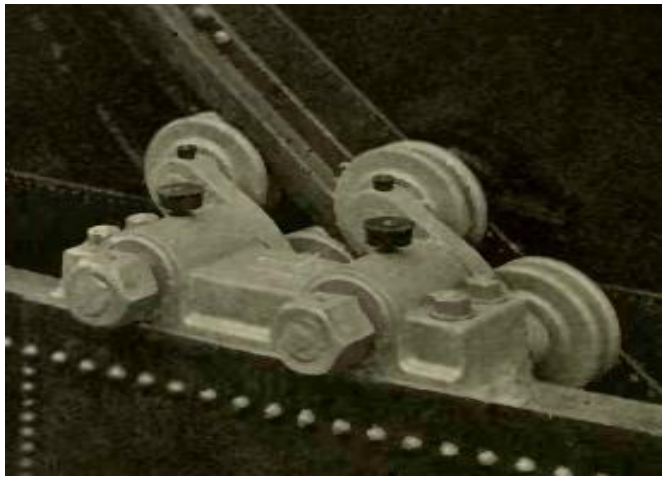


Source: Author

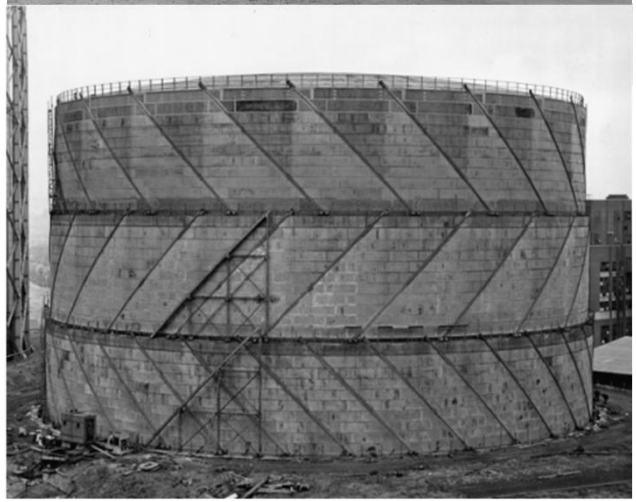
- Telescopic gasholders could store a greater volume of gas within the same.
- The first example is attributed to Tait and was built in Leeds.
- Clegg Jnr in his 1841 treatise, commented that telescopic gasholders were an expensive exception, only to be used in highly constrained sites.
- They became common with many single-lift gasholders retrofitted to multiple-lift holders.

Spiral Guided Gasholders

- The spiral-guided gasholder concept invented by William Gadd.
- First example built Northwich in 1890.
- Dispensed with the external frame above the tank.
- Lifts were strengthened.
- Spiral guide rails were fixed to the side of the gasholder lifts & carriages to the tops of tank & lifts.
- Built in above & below ground tanks.

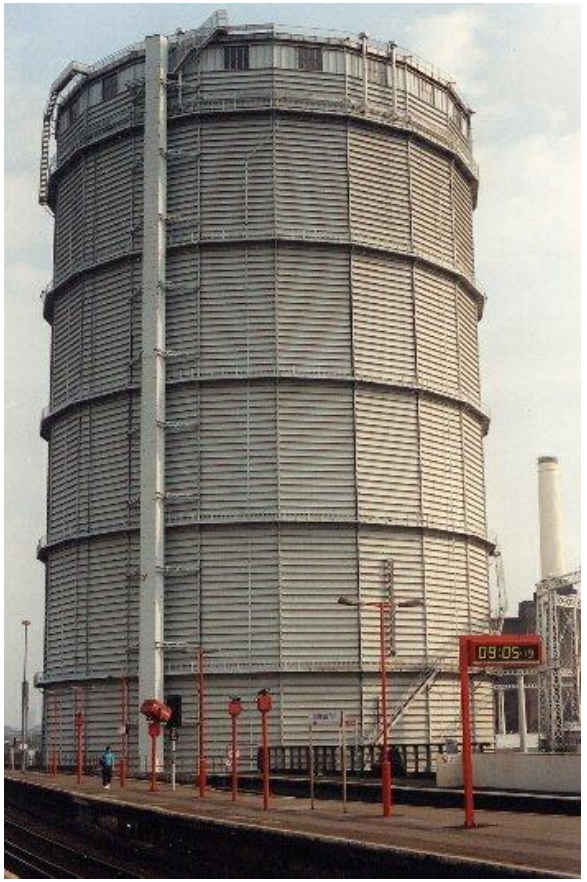


Source: IGEM PHI/ Author/NGGA



Flying Lifts and Dry Gas holders.

- A flying lift was an additional inner lift retrofitted into the gasholder;
- The flying lift would extend above the columns or standards without being directly attached to them



- Dry gasholders were a simplified system, no tank required, the major moving part was the piston, which moved with the aid of guide rollers.
- MAN (tar sealed), Klonne (grease sealed) & Wiggins (Rubber seal)

Source:
Author/NGGA

Gasholder Crown Support and Dumpling

- Crown support stopped the crown from collapsing when empty of gas
- Could be wood or metal.
- Some crowns are internally trussed and rest on a central pillar.

Source: N.Snedker

War and the Gas Industry

- Gas infrastructure heavily targeted and damaged during the war.
- UXO risk.

Services and Infilled Land.

- Services may cross historic structures. Drainage.

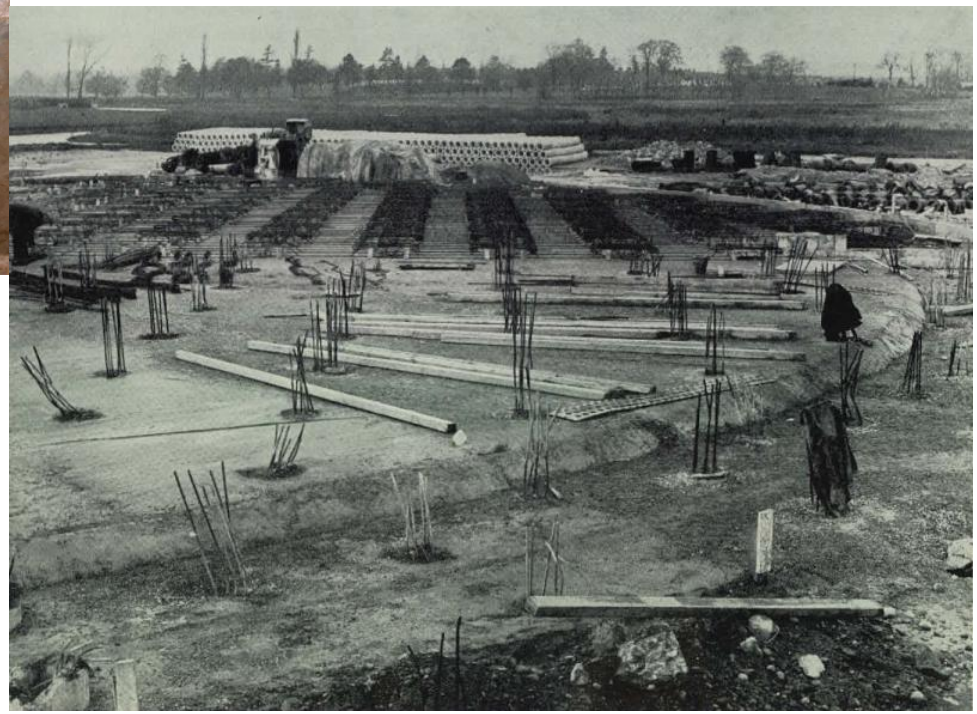
• Vast areas could be subject to disposal of site won material including wastes.

- Gas mains can be very complex, some redundant mains can still be live.

Foundations

- Underground tanks, basements, subways are all common.
- Piling used to support above ground gasholder tank platforms.

- Many gasworks buildings required substantial foundations.
- Massed concrete foundations are common.
- Piling was regularly used.



Voided Structures & Unresolved Past Contamination

More recent buildings may have been built over older structures without remediation.

Foundation slab of former regional office.

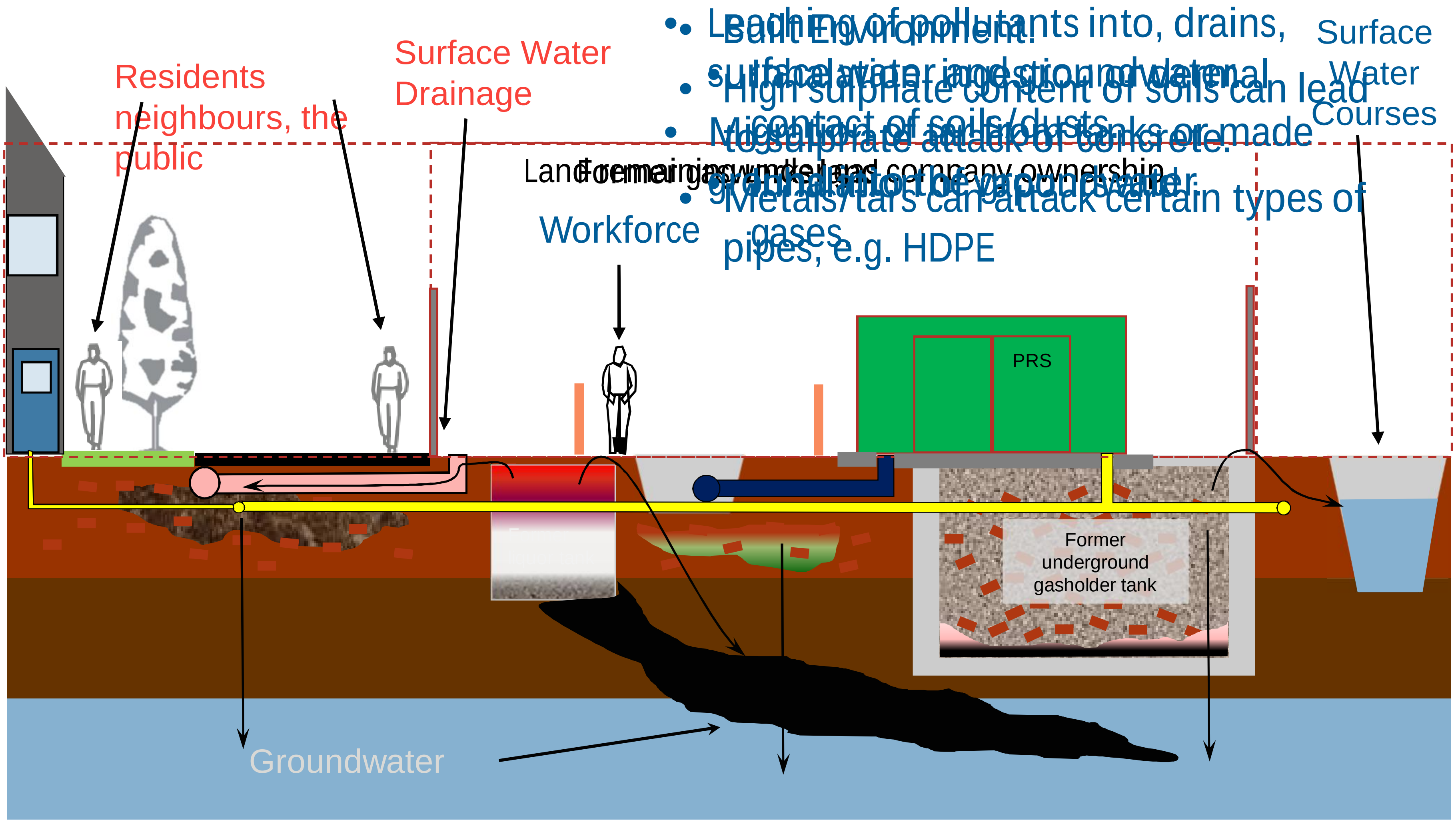
Some tanks may remain voided.

Contaminants which may be Present

When analysing soils or water obtained from former gasworks sites then the following contaminants are usually tested for.

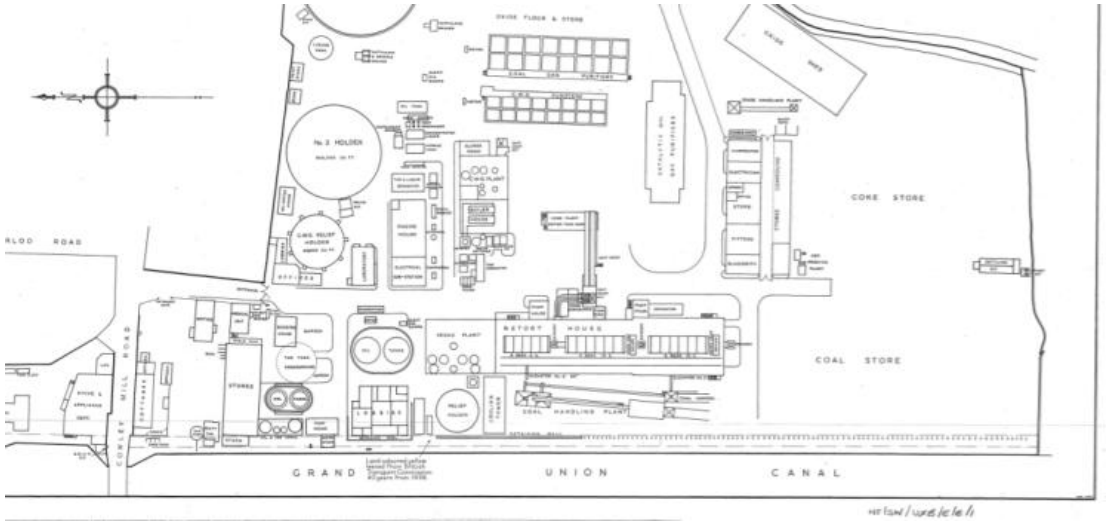
Contaminant	Associated with
• Heavy metals, in particular arsenic and lead.	• Ash.
• Polycyclic Aromatic Hydrocarbon (PAH).	• Ash, coal, tar and liquor.
• Phenols.	• Tar and Liquor.
• Benzene, Toluene, Ethyl Benzene, Xylenes.	• Tar and Benzol.
• Ammonium, sulphur and Sulphate, Cyanides (complex and free cyanides), thiocyanate.	• Spent oxide, foul lime, liquor, sulphate and acid plants.
• Total Petroleum Hydrocarbons.	• Tar and water gas plants.
• Asbestos containing materials (ACM).	• Lagging on pipes, boilers and ACM tiles and panels.

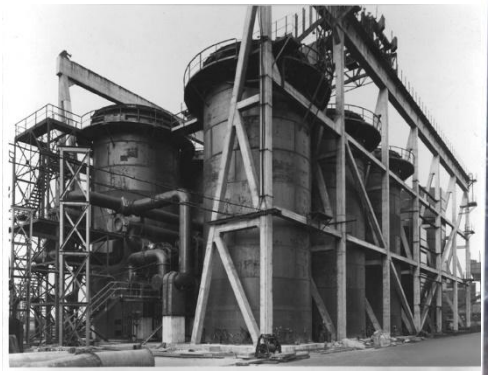
Potential Risks

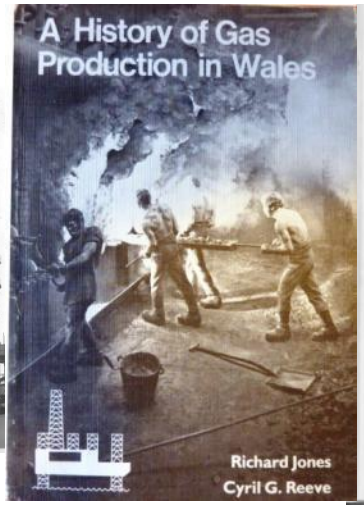


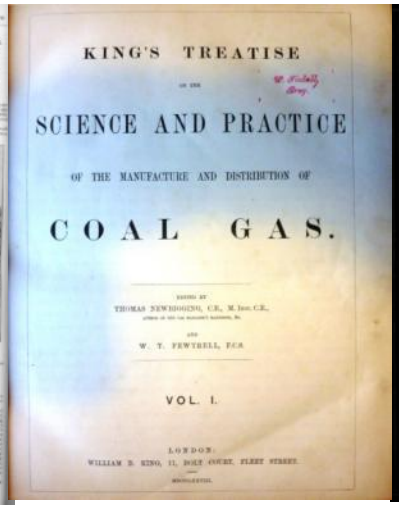
Resources for Understanding a Former Gasworks

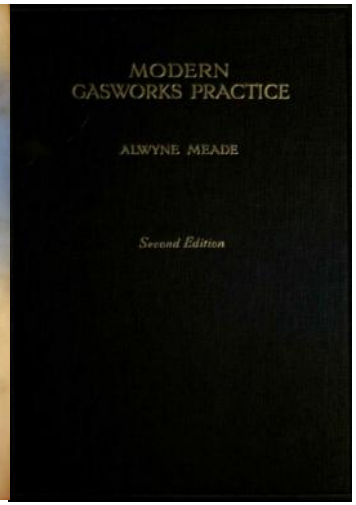
- Historical maps
- Archive plans and photos,
- Journal articles,
- Manufacturers booklets,
- Gas acts,
- Directories,
- Gas company minute books
- & estate records.





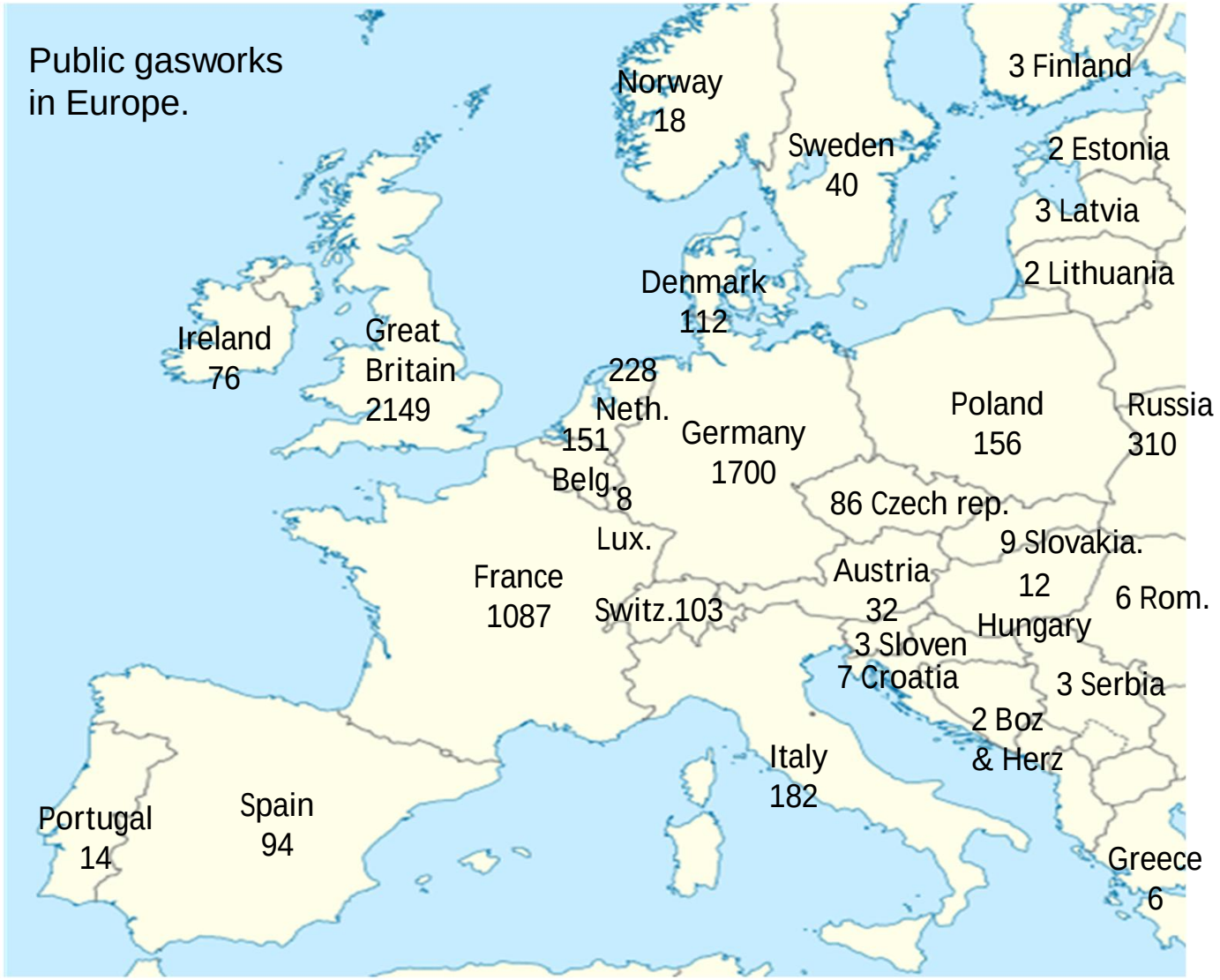


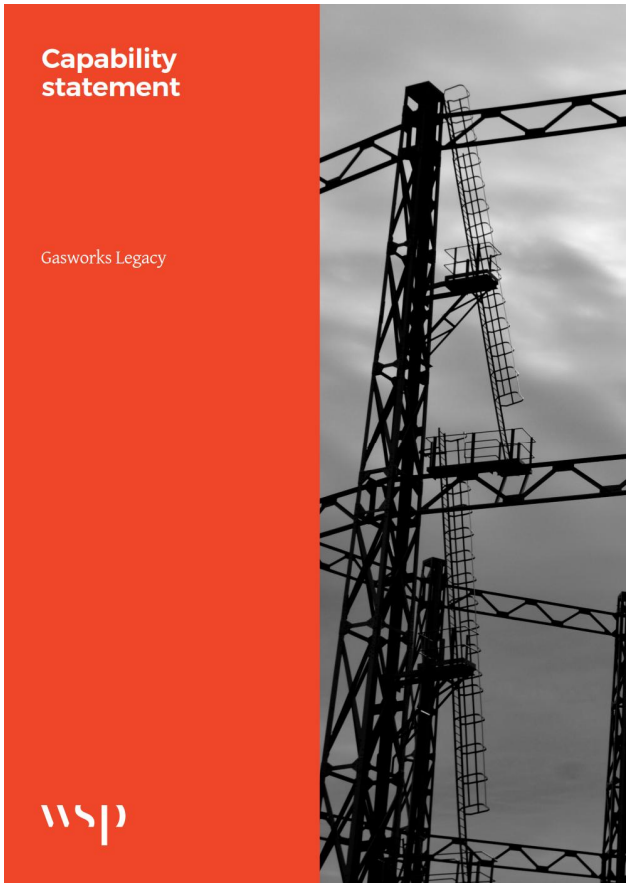




Gas – A European Perspective

- >10,000 gasworks & >1000 by-product coke ovens were built in Europe.





WSP have over 25 years experience in the understanding, investigation and remediation of former gasworks sites.

- Watch out for “How the Victorian Built Britain” later this years which featuring gas lighting and Fakenham Gasworks Museum in Norfolk in Episode 3.

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Thank you!

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