Cuningar Loop, Glasgow:
Cultural Heritage Assessment and Survey

Assessment Report

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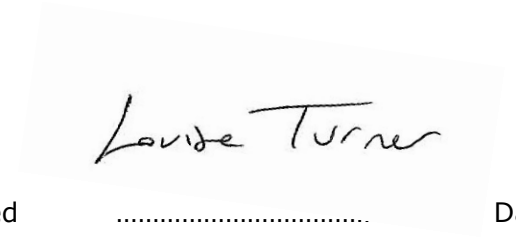

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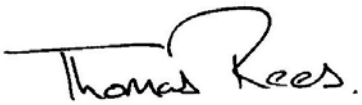

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2. The earliest map evidence for the Glasgow Water Works comes from the Ordnance Survey 1st edition map of 1858, but the origins of the water supply system date back to almost fifty years earlier, when the Committee of Management for the Glasgow Water Works first invited Thomas Telford to draw up a plan and estimates for the scheme. The physical form of the works changed over time, as did their geographical extent, as new challenges were faced and overcome. These challenges took two forms: firstly, the problems posed by securing a constant supply of pure water obtained from sources close to the city, and secondly, the difficulties presented by the almost constant growth in demand from the rising city's population.

3. The physical remains of the water works at Cuningar have been obliterated by the large-scale dumping of slum debris on the site during the 1960s. However, it is reasonable to infer that the physical remains survive, largely undisturbed, beneath this recent overburden. Sufficient documentary evidence survives to enable us to establish the likely form of these remains, in particular the structural details of the reservoirs and engine houses.

Executive Summary

4. A detailed desk-based assessment and survey was carried out at Cuningar Loop, Glasgow, for Forestry Commission Scotland during October and November 2011. This work focussed upon the site's industrial past, in particular the role it played in the evolution of the city's water supply. Using cartographic, archival and documentary sources it was possible to establish the role played by Cuningar, and to place this within a wider narrative that encompassed the whole history of the Glasgow Water Works and its successor, the Glasgow Water Corporation.

5. During the medieval and early modern periods, Glasgow's inhabitants had been supplied almost exclusively with water drawn from a number of wells, in both public and private ownership, located around the city. As far back as the sixteenth century, there had been issues regarding both the quantity of the water available for public consumption, and its quality. As the city's population increased throughout the seventeenth and eighteenth centuries, the issue became more and more pressing, and by the close of the eighteenth century (Anon, 1791-9) there were proposals being put forward to remove water from the river Clyde, collect it in a large reservoir, then pump it through the streets via a mains network.

6. On 1st January 1806, David Denny, Secretary to the Committee of Management of the Glasgow Water Works Company, wrote to the eminent civil engineer Thomas Telford, asking him to submit a plan and estimates for a scheme to supply the citizens of Glasgow with water. Telford was an obvious choice for the task: he had recently been employed in establishing a water supply for the city of Liverpool.

7. The plan proposed by Telford fits the model as described in the late eighteenth century account very closely. The water was drawn directly from the Clyde via a pump operated by a steam engine, then passed through a series of filtration beds before being sent out into a network of cast iron pipes that supplied the city. There were, however, difficulties from the outset regarding the purity of the water. Telford's initial plan had been to pass the water through two adjacent reservoirs, each acting as a filtration bed. These reservoirs were to be located on the north bank of the Clyde, directly opposite the lands of Cuningar, in the area now occupied by Springfield. Once the filtration process was complete, the water was to be pumped into one of two reservoirs located throughout the city – one located at Duke Street, and another at high level at High Street. From these

reservoirs, the water would then be distributed throughout the city.

8. From the outset, Telford sought the advice of James Watt on various aspects of the project. Watt, working with Boulton Watt & Co., had worked previously with Telford, providing him with steam engines for the Caledonian Canel. Telford asked Watt's opinion on a variety of issues, ranging from the performance of the steam engines, to the best material for the mains network. There were hints - even at this stage - that relations between Telford and the Committee were not altogether perfect, but the project progressed smoothly. Land was acquired, a Bill passed by Parliament in the summer of 1806, and work on the city's new water supply was soon underway.

9. The Glasgow City Archives still hold the letter book of the Committee of Management of the Glasgow Water Works, detailing the correspondence penned by its secretary, David Denny. These letters clearly illustrate how – after an initial halcyon period – strains developed between the Committee and their suppliers. The pipes for the mains network were being manufactured (perhaps on Telford's recommendation) by Booth & Co., an iron foundry located near Sheffield. The pipes had to be transported via inland waterway to Hull, then shipped around the coast of Northumbria to Leith, before being transferred onto another vessel for shipping via the Forth and Clyde Canal to Port Dundas.

10. The founding of a rival water company in the spring of 1808 – the Cranstonhill Company, ostensibly created to service the area around Anderston – resulted in a race between the two companies to lay as extensive a mains network as possible in as short a time. With more streets included in the mains network, more households could be provided with water: this in turn would result in an increase in the amount of water rents being gathered, which would in turn increase the company's income, allowing future investment in infrastructure, and increased dividends for shareholders.

11. Delays in the receipt of the cast iron pipes from Sheffield soon became a serious problem. There were disagreements over freight charges, and an even greater disaster struck in the winter of 1807, when the entire cargo of seven inch pipes was lost aboard the Earl of Dalkeith, resulting in an on-going negotiation with the salvage crew. On occasion, the Glasgow workforce was left without any pipes to lay. This encouraged Denny to seek alternative supplies of cast iron pipes: from 1807 onwards, he was commissioning consignments of pipes from a number of local producers, including the Carron Company, the Shotts Ironworks, the Clyde Ironworks and the Omoa Foundry.

12. Problems soon became apparent in Telford's original design plan. He was forced to rethink his scheme for a two-part filtration system, and replace it with an equivalent three-part version. Nonetheless, by February 1807, Denny was waxing lyrical about the quality of the infrastructure. This delight was short-lived, however. In the autumn of 1809, Denny was writing to James Watt via Boulton Watt & Co. complaining that Telford's scheme was proving 'very defective' (Glasgow City Archives, F13/1) and that the Committee didn't feel inclined to approach Mr Telford in their attempts to rectify the situation.

13. Watt proposed an alternative to the existing, Telford-designed scheme. He suggested that instead of drawing the water directly from the Clyde and purifying it via filtration beds, it should be filtered using natural sands and gravels, where available, and drawn up via a pump from a well. A likely location was found in the lands of Cuningar, a peninsula composed mainly of sands and gravels bounded to the north by a marked meander in the river. It lay on the south bank of the river directly opposite the upstanding Telford filtration basins, which allowed any new scheme to be tied into the existing mains system without too much difficulty.

14. Test pits proved positive, and work was underway on the new scheme by the summer of 1810. In Watt's plan, water was to be extracted via a tunnel, formed out of unjointed masonry. This tunnel fed a well, from which water was pumped via a steam engine into a series of iron pipes, built with flexible joints to allow them to lie upon the bed of the river Clyde. These linked in with the mains system on the north bank, allowing the water to be fed into the existing reservoirs, and distributed throughout the city.

15. Watt had asked no reimbursement for his suggestions, and his alternative scheme

achieved such success following its completion that in 1811 the grateful Committee purchased a solid silver soup tureen from a goldsmith in London which was then presented to him. By the 1820s, new engines were being installed on the south bank of the Clyde at Cuningar in order to both increase the amount of water being extracted. By 1838, moves were afoot to create a large complex of reservoirs and filtration beds on the site, occupying the entire peninsula.

16. Public dissatisfaction with the quality of the water remained, however, and with the city ever increasing in size to encompass such outlying areas as Garnethill, alternative methods of provision had to be sought. Following the creation of the Gorbals Gravitation Water Company in 1846 (which made use of water derived from outwith the city, with notably improved results) alternative sources of fresh water were sought. A variety of possibilities were explored, ranging from the upper reaches of the Clyde to the river Avon in Lanarkshire. Eventually, by the mid-1840s, this selection was narrowed down to two potential contenders: Loch Lubnaig in Stirlingshire, or Loch Katrine in Perthshire. Loch Lubnaig was initially chosen as the preferred option, but problems inherent in the scheme led to its eventual abandonment.

17. Glasgow Corporation turned instead to an idea first proposed by two civil engineers from Glasgow, Professor Macquorn Rankine and John Thomson – to move fresh water from Loch Katrine for use in the city. The engineer John Frederick Bateman was employed to put forward a plan and estimates for the work, but a first attempt to pass a Bill at Parliament was opposed on various grounds. A second succeeded – perhaps assisted by input from two distinguished engineers of their day, Robert Stephenson and Isambard Kingdom Brunel, who were encouraged to add their support to Bateman's proposal.

18. In 1855, a Bill was passed in Parliament, and by the autumn of 1859, the water supply from Loch Katrine came into operation, covering a total of 36 miles and utilising a combination of tunnels, aqueducts and pipelines. The existing holdings of the Glasgow Water Corporation – formed earlier when the Glasgow Water Works and the Cranstonhill Company were merged – then fell into disuse.

19. Map evidence dating to 1898 supports this: by this time, the complex of reservoirs and filter beds located at Cuningar had begun to decay, surviving only as earthworks. The site was occupied inside by the Westthorn River-Supply Works. Two compound tandem horizontal engines installed here in the late 1870s allowed water to be drawn off from the river in this location for industrial use, a process interrupted in 1911-12 when coal extraction beneath the engine house caused the apparatus to collapse. The engines were reinstated when mining operations ceased, with the remains of the old mid-nineteenth century waterworks remaining identifiable as vestigial traces until the 1960s. At this point, debris from slum clearance in the Gorbals was used to infill the remains of the reservoirs, effectively obscuring all physical evidence of the site's earlier history.

Methodology

20. The programme of works agreed with Forestry Commission Scotland commenced with a desk based assessment. All works were undertaken in keeping with the Contract issued by Rena Tarwinska, Forestry Commission Scotland. The archives consulted included:

    a. the National Monuments Record of Scotland (known archaeological sites; oblique aerial photography; archived commercial reports);

    b. the Mitchell Library (Glasgow City Archives);

    c. Birmingham Central Library (Boulton & Watt Collection);

    d. Houses of Parliament (Parliamentary Library);

    e. Glasgow University Library (Special Collections);

    f. Ironbridge Gorge Museums (Telford Collection);

g. The National Monuments Record of Scotland (known archaeological sites; oblique aerial photography; archived commercial reports);

h. Sites & Monuments Record (known archaeological sites);

i. Historic Scotland records (Scheduled Ancient Monuments and other designations);

j. National Library of Scotland (bibliographic records, historic Ordnance Survey and pre-Ordnance Survey mapping); and

k. local museums, libraries and other archives (Old & New Statistical Accounts, local history books).

21. The research was undertaken between the 25th October and the 25th November 2011.

The Glasgow Water Works Company

Pre-Nineteenth Century Water Supply

22. Evidence of human occupation in and around the modern city of Glasgow goes back to the prehistoric period. Expansion of the city during the late eighteenth and early nineteenth century revealed all manner of prehistoric artefacts, including polished stone axes of Neolithic date, and Bronze Age cremation urns. Of particular note, were a number of dugout logboats which were uncovered from where they were buried deep in the riverine silts of the River Clyde: these objects were progressively revealed during the large-scale engineering works associated with the construction of the city's quays and harbours, and are believed to be of Iron Age date.

23. The city as we recognise it today is, however, of later date, having its origins in the early medieval period, where it was reportedly the residence of St Ninian of Galloway, who settled on the banks of the Molendinar Burn, close to the modern cathedral (Gregory, 1921, 6) in the fourth century AD. However, it was a later ecclesiastical figure named Kentigern or Mungo who later became synonymous with the city: he built a church on St Ninian's cell which was later to become the medieval cathedral, dedicated to St Kentigern who had by this time become canonised. To this day, Saint Mungo remains the patron saint of Glasgow, whose legendary exploits are immortalised in the city's coat-of-arms.

24. The cathedral enjoyed great success and prosperity throughout the medieval period, fuelled at least in part by its popularity with pilgrims, who travelled sometimes considerable distances in order to venerate the relics of St Kentigern. As this ecclesiastical centre grew in importance, the settlement that had grown up around it in order to service its needs also increased in size. The town was granted burgh status at an early stage, at some time between 1175 and 1178, in favour of the cathedral, which as a result was granted all the all revenues generated from the markets and trade carried out within the burgh's limits.

25. As the burgh increased in size, so the provision of a reliable water supply became more of an issue, both to supply the burgh's inhabitants and their livestock with drinking water, and to supply the various industries such as tanning, dyeing, etc. with sufficient water for their needs. Information relating to the early burgh period is absent, but it's thought that throughout the medieval period, water for public use was drawn from the Molendinar Burn, and a number of public and private wells, as well as from the River Clyde itself (Marwick 1901).

26. The earliest references to the town's public wells come from the Protocol Books of the Town Clerks, and date from the reign of James V onwards. Marwick relates this information in detail, noting references to the 'Deynside' (Deanside) Well, the Well of St Tenue, Saint Mungo's Spoutis, near Gallowgate, and St. Kentigern's Well, near the Gallowgate (Marwick 1901).

27. Even the earliest references to these wells highlight the problems inherent in their upkeep. For instance, the Town Council Records of 1574 note that '*the commone well, calleit Gleghornis Well, beside Andrew Sympleis house, under Robert Bareis house'*, was

'*fillit up with stones, contrar the common weil*' (cited in Marwick 1901, 5).

28. Prior to the 1800s, the city of Glasgow was provisioned with a water supply derived from approximately thirty public wells, augmented by a small number of private wells. However, the demands imposed by burgeoning levels of industry, and of course the needs of their associated workforce, meant that this level of provision was rapidly became inadequate for the city's needs.

Social and Political Background

29. The use of public wells continued throughout the eighteenth century. However, there was increasing dissatisfaction with the existing arrangements for water provision. In many instances, the quality of the water was poor, and there remained the ever-present concern that the amount of water provided by these traditional sources was insufficient for the still-burgeoning city's needs. This situation is summed up perfectly in the Old Statistical Account of 1791-99:

> *'The Water, with which the city is in general supplied, is not of the best quality, as most of the springs contain felenite in greater or lesser proportion's and some of them contain iron, which is for the most part suspended by the carbonic acid. One spring, not far from the city, contains calcareous earth, which it deposits, in its course, on the vegetables… forming therewith sundry incrustations. Towards the west part of the city, however, the water is much purer than towards the east, and there is in the Green, belonging to the community, a spring of water of the very best quality in the country. The quantity of it, however, is not sufficient to afford a supply to the whole inhabitants; and it lies so much below the level of the greatest part of the city that it has prevented its being conducted into it. Many proposals have been made, for supplying the city with water from sources in the neighbourhood, but the quantity of spring water, to be found in any one place, has been thought too small to supply the wants of the inhabitants; besides, a very great expense must be incurred in conveying it to the city, and in preparing reservoirs for it, which has hitherto prevented this useful scheme being put in execution. Perhaps the only permanent sources, and the best supply in point of purity, would be from the river Clyde, but this would occasion it to be forced up by a steam engine and a large reservoir to collect it in, in order to supply the pipes necessary for the different parts of the city; which would be such an expense as could not be gone into, without a probability of being reimbursed by a tax, which would not, perhaps, be an agreeable measure.' (Anon, 1791-9, 533)*

30. The passage quoted above indicates that, even at this early point, the stage was being set for the project that would ultimately develop into the Glasgow Water Works. The nature of the supply as envisaged here is almost identical: water from the River Clyde would be pumped by steam engine into a large reservoir, where it would be purified by the filtration method before being circulated via a network of pipes throughout the city.

31. By this time, large-scale engineering projects were becoming increasingly common around the British Isles, constructing roads, bridges, canals and harbour improvements. At the vanguard of these improvements was the Leeds-born engineer, John Smeaton (1724-92), who earned the epithet 'father of civil engineering' for his work. He was responsible for the Forth-Clyde Canal, an important piece of transport infrastructure built between 1768 and 1790 which was to prove invaluable during the construction of the Glasgow Water Works. The canal's positive impact on Glasgow's commerce and communications demonstrated how advances in science and engineering might be used to transform the world, for the benefit of both commerce and social welfare. It is therefore not surprising that by as early as the 1790s, when the Old Statistical Account was being compiled, ideas were already being floated which applied these new technologies towards securing a clean and reliable water supply for the city of Glasgow. It was, however, the next generation of engineers – Thomas Telford (1757-1834), James Watt (1736 – 1819), John Rennie (1761-1821) and Henry Bell (1767-1830) – who would

build upon the achievements of the past and apply newly acquired knowledge to transform Britain's transport and amenity infrastructure.

32. Two of these figures – Thomas Telford and James Watt – played significant roles in the Glasgow Water Works. Born in Dumfriesshire in 1757, Telford started out as a stonemason in Edinburgh, before moving on to London, where he worked between 1782-4. He was rapidly promoted to Clerk of Works for two building projects at Portsmouth Dockyard, before being employed as an architect in Shropshire in the late 1780s, where he undertook a number of important projects in the town of Shrewsbury, including alterations to Shrewsbury Castle and the construction of Shrewsbury Gaol. Telford's portfolio was varied, ranging from bridges and canals (including such celebrated pieces of infrastructure as the Pontcysylltyte viaduct near Llangollen) to docks and harbours, railways and even buildings.

33. Between 1799 and 1802, Telford was involved with providing a water supply for the City of Liverpool. The Resident Engineer on this project was Henry Bell – presumably the same Henry Bell who later became famous for developing the first steam-powered ship, 'The Comet'. Towards the end of this period, Telford was involved in an increasing number of projects in Scotland, including docks and harbours at Wick, Tobermory, Aberdeen and Kirkcudbright. From 1803 onwards, he was also engaged in the building of the Caledonian Canal, and the Glasgow-Paisley and Ardrossan Canal.

34. James Watt was born in Greenock in 1736, and was granted an opportunity to work with Dr Roebuck of the Carron Ironworks, a pioneering iron foundry established in 1759. As a secondary interest, Roebuck had embarked on a coal-mining enterprise at Bo'ness, which proved troublesome on account of flooding (Watters 2006). The young James Watt was employed to construct a separate condensing steam engine which might solve this problem: under Roebuck's guidance, he carried out a series of experiments which culminated in the creation of his first steam engine. Its parts were cast at Carron, and the engine built at Roebuck's residence, Kinneil House (Carron Company 1938), where Watt had his workshop. An entry in the New Statistical Account for Glasgow (MacFarlan, 1834-43, 139-40) reports that '*The first experiment, which was made at a coal mine, succeeded to admiration, indeed his success was so great that he procured a patent 'for saving steam and fuel in fire-engines'*.

35. By this time, James Watt had already made contacts in Birmingham. It was via one of these individuals, Dr William Small, that he was introduced to Matthew Boulton, then a manufacture of silverware, and small items such as steel buckles, watchchains, and sword hilts. The two men struck up a friendship, and Boulton was keen to support Watt's desire to improve the steam engine. He had high hopes for the enterprise, writing to Watt in 1769 that his intention was not to make engines '*for three counties, but… to make for all the world.*' (Birmingham City Archives, Introductory Notes to Boulton & Watt Papers). Watt was, however, still shackled to the north by his partnership with Roebuck, who had a share in Watt's invention. Roebuck's increasing financial problems eventually resulted in his bankruptcy, forcing Roebuck to sell both his share in the Carron Company and also in Watt's steam engine. In 1774 Boulton bought his share in the steam engine, and later that year James Watt moved to Birmingham, and established a partnership which was to endure for many years to come.

From Concept to Act Of Parliament

36. At some point prior to 1806, a group of Glasgow residents came together with the aim of improving the city's water supply. A committee was established (known from then-on as the 'Committee of Management'), an initial sum raised by subscription, and a Secretary appointed. This secretary would become a central figure in the history of the Glasgow Water Works: David Denny, whose long association with the project made him into a figure of some renown throughout the city. A mid-nineteenth century account of Glasgow's clubs (Strang 1857, 464), for example, cites the following:

> *'We might also have alluded to the singular band of oddfellows who, about the commencement of the century, assembled under the nowise attractive banner of the 'Dirty Shirt', but whose bond of union, if it was occasionally sported by*

> *some of its members when water and soap was scarce and dear, assuredly fell prostrate before the shadow of David Denny and before the still more purifying effects of the articles produced under the protective favour of that purest of all saints – St Rollux!* [St Rollux being the site of a chemical works that produced soap and bleaching powder].

37. The same article adds, in a footnote, that '*to raise a glass of David Denny'* was a term used to describe the drinking of a '*limpid beverage*' (Strang 1857, 464).

38. On the 1st January, 1806, sufficient funds had been raised for work to begin, so Denny wrote to Thomas Telford to inform him that '*A large sum of money has lately been subscribed towards bringing a supply of water into the City, and in all probability the measure will be carried into execution*' (Glasgow City Archives, F/13/1). With Telford already becoming an established figure in the design and build of large-scale civic water supply projects (having previously worked at Liverpool), he was an obvious choice for the execution of a similar scheme in Glasgow.

39. Actually tracking Telford down proved, however, to be more of a problem. An initial invitation sent to London was followed a fortnight later by a second request, addressed this time to Shrewsbury (Glasgow City Archives, F/13/1). Denny was already under pressure at this point to get Telford's response – the Committee was aiming to prepare a Bill which would be placed before Parliament and approved during the coming Session.

40. Telford's geographically diverse portfolio of works meant that he followed an itinerant lifestyle: his letters to Boulton & Watt between March 1805 and March 1806 indicate that during the period he travelled between London, Salop, Liverpool (where he was involved with the water works), and Fort William. This correspondence between Telford and Boulton & Watt indicates that during this period, Telford was involved in erecting Boulton & Watt-manufactured steam engines on the Caledonian Canel (Boulton & Watt Coll. MS3147/3/525/1-5). Throughout the course of this work, his responsibilities took him variously to Fort William and to Chester (the port to which the dismantled engines were delivered for dispatch to Inverness and then on to Fort William). Telford's reply to Denny, which unfortunately does not survive, indicates that he was in Cheshire in early February, and that he would then be travelling north in early March: a subsequent letter from Thomas Telford to James Watt (sent from Shrewsbury on the 25th March, 1806) indicates that he had indeed paid a visit to Glasgow at around this time (Boulton & Watt Coll. MS 3147/3/525/10).

41. Denny had already outlined a plan for the scheme in his earlier letter of 25th January, 1806. In this, he informs Telford that. '*The Clyde will certainly be the place from whence the City is to be supplied with Water – to be taken off either the Green or Above Rutherglen Bridge – the Water must be purified by filtration or making subsidiary Basons somewhere about the Green – from thence to be forced by a Steam Engine to the highest part of the City, and afterwards distributed in pipes throughout the Streets*.' (GCL, GWW lb).

42. From the 1st March 1806 onwards, Denny's letters demonstrate that the administrative work required to successfully deliver the project was well underway in Glasgow. Tasks included arranging the delivery of the petition of the City Council of Glasgow to either the City Member (of Parliament) Mr Boyd Alexander, or to the County Member, Lord Archibald Hamilton. Equally important was the arrangement of a lease on four acres of ground on the Banks of the Clyde for the site of a reservoir.

43. Later that month, Telford was in correspondence with James Watt (Boulton & Watt Coll. MS 3147/3/525/10). The tone of the letter clearly indicates that Telford was keen to obtain Watt's advice on the project design, pointing out that:

> *'I have reason to hope that Engines of your construction will be employed in raising water to supply the birthplace of their progenitors, and as you are familiarly acquainted with the Situation of the River and City, and have had reason to pay some attention to the subject, I am particularly desirous of benefitting by your opinion and advice'.*

44. Telford's tone is deferential, which seems appropriate considering the fact that he is addressing a man twenty years his senior, and at the top of his profession. Watt's involvement with Boulton Watt & Co. was ebbing by this time – following the death of his son Gregory in 1804, Watt stepped back from active participation in many aspects of the company, leaving his son James Watt (Junior) to carry on in his stead (Birmingham City Libraries, *pers. comm*.) Telford was no doubt aware of this: nonetheless, he encloses a copy of his report, and asks Watt to comment upon it, in particular raising particular concerns and queries regarding the performance of the steam engines.

45. The next piece of documentary evidence relating to the project is a letter dated 30th March, 1806 (Boulton & Watt Coll. MS 3147/3/525/21). This appears to have been written by Watt's assistant, John Southern, with amendments by Watt. Southern had been working with Watt since 1782 and had already dealt directly with Telford on the steam engine orders for the Caledonian Canal. The total amount of water required to supply the city is calculated as being 1,440,000 gallons per day (supplying 120,000 inhabitants plus industrial users such as printers and dyeworks). To deliver this, Southern writes (to Watt) as follows:

> *'I should be inclined to recommend this to be done by 2 steam engines in 12 hours so that if one should be out of repair for any time the other will by working 24 hours give the whole supply…The quantity by the two engines will be 120,000 gallons per hour… This exceeds Mr Telford's quantity, very much.'*

46. Calculations are also given for the various diameters of mains pipes required to furnish the city with water, before a final concluding paragraph states '*I am of opinion that a rotation engine would be the best for them, working by means of two wheels to reduce the speed…*'

47. Their response was duly sent to Telford. Telford notes on 5th April 1805 (Boulton & Watt Coll. MS 3147/3/525/22) that he received '*both yours'*, which may indicate that Watt had written twice, or that he'd received correspondence from both Watt and Southern. A rather sheepish response from him – '*Altho' I shall not, in future trouble you on the subject of the engines, but correspond… with Messrs. Boulton & Co*.' suggests that Watt may not have appreciated being troubled with such routine business. This followed up with a comment on the calculation proposed by Watt and Southern. '*I perceive'*, Telford writes, '*that you are of opinion that powers should be established capable of attending a supply of nearly 3000 Scotch pints per minute. There can certainly be no risque of error on this side, expecting the scale of operations exceeding the funds, a circumstance not infrequent in the practice of engineering.'* Telford's wry observations have been borne out in many large-scale engineering and construction projects right up to the present, and indeed returned to haunt him as this particular project proceeded.

48. More intriguingly, Telford moves on to more personal matters, adding '*I am truly sorry to hear that Mr Rennie has suffered so serious and disturbing a loss, and I am also sorry to inform you that his conduct prevents me from benefitting by his acquaintance'.* Telford does not elaborate further on the cause of this bad feeling between himself and John Rennie (who at this time was engaged with constructing the Greenock docks), though he certainly seems to be aggrieved by some kind of personal sleight or criticism that Rennie has levelled against him. John Rennie had enjoyed a good working relationship with Watt for a number of years before setting up his own company: despite this disagreement – real or imagined, from Telford's perspective - just a few years later, they would be working together on another project, so it appears that this disagreement was short-lived.

49. Armed with observations provided by both Southern and Watt, Telford returned to Glasgow for a meeting with the Committee at some point between March and May 1806, at which he presented a revised report of the plans for the water supply and convinced them that their best course of action was to take water from the River Clyde '*nearly opposite to Ruglen* [i.e. Rutherglen] *farm'* and raise it via steam engines.

50. With the plan approved, Telford, Watt and Southern continued to work their way through the challenges posed by the project: in a letter dated 23rd May, 1806 (Boulton & Watt

Coll. MS 3147/3/525/25).Telford describes the scheme as comprising one reservoir on the bank of the river, into which a steam engine would raise water from the Clyde. From here, water would be pumped into another reservoir at Duke Street, from which the town's supply would be drawn. At this stage, Telford envisaged the riverside structure as comprising a single reservoir measuring six foot deep, with surface area of one English acre. However, even at this point he suspected that the water from the Clyde might prove difficult to purify by the filtration method, so he was already entertaining the possibility of constructing two reservoirs of roughly similar surface area, each measuring three foot in depth. By 12th June, 1806 (Boulton & Watt Coll. MS 3147/3/525/26), Telford had drawn up a plan of the mains network, and was asking Watt for advice on what material should be used for the distribution pipes.

The 1806 Act of Parliament

51. While Telford, Watt and Southern were engaged in refining the project design, David Denny was endeavouring to ensure that the Act of Parliament pertaining to the Glasgow Water Works was presented before Parliament and that it was passed within that year's parliamentary session.

52. From the outset, minor alterations were required, ranging from a correction to the list of subscribers to the alteration and addition of various clauses. Denny's contact throughout this period was Alexander Mundell, who appears to have been acting both as a point of contact between the Committee and the local Member of Parliament, and as a lobbyist.

53. These alterations proved to be nothing more than trivial diversions. Of far more consequence was a concerted opposition to the scheme, orchestrated by the proprietors of various coal works and coal grounds located on the banks of the Clyde. Denny notes in a letter to Mundell, dated 28th June, 1806 (Glasgow City Archives, F/13/1), that these individuals were getting '*alarmed'* at the quantity of water that might ultimately be removed from the Clyde, and that they were attempting to impose a restriction, '*under the pretence that so may be taken off as to leave to little for the purposes of Navigation'*.

54. These initial hints of objection soon turned into something far more serious. Denny wrote to Mundell again less than a month later, noting that this renewed opposition appeared '*to the Committee entirely to arise from a wish to prevent the proposed undertaking from being carried on to effect'* (Glasgow City Archives, F/13/1). He then added '*The Committee therefore hope that you will be successful in convincing the Lords Committee of the Weakness of the objection… for it would be greatly to be lamented if a factious opposition of this nature were to deprive the public of so great a benefit and the Inhabitants of this large and populous city of so great a comfort and advantage as the abundant supply of good water.'* (Glasgow City Archives, F/13/1).

55. Mundell's lobbying was not undertaken without august support. A week previously, in a letter dated 1st July 1806, Denny had written to Thomas Telford (*Glasgow City Archives, F/13/1*), asking him to consult with Mundell so they could '*concert together on the measures to be taken to counteract a new opposition that is about to be made to the Water Bill*.' He further relates that '*Some of the Proprietors of Coal Works on the Banks of the Clyde and others have got it into their heads that the Water Company may pump all the water out of the river and leave none to float their coal boats'* – though the idea to him seemed '*frivolous'*. He notes that it was impossible for a boat to travel beyond the Broomielaw on account of the shallow depth of the river, and with the water for the city water supply being removed by pipes as opposed to a canal, it seemed even less likely that there would be any significant impact on river levels. Denny remained fearful, however, that the opposition might slow the passage of the Bill or even prevent it from passing during the current session of Parliament.

56. Telford duly obliged, travelling to London where he succeeded in dispelling the fears of the opposition, and lobbying the Committee of the Lords. The Act was passed on the 21st July, 1806 and Telford immediately set to work on elaborating out the details of the scheme.

The Initial Stages

57. By early July, Telford was already preparing for his forthcoming trip to Glasgow for a meeting with the Committee. It is clear, however, that he had hoped that on this occasion, James Watt would be attending with him. Watt, however was not prepared to do so, prompting Telford to write on the 7th July:

> *'I have received yours of the 6th. I shall regret very much to proceed in the business of the Glasgow Water Works without the aid of Mr Watt.*
>
> *On any occasion where Science or ingenuity were concerned, his opinion and advice would by me be considered of the first importance, but in this instance of giving his nation city a plentiful supply of Water by means of Engines through his Genius have added so [?-]lly to the Physical powers of Man, I feel it to be in the shape of sacrilege to proceed without him. State this to him, and add that now I must make my appearance at Glasgow before the 20th expected and be fully prepared to set in motion, what they consider to be a very simple operation…'*

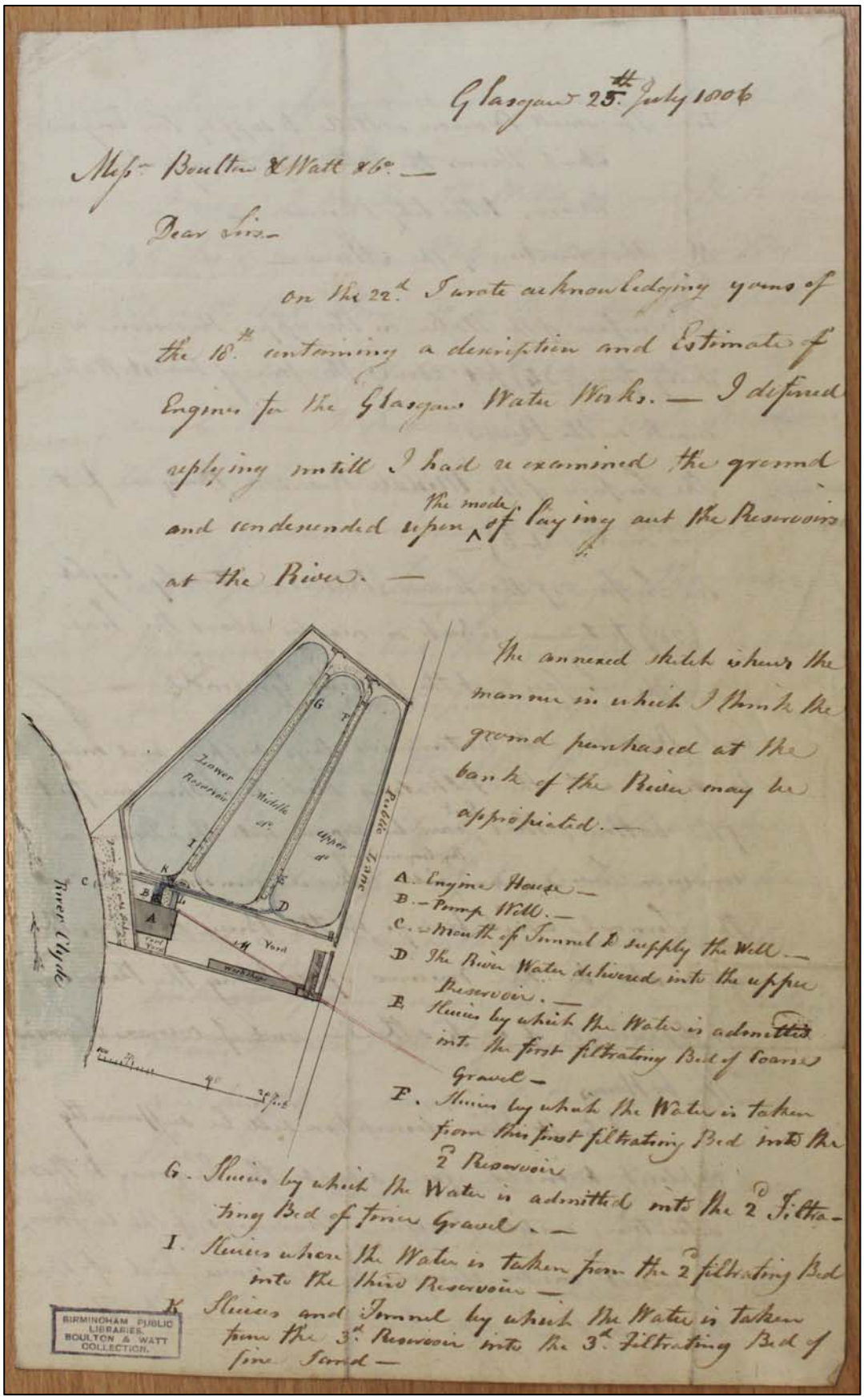
58. The tone of this letter is curious. It suggests that Telford strongly desired Watt's presence at the forthcoming meeting, but whether this was because he felt less qualified to discuss the subject of steam engines, or because he was already finding himself at loggerheads with the committee cannot be established. Certainly, that one phrase, '*what they consider to be a simple operation*', suggests that the relationship was not without its difficulties: perhaps Telford suspected that he would be forced to manage the unrealistic expectations of an enthusiastic committee armed with high ideals and limited resources.

59. In a letter to Boulton Watt & Co. dated 25th July 1806 (Boulton & Watt Coll. MS 3147/3/525/30), Thomas Telford sets out his plans for the project (Figure 1). He has opted for a scheme which is located immediately adjacent to the River Clyde, sitting on the north bank in the area lying to the west of the Cuningar Loop in the area later occupied by the Springfield Print Works (as shown on the 1898 Town Plan – see Figure 12).

60. Telford's plan is worth exploring in greater detail. His scheme featured three reservoirs, with an adjacent engine house. Water was pumped from the river via a tunnel (marked 'C' on the plan) into the highest of the three reservoirs, each of which held a day's supply of water. Each reservoir acted as a filtration bed, with the water moving progressively from the upper to the middle to the lower reservoirs, before being pumped off for storage in one of two reservoirs located within the city itself. One of these was located at Duke Street, the other at High Street (Figure 2). From these reservoirs, pipes would circulate water around the streets, most likely via a gravity-fed network. It should be noted, that the final layout, as depicted on the later plan of the test pits at Cuningar, differs slightly regarding the layout of the engine house, which is located further to the north in the final version than it was in Telford's plan, where it is located closer to the river bank (see Figure 6).

61. The letter book of the Committee for the Glasgow Water Works paints a detailed picture of how the project progressed. By the 11th August 1806, Denny wrote to Telford informing him that tenders had been sent out for masons tasked with building the reservoirs (Glasgow City Archives, F13/1). Quotes had been received from nine of them: in the end, Sinclair and Freebairn were selected for the task, having provided the second lowest quote (£4906 18s. 4p.).

62. By the 24th September 1806, the Committee was pondering the matter of how best to construct the mains system (Glasgow City Archives, F13/1). One of their number, a Mr Hamilton, was convinced that stone pipes would be cheaper than either cast iron or wood. Portland stone was cited as a possible material, with samples and accompanying estimates requested from a company in London. Various way of further reducing costs were discussed, such as sourcing an equivalent local stone, or having the stone blocks transported north with the final working carried out locally.



Glasgow 25th July 1806

Messrs Boulton & Watt &c. —

Dear Sirs —

On the 22d I wrote acknowledging yours of the 18th containing a description and Estimate of Engines for the Glasgow Water Works. — I deferred replying until I had re examined the ground and condescended upon the mode of laying out the Reservoirs at the River. —

The annexed sketch shews the manner in which I think the ground purchased at the bank of the River may be appropriated. —

A. Engine House —
B. — Pump Well. —
C. — Mouth of Tunnel to supply the Well. —
D The River Water delivered into the upper Reservoir. —
E Sluices by which the Water is admitted into the first filtrating Bed of coarse Gravel —
F. Sluices by which the Water is taken from this first filtrating Bed into the 2d Reservoir
G. Sluices by which the Water is admitted into the 2d Filtrating Bed of coarse Gravel. —
I. Sluices where the Water is taken from the 2d filtrating Bed into the third Reservoir —
K Sluices and Tunnel by which the Water is taken from the 3d Reservoir into the 3d Filtrating Bed of fine Sand —

Lower Reservoir
Middle do
Upper do
Public Road
River Clyde
Yard
Yard

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Figure 1: Detail of Sketch Plan by Thomas Telford, Showing Layout of Original Build

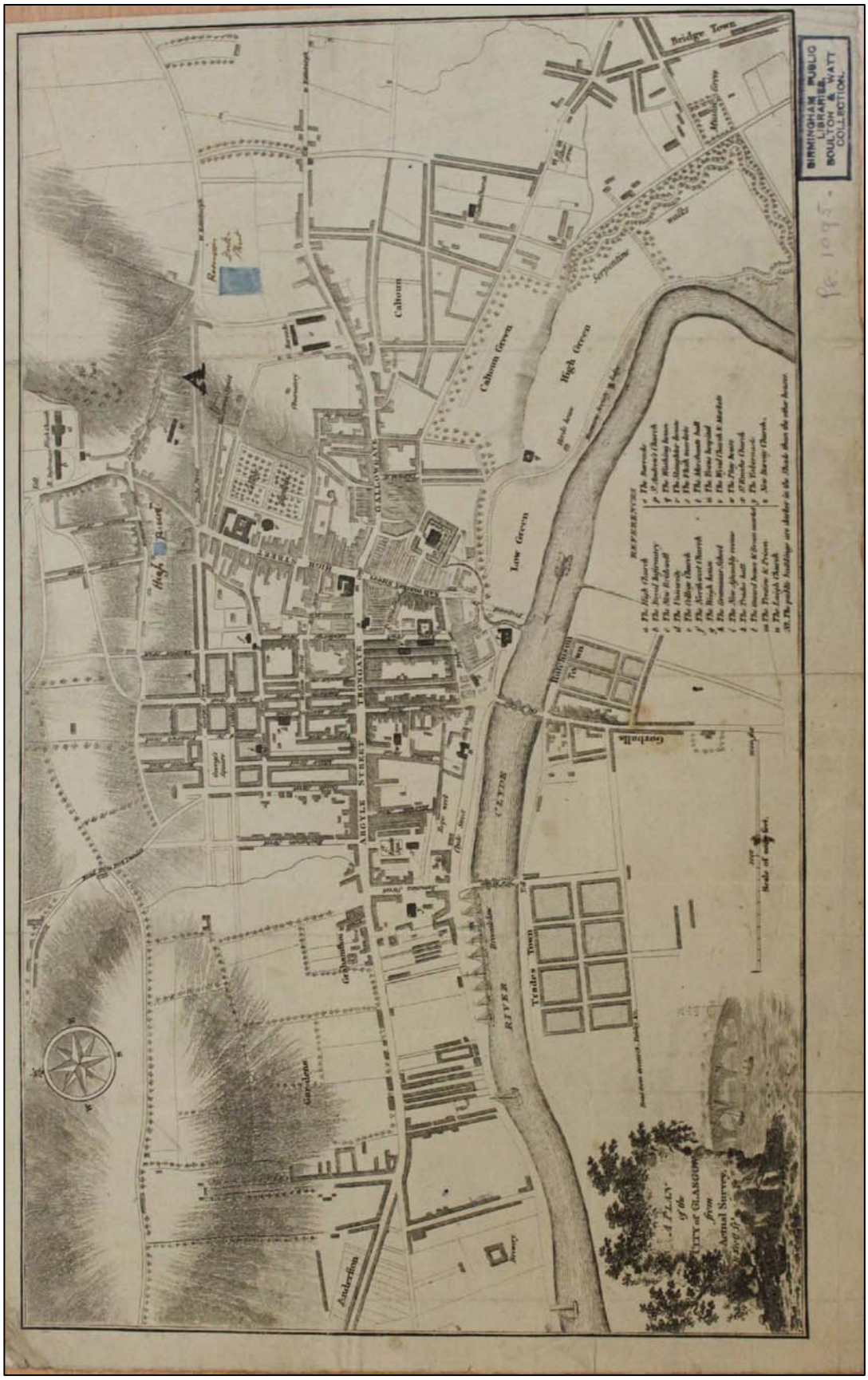

Figure 2: Town Plan of Glasgow, annotated by Thomas Telford to show locations of proposed reservoirs (shown in blue)

63. By the 16th August 1806, Telford had installed a Resident Engineer named James Howell. Telford's last known correspondence of this year is dated 4th August (Boulton & Watt Coll. MS 3147/3/525/36). This letter was sent to Boulton Watt & Co. from Glasgow, where he was presumably setting up the project. In it, he requests that the cylinder, boiler and pumps mentioned in a previous letter are added to the former estimate of £4210 , and thanks one of their number (presumably John Southern, as reference is made to a forthcoming letter from James Watt) for their observations on pipes. He also asks for a delivery date when the engines will be delivered at Liverpool, so that he can arrange payment.

64. Drawings of the various engines and engine houses survive in the Boulton and Watt Archives, dated to 1806 (Figs. 3, 4 & 5), but a later letter dated 27th October 1809 from David Denny to James Watt (Glasgow City Archives, F/13/1) suggests that in at least one instance, the committee turned down the opportunity of obtaining a Boulton Watt & Co. engine in favour of a second hand specimen. Once again, this would suggest that at times the Committee of Management was making decisions *contra*. Telford's wishes. It is evident that Telford had a Resident Engineer working on-site at an early stage - Mr James Howell. However, Denny remained in regular correspondence with Telford, informing him of all the major developments, while Telford continued to harry Boulton Watt & Co. on the subject of engines. The beginning of 1807 once again found Thomas Telford in Glasgow – he writes to Boulton Watt & Co. on the 7th January 1807, once again on the subject of engines, where he states, 'As I wish to make some arrangements respecting the execution of the Glasgow Water Works, I am desirous of knowing in what state of forwardness the Engines which you are making are at this time, and when we may, with certainty, rely on them being completed.' In this same letter, Telford states that his address for the coming fortnight would be the Star Inn, Glasgow (Boulton & Watt Coll. MS 3147/3/525/37).

65. During this fortnight's residency, the issue regarding the mains pipes was finally resolved. There had been a flurry of correspondence relating to stone pipes, but in the end an iron foundry – Messrs. Booth & Co., based in Sheffield – was chosen for the task. They were commissioned to carry out the work in October 1806, with Telford's Resident Engineer, James Howell, in contact with them again in November, enclosing a design specification for 14" pipes (Glasgow City Archives, F13/1). By 15th February a consignment of iron pipes had already been forward from Messrs. Booth & Co. to the Glasgow Water Works.

Constructing the Water Mains

66. Booth & Co.'s connection with the Glasgow Water Works is unclear: with the Carron Company already established in 1759, it seems surprising that the Committee did not seek to appoint a manufacturer closer to home. It is possible that they were another recommendation by Telford, who with his Shrewsbury connections would have had many personal contacts in the Midlands.

67. Established by 1794 (when they were described as having 36 grinding wheels employing 36 men), Booth and Co. had a foundry at Royds Mill, in Attercliff, Sheffield. By 1821, they were described in a Sheffield Trade Directory as 'Booth & Co', iron and steel rollers, anvil, vice, boiler, plating forge for horseshoes, and ironboat manufacturers'.

68. With the sole supplier of iron pipes located in Sheffield, the task of procuring the pipes proved to be a difficult one. As it was, finished pipes had to be transported from Sheffield to Hull, presumably via inland water way (perhaps via the River Don, and the Stainforth & Keadby Canal), before being shipped from Hull to Leith. Once unloaded at Leith, the pipes were shipped via the Forth and Clyde Canal to the basin at Port Dundas, from whence they were delivered by cart to their final destinations in the city.

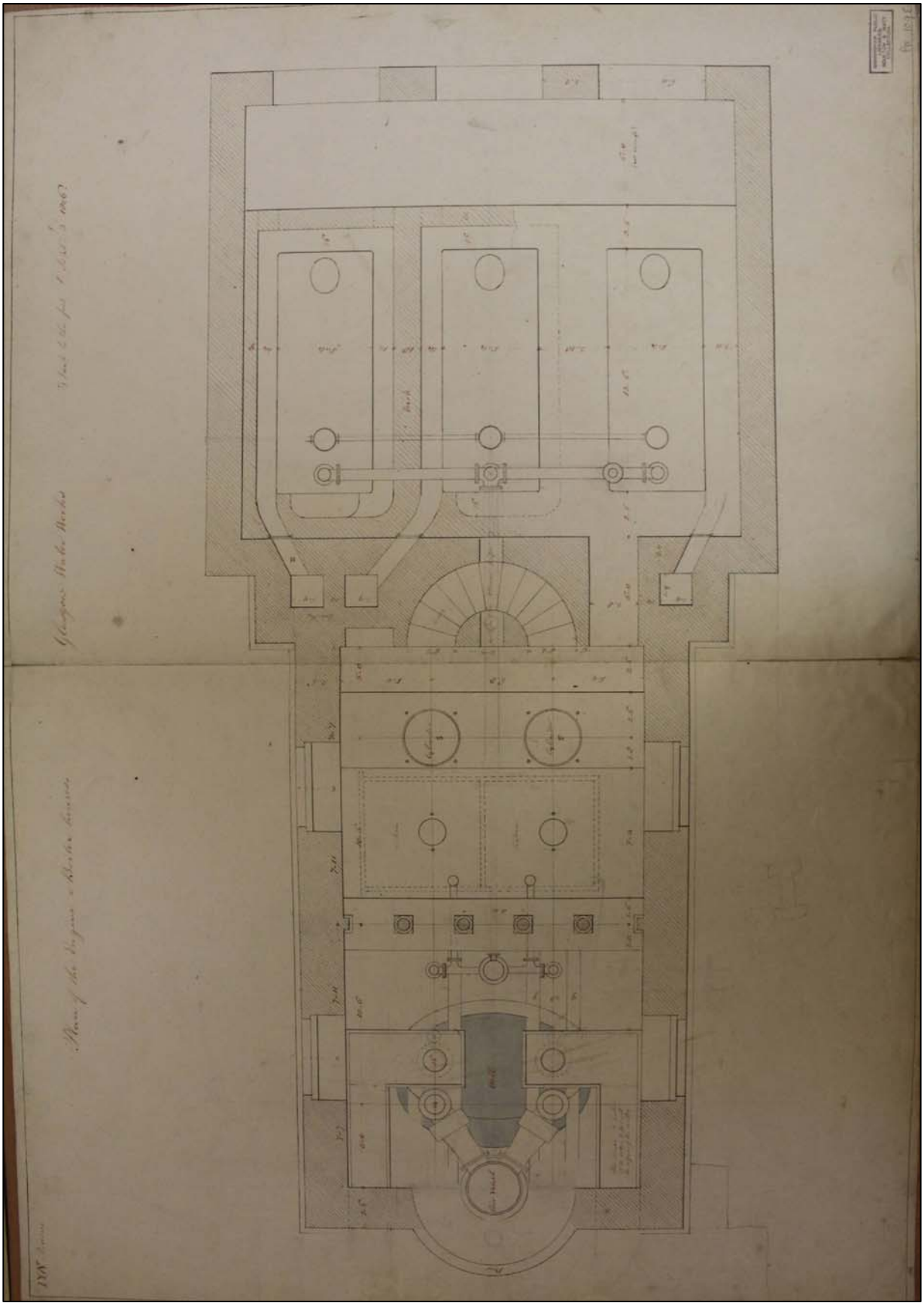

Figure 3: Plan of Engine House, dated 1806

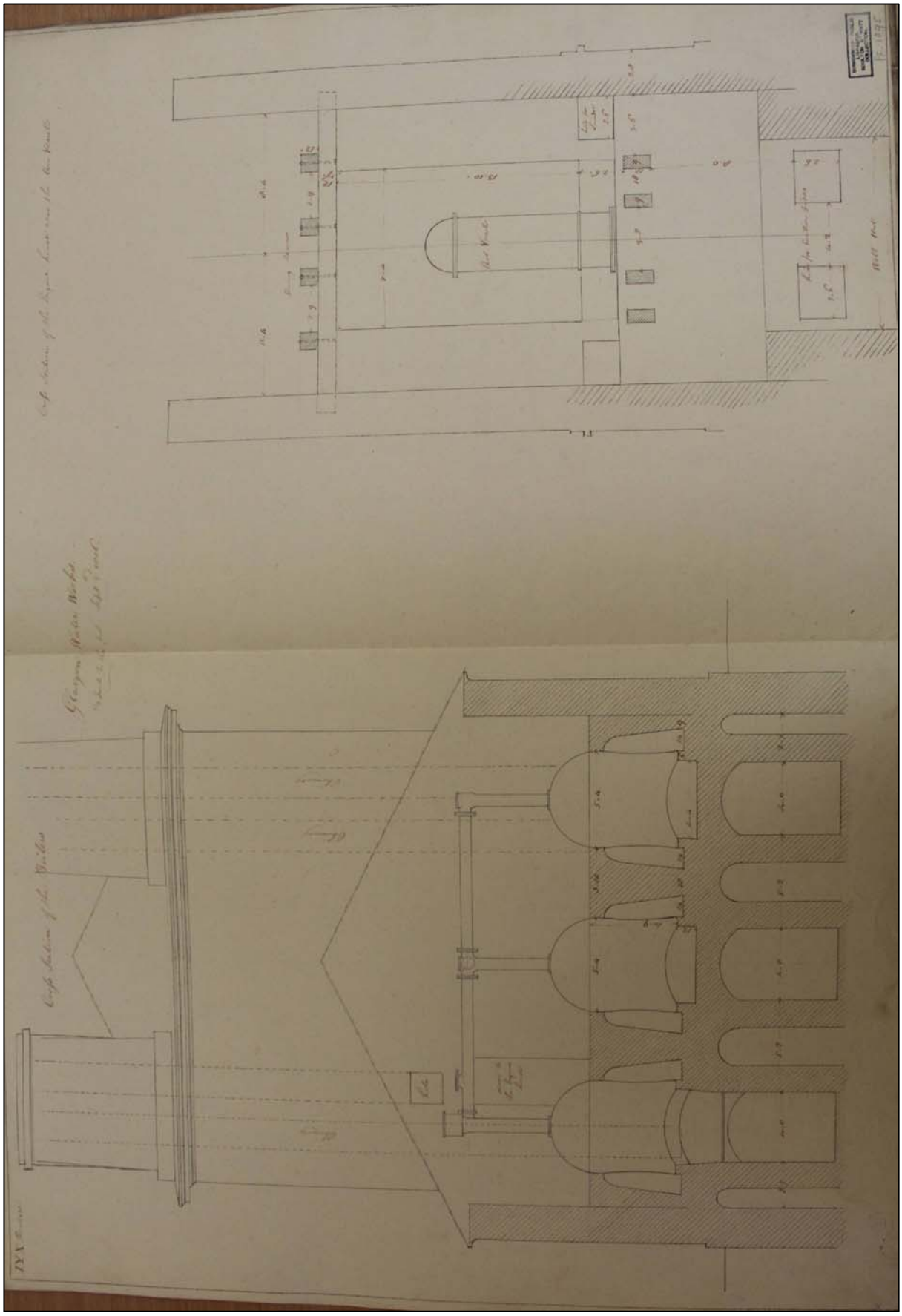

Figure 4: Sections of Engine House, dated 1806

© Birmingham City Archives)

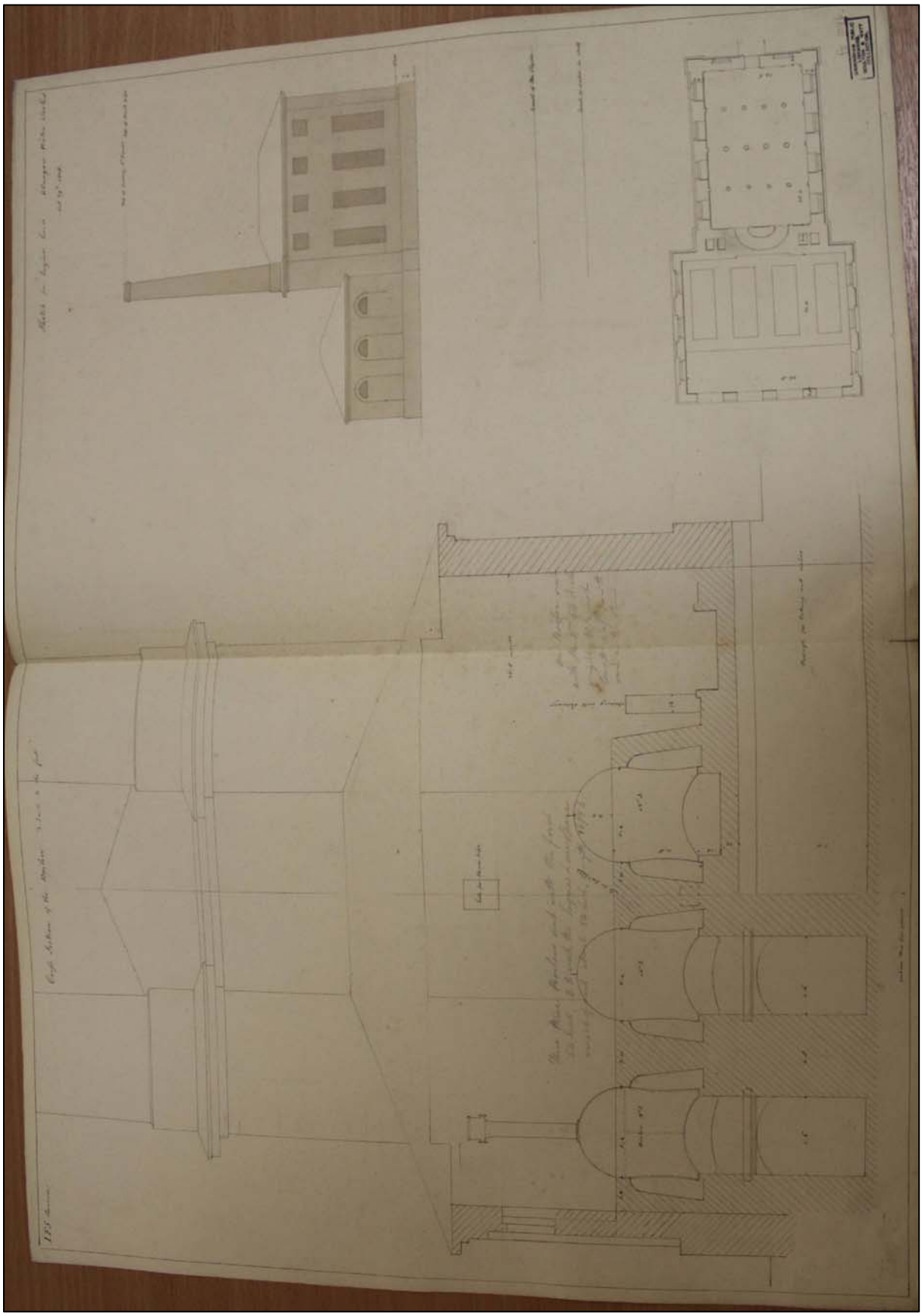

Figure 5: Sections of Engine House, dated 1806

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69. Pipes were required in a variety of sizes – from the 14" main that formed the main artery of the system, through the 4" or 5" pipes which supplied individual streets, to the 1½ to 1" pipes which serviced each close, with lead pipes then affixed to allow individual households to be supplied (cast iron pipes of that thickness being too susceptible to rust, and therefore too short-lived to be practicable). An example of the specification for manufacture can be seen in a letter sent by Denny to Booth & Co. on 14th April, 1807 (Glasgow City Archives, FS/13/1):

> *'The pipes are to be cast on end in dry sand in lengths of Nine feet four inches and a half each – They are to be nine Inches Diameter within and to consist of Metal five eighths of an inch in Thickness – the quality of the metal is to be such as to receive a Column of Water two hundred feet in height. Each pipe to have a facet four inches and a half in length of a diameter to receive the end of a nine inch pipe with proper jointing as Shewn in the Section…'*

70. The quantities required were copious: in the year 1807, Booth & Co. had been commissioned to manufacture 104 pipes (size unspecified – presumably 14"), 240 1 and an eighth inch pipes, 266 1" pipes, 440 9" pipes, 600 7" pipes and 500 yards each of 2, 3 and 4" pipes.

71. During this period, pipe production seems to have progressed at a rate consistent with the laying of the mains. However, in 1808, the weaknesses in the system began to manifest themselves, exacerbated by the establishment of a rival Water Company – the Cranston Hill Water Company, which although ostensibly set up in the west end of the city to service the area around Anderston, was clearly created as a competitor. This removed the Glasgow Water Work's monopoly over service provision, and a race ensued: the more pipes could be laid by the Glasgow Water Works, the more streets could be serviced, the more households and businesses supplied. This would increase the income generated for the company through the payment of annual rates, ultimately yielding a greater return for the investors who had bought the shares by which the works had been funded in the first place.

72. Agents located at both Hull and Leith were employed to identify potential vessels by which the pipes could be shipped. Thanks to the survival of the Committee's letter book, the information relating to this procedure is copious, with records relating to the shipping agents, the vessels used for shipping, and even the names of the captains. The agent in Leith was a Mr James Kidd, the agent in Hull was initially a Mr Stainton, with a Mr Ross later taking over the role. Freight was paid by Booth & Co., and reimbursed by the Glasgow Water Works Committee, along with the stamp duty, when the invoices were settled. Naturally, this meant that Denny was keen to obtain a competitive price from the freight companies.

73. A letter sent to Booth & Co. on 24th June 1808 details all the consignments of pipes sent between Hull and Leith. Regular use was made of the *Montagu*, the *Edinburgh Packet* and the *Hull Packet*, with the *Earl of Dalkeith* making an ill-fated trip on the 2nd September, 1807, which will be referred to in detail at a later point. Incidents and accidents were occasional tribulations to be endured as necessary.

74. One such tribulation was a long-running dispute with a Captain Murton, who was responsible for moving at least some of the 14" pipes between Leith and Port Dundas, via the Forth and Clyde Canal, aboard the *Hawke* and the *Joseph & John*. Murton demanded payment upon delivery, and though informed that he had to invoice Booth & Co. for the costs, threatened to impound the pipes, as Denny recounts in a letter to Booth & Co. dated 26th September, 1807 (Glasgow City Archives F13/1):

> *'Mr Murton the owner of the vessels which brought the 14 inch pipes called for the freight of the last cargo – on being informed that I had neither the funds nor authority to pay it but that he must call on you for the freight, he threatened to arrest the pipes until he was paid. In case he should resort to any such measure which I think very likely be so good as to advise me on how I am to act.'*

75. The dispute with Murton was not settled until 1809, when a court hearing found in Booth & Co.'s favour. However, it was something of a pyrrhic victory, as correspondence from Denny to Booth & Co. dated 11th April, 1809 clearly demonstrates: '*The suit with Murton is now settled in your favour, but as he is bankrupt, you have to pay your own lawyers expenses*.'

76. Besides the *Hawke* and the *Joseph & John*, pipes were also freighted in these early months aboard the *Nancy*, the *Nonsuch* and the *Friendship*, not always to Denny's satisfaction. He notes, for example, on 11th July, 1807, how '*the charges on the Friendship's cargo in particular are extravagantly high*', and asks Booth & Co. to look into it (Glasgow City Archives, F13/1).

77. The precarious nature of this long-distance supply chain was shown into sharp relief with the sinking of the *Earl of Dalkeith* in the winter of 1807. A letter from Denny to Booth & Co. dated 28th February 1808 refers to the loss of 28 7" pipes during the incident. Little is known of the circumstances surrounding the incident, apart from the fact that the unfortunate vessel foundered off the coast of Northumbria. This resulted in a shortage of pipes in Glasgow, and sparked off a long dispute with the Busby brothers, John and Daniel, who managed to salvage some of the cargo from the *Earl of Dalkeith* and expected reimbursement.

78. John Busby was himself a noted surveyor and civil engineer (Walsh, 1966). Born in Northumberland, he subsequently moved to Leith, where he was involved in various projects which included the Caledonian Canal (linking him, of course, with Thomas Telford, from whom he obtained a glowing testimonial when applying to the Colonial Office for employment in New South Wales). He spent his later years in the Antipodes, where he became a celebrated figure for his successful attempts to refloat the Australian government brig *Elizabeth Henrietta* off New Zealand. He was also responsible for the design and implementation of a project to supply the citizens of Sydney, Australia, with water.

79. A letter from Daniel Busby dated 4th March 1808 informed Denny that 12 pipes had been recovered, and enquired as to their value. The Busby brothers expected to be paid the full value for the pipes – Denny responded in a later letter to John Busby with the riposte that '*the pipes are injured by being so long in the Salt Water there is no doubt – nevertheless if you send fifteen or sixteen of them here, you will be paid the salvage* [that is, the value of the raw material, as dictated by Booth & Co.] *according to agreement*.'

80. In an example of the misunderstandings that arose along the various links of the supply chain, it turned out that instead of the 28 9" pipes Denny thought to be on the cargo schedule of the Earl of Dalkeith, the entire consignment of this particular size were aboard, numbering a total of 73 pipes. John Busby managed to salvage 36 of their number, and facing a dearth of these pipes, without which work on the mains could not proceed, Denny asked for them to be forwarded directly to Glasgow.

81. By May 1808, Denny was becoming increasingly frustrated in his attempts to procure more pipes for use in the project. Busby had not delivered the pipes salvaged from the *Earl of Dalkeith*, and there appeared to be delays in shipping at both Hull and Leith. This prompted Denny to write to Booth & Co. on the 9th May, to ask them to inform him of progress in manufacture and shipping of 7", 5" and 4" pipes, because if '*it should be so, which I very much fear if the case, that they have not forwarded these pipes – it will be [?] with us again indeed for we are again entirely out of work. I have therefore to request that you will take the means to get the pipes forward as fast as they are made – we shall else be under the necessity of getting pipes made here – for our work must not stand, especially with a Rival Company taking possession of the Streets before us'*.

82. Unbeknown to Booth & Co., Denny had already made alternative arrangements: on 27th February 1808, he had contacted the Carron Company to inform them that:

> *'We have made a Conditional agreement with an English house to furnish the whole that may be wanted for the works – but are now satisfied it will be*

> *impossible for them to get the whole ready in sufficient time for our operations. Will therefore be glad that you advise me on what terms and what time you could supply us with about 2000 yards of each sort [3 & 4") delivered at Port Dundas – to be paid in cash two weeks or so after delivery.'*

83. This ultimately proved to be the way forward for Denny and the Committee. By the end of 1808, they had added a number of local foundries to their suppliers, including James Sword & Co., Martin Dalrymple of the Omoa Foundry (founded in 1787 by Colonel William Dalrymple on his Cleland estate and named after the Capture of Omoa in the West Indies), Hugh & Robert Baird (Shotts Ironworks), Messrs. Thomas Edlington & Sons (with both Hugh Baird and Thomas Edlington also having interests at the massive ironworks complex at Muirkirk), Robert Fenton and Joseph Outram of the Clyde Ironworks, Ayden & Elwell (Yorks.), William Douglas of the Glenbuck Ironworks. This illustrates how hard pressed the Committee were to obtain large quantities of pipes for their works, and how valuable the project was in providing local foundries with employment (further information relating to the history of iron-founding in Scotland, and mentioning many of the foundries listed above, and the personalities involved in running them, can be found at http://www.forestry.gov.uk/forestry/INFD-7DRFKC).

84. There were problems regarding quality: Denny remarks on 22nd March, 1809 that the pipes provided by Hugh & Robert Baird were '*rather slender'* and that they do '*not appear to me capable of bearing caulking*'. While Martin Dalrymple was informed on the 30th March 1809 that '*Split facets were found on several pipes and others lifted. The metal is much too hard and I fear we dare not [?] to lay them for they will not bear caulking*'. This was followed by another letter dated 8th July 1809 informing them that '*Yesterday we began to prove the 6½ inch pipes for the first time and am sorry to acquaint you that they are turning out very ill indeed – for out of which were proven 8 of them appear to be faulty. The pipes (excepting 2 or 3…) are quite unexceptional to the eye – and am at a loss to account for their being so bad'*. James Reid, at the Omoa Foundry, was told by Denny on 21st June 1809 that '*I have seen the 6½ Inch Pipes the faucets are too slender, unless they are made stronger they will not do at all. They are besides rather under 6½" diameter and lay only 8 feet 11 inches, instead of 9 inches*.

85. Booth & Co., whose issues had until that date apparently revolved around supply, were not, however, immune from deficiencies in quality – a letter from Denny dated 28th February 1809 sent to the foundry adds almost as an afterthought: '*There ought also to be some deductions on account of several defective pipes – but this I believe we shall pass over*.'

Supplying the City

86. On the 11th February, 1807, Denny wrote a letter to Alexander Mundell Esq., summarising the work to date (Glasgow City Archives, F13/1):

> *'The Glasgow Water Works are not yet so advanced as to enable us to draw Rents but in the Month of June there is little doubt but we will be able to supply the East End of the Town and all along the Main Street, the Main Pipe is now within 100 feet of the Cross – and but for the untoward Season – either heavy rains or frost – we would have been in a greater state of forwardness. To what amount the rents may turn out to be, it is impossible to say – but when the bad quality and even scarcity of our own present supply is taken into consideration, the great population of the town, and numerous manufacturers it is reasonable to suppose there will be a great demand for the water and that the Revenue will be considerable'.*

87. He concludes with a tribute to the works undertaken to date:

> *'As to the Glasgow Water Works we may safely assert that for beauty and desirability there is none in the Kingdom to be compared to them all the pipes are of cast iron and all the Basins and Reservoirs of polished stone'.*

88. This eulogy masked some discontent, however, which was to become more and more

manifest as time progressed. Telford had fitted his responsibilities towards the project into a very busy schedule, and he had clearly aimed to complete the project according to his very high standards. For instance, he writes to Boulton Watt & Co. regarding the reservoirs on 25th July 1806 as follows (Boulton & Watt Coll. MS 3147/3/525/30): '*I hope to make it* [the Engine House] *handsome, as a decent appearance has a considerable effect in cases of this sort. I mean to make the walls around the reservoir to be faced next the water, and covered on the top, with cast stone, so as to render the whole either a matter of curiosity, or at all events, enable them to keep every part remarkably clean.*' Unfortunately, the engine house has not survived to the present, though its footings were uncovered during recent excavations undertaken by CFA Archaeology during redevelopment works taking place in advance of the 2014 Commonwealth Games (McBrien, pers. comm.).

89. Denny's subsequent letter to Mundell indicates that Telford's high standards were maintained, but there were certain aspects of the project that may have been a source of irritation. Telford's itinerant lifestyle meant that on some occasions, progress was delayed while they awaited his arrival. On 27th October 1807, Denny relates to Booth & Co. for example, how he '*delayed answering your letter of the 12th… waiting the return of Mr Telford to have opinions about the thickness of the 2, 3, 4, and 5" pipes'*.

90. It has already been noted how Telford's correspondence to James Watt and John Southern at Soho hints of strain between the Committee and their appointed engineer. His disquiet does not appear to be unjustified: Denny notes in a letter dated 6th August 1808 that they '*would not be in want of more than £1500 or £2000 but that the Committee have resolved on extending the plan considerably that is by laying pipes in many inferior streets and lanes in Glasgow not taken in to the estimate by Mr Telford*' (Glasgow City Archives, F13/1). He is also critical of the sub-contractors chosen for the work. On the 19th December 1808, he writes to Howell, Telford's Resident Engineer, complaining because Sinclair & Freebairn, the masons chosen to build the reservoirs, had exceeded the sum quoted in their tender by more than £2000 (Glasgow City Archives, F13/1). He closes this letter with a terse comment: '*I shall be glad that you state the particulars for which this firm has been disbursed – in order that it may be laid before the Committee of Management*.' These comments make Telford's earlier observations regarding the ease by which engineering projects can run over budget seem oddly prophetic.

91. Nowhere is Denny's dissatisfaction with Telford's performance more starkly presented, however, than in a letter to Boulton Watt & Co dated 27 October, 1809 (Glasgow City Archives, F13/1). Here he reveals that the system as designed by Telford has not proved as worthy as had been hoped, stating '*Having found the filter … on the plan constructed by Mr Telford very defective, the attention of the Committee has been for some time directed to the means of finding a supply of pure water in the Neighbourhood of the Works and from the trial already made they are led to entertain sanguine hopes of success.*' He continues, ominously, with the words '*The Committee do not feel inclined to apply again to Mister Telford'.*

92. James Watt's role in the early stages of this affair remains mysterious. Telford had been anxious to receive his advice from the very outset. Indeed he had confessed to Watt at an early stage that he had been experiencing difficulties in getting the water perfectly pure. Despite Telford's entreaties for more direct involvement, James Watt remained a remote participant in the project. However, correspondence between Watt and his son, James, dated 13th [?] 1807, indicates that not only was James Watt Junior, who was also experienced in the running of steam engines, in residence at the Glasgow Water Works (presumably supervising the installation of a steam engine) but that James Watt Senior was preparing to join him, and that his intention had been to do so earlier. Family circumstances had, however, delayed him, with Watt noting: '*I have been as well as Mrs Watt confined to the house for some days with the cold, but we are now recovering and hope to get away by Tuesday next…*' (Boulton & Watt Coll. MS3147/3/31)

93. During his stay in Glasgow, James Watt Senior met with Denny and the Committee of Management, who responded enthusiastically, as Denny notes in a letter to Boulton Watt

& Co. on the 27th October, 1809 (Glasgow City Archives F13/1): '*Mr Watt's stay here has fortunately presented them with much valuable information'*, before adding that '*as they are most anxious to have the work done in the best manner they have directed me to request your* [i.e. Boulton Watt & Co.'s] *advice in the business and even propose to you the accomplishment of it*.' The Committee appears to have put this proposal directly to James Watt Senior, but he declined to accept it, asking them instead to send their proposal directly to Boulton Watt & Co. Their strength of feeling is summed up by Denny when he writes: '*The committee feel themselves under the greatest obligation to Mr Watt and are very anxious that those hints which he has in the most obliging manner given them may be executed in the best manner possible – it is for this reason that they wish the whole undertaking placed under your management*.' What seems all the more remarkable is that throughout the whole undertaking, Watt provided his advice free of charge, though in the long run, this appears to have paid dividends, as the Committee from then on felt obliged to purchase their steam engines from Boulton Watt & Co..

94. Watt initially advised that they seek a supply of water on the north bank of the Clyde, as running pipes across the river bed would be a difficult exercise, and there was always the possibility that the land would end up so heavily choked with mud that the supply of water would be considerably reduced. This was not, however, practicable: Denny reports in a letter dated 12th December 1809 to Boulton Watt & Co. that '*trials have not been attended with success*' (Glasgow City Archives, F13/1). Attention turned instead towards the peninsula lying immediately opposite Telford's reservoir, on land then occupied by Cuningar farm – here, initial test pits (Figure 6 - Boulton & Watt Coll. MS3147/5/1095) proved extremely positive, with a copious supply of pure water occurring, naturally filtered by the sands and gravels which made up the peninsula.

95. Watt's plan for transporting the water across the Clyde was particularly revolutionary. He suggested that after being pumped up from the sands and gravels on the peninsula by an engine, it should be pumped across the Clyde via a series of iron pipes (Figure 7 - Boulton & Watt Coll. MS3147/5/1095), furnished in some cases with hemi-spherical joints to enable them to have sufficient flexibility as they crossed the river bed.

96. By the 14th March, 1810, the Committee had obtained several alternative proposals for the transportation of fresh water across the River Clyde to the reservoirs on the north bank. The first was the scheme mooted by Boulton Watt & Co., described above. The others were less radical in design: the first suggested substituting the 15" cast iron pipe with 4" lead pipes of 5" or 5½", the idea being that '*owing to the natural flexibility of the metal it will easily accommodate itself to the curvature of the bed of the River – and with a view to give it sufficient room to sink in the Mud or Clay in the event of the bed of the River being scooped away by floods – the pipes would be laid with a bend upwards meeting the current'*. The third proposal was to carry the water via a wooden trough supported on piles, from the well on the peninsula to the lower basin of Telford's trio of reservoirs. Slide rods would be connected with the engines in order to pump the water into the trough, with the wooden trough.

97. The proposals were put to a new Resident Engineer hired to deliver this next phase of works. His name was Hugh Baird: not, evidently, the eminent Scots-born engineer of that name (who was later assisted by Telford in the delivery of the Edinburgh branch of the Forth & Clyde Canal). Instead, it was one of the Baird brothers who managed the Shotts Ironworks – as a letter from Denny dated 10th April 1810 confirms, when he writes '*I have just written to your Brother Robert requesting to see him about the pipes and other ironwork necessary for the undertaking and he shall get on with all the parts of the work as fast as possible'* (Glasgow City Archives, F13/1/)

98. Baird agreed to the execution of the Boulton Watt & Co. plan, and on 27th April, Denny wrote to Boulton Watt & Co. informing them that '*It was only on the 18th… that the Committee of Management… finally determined in executing in all its parts the ingenious plan which you had the goodness to transmit'*. Denny lamented the delays to date, before informing Boulton Watt & Co. that they hoped to carry out the works in July (Glasgow City Archives, F13/1).

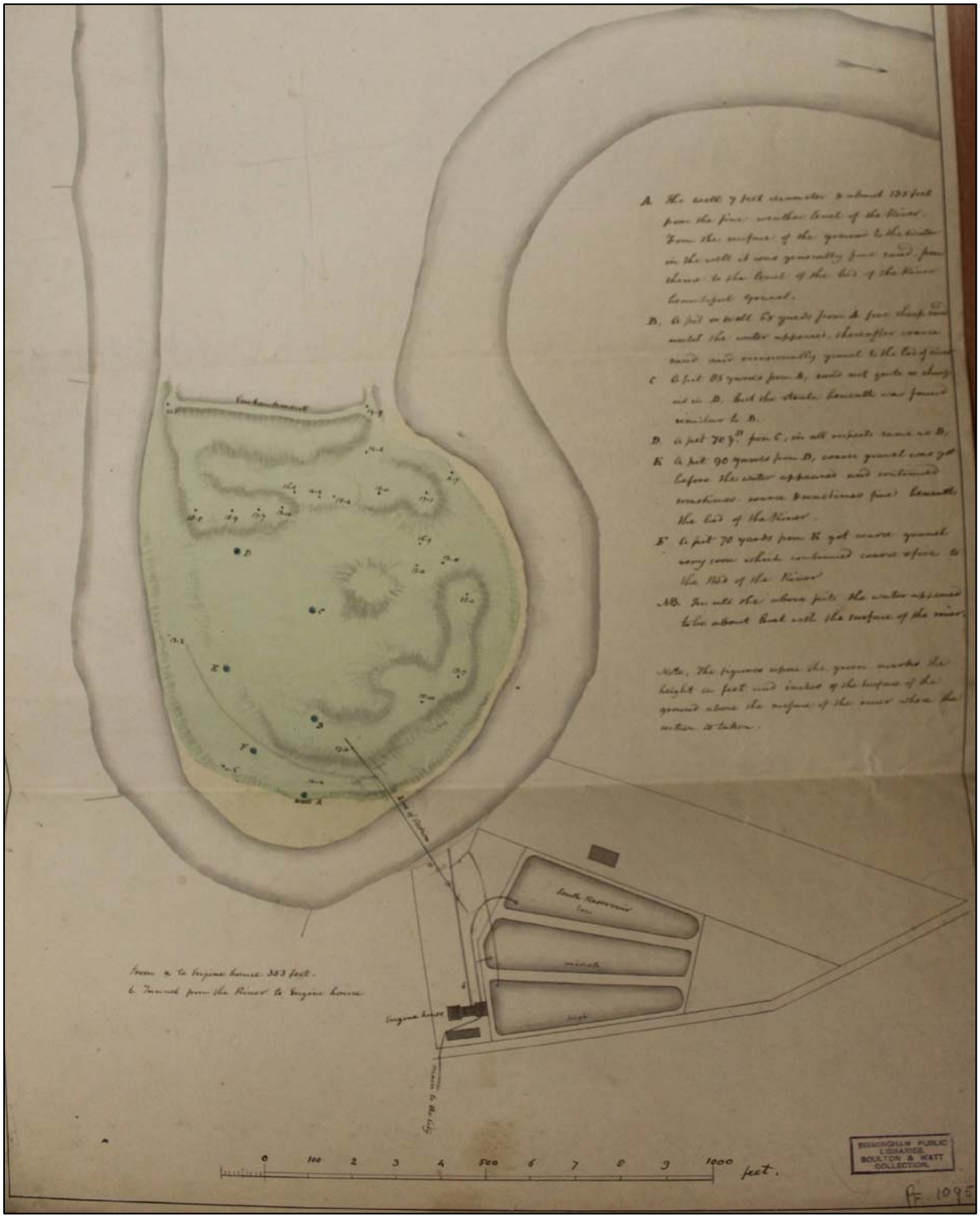

Figure 6: Layout of Test Pits on Lands of Cuningar

©Birmingham City Archives

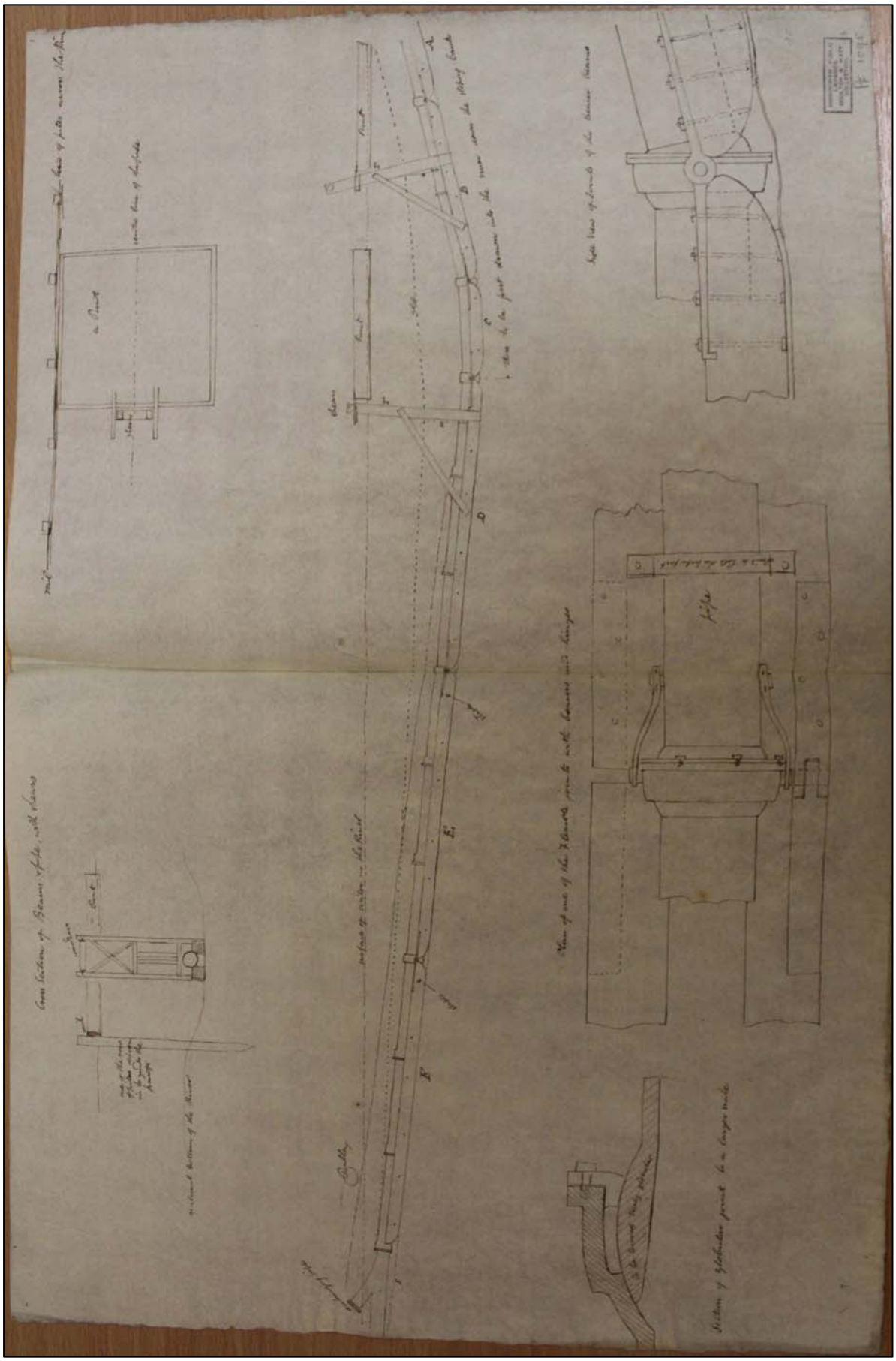

Figure 7: Boulton & Watt Drawing showing construction of Pipeline under River Clyde

99. A report held in the Birmingham City Archives which appears to be in James Watt's handwriting gives a detailed account of how these works should be undertaken (Boulton & Watt Coll. MS3147/5/1095). The pipes would be fixed upon timber frames, joined together with hinges of cast iron – Watt pointed out that '*care must be taken that the axes of the pins of these hinges be in a line with the axis of the globular joints to which they correspond, otherwise the motion of the whole would be obstructed*.' In theory, pipes and frames would then form a flexible chain which would adapt itself to the base of the river.

100. Firstly, a row of piles was to be laid across the river in a straight line (each set approximately 4m apart) with their tops projecting and joined by a rail. A groove at least 4m wide would then be dredged across the river bed (to be made deeper on the south side, where the basal deposits were sand), with a similar channel to be hand cut on the south bank, where the pipes and frames would be assembled in readiness for the operation to commence.

101. With the pipes assembled and the joints caulked with rope soaked in a warm mixture of tallow and whiting, the pipes would be hauled across the river via a rope affixed to a capstan set on the north shore. Ponts (i.e. small ferry boats) were to be floated on the river, guided by the rail mounted along the line of piles: projecting pieces mounted on the ponts allowed the frame and pipe to be guided accurately down the centre of the channel. Watt envisaged that the weight of the pipes and frames should be borne largely by the river bed, as this would enable the ground to be levelled as the pipe proceeded. The operation had to be executed quickly, as there was every possibility that the movement of the pipes would disturb sufficient sediment to fill up the groove so painstakingly dredged prior to the work commencing.

102. On the 27th June 1810, Watt's plan was put into action. Denny triumphantly writes to Boulton Watt & Co. on the 28th, informing them that:

> *'I have the pleasure to acquaint you that following out your excellent plan and directions, and without employing any Engines we yesterday succeeded in laying 15 pipes of 15 inches diameter measuring 136 feet in length across the River Clyde… The only deviation we made from your instruction was by attaching the whole 15 pipes and launching them altogether which was done with great care and exactness.' (Glasgow City Archives, F13/1)*

103. At the same time, a filter well was sunk on the south side of the river (Figure 8 - Boulton & Watt Coll. MS3147/5/1095): Watt had instructed that this should be lined with ashlar, unmortared, with a timber platform at the base. The depth could not be ascertained in advance, as it depended upon the head of water required to force a sufficient quantity through this natural filtration process as was necessary to supply the city. This water was obtained via a tunnel, constructed of unmortared whin and packed with gravel: it was driven parallel to the river, at a depth of approximately 3m below the surface of the river for a distance of 18m. They could not proceed any further, as the amount of water entering the tunnel exceeded the efforts of a pump working day and night. Denny conceded that '*As far as we have yet gone in executing this plan, all things have turned out fortunate and I think we may now venture to speak with some degree of certainty that we will completely answer the purpose*.'

104. Three acres of land were duly purchased at Cuningar, with work upon the well and the tunnel completed by 3rd August, aided by a spell of very dry weather. Despite the fact that the river was usually low on account of the weather conditions, Denny reported to Boulton Watt & Co. that '*the Engine was wrought at more than ordinary speed in order to keep down the Water*.' Furthermore, he concluded that: '*We are every day more and more convinced that the supply of water from the Well will be quite equal to the consumpt of the City and Suburbs, - and by lengthening the tunnel and down other wells the quantity can be increased at least five fold'*. (Glasgow City Archives, F13/1)

Consolidation and Expansion

105. Following the purchase of land at Cuningar, the area was subject to further development

as the demand for water increased and the mains network grew ever more extensive. A Report of the Committee of Management on the Glasgow Water Works for 1813 stated that:

> *'Nearly 6000 yards of pipes have been laid. The whole city, most of the suburbs, and part of the adjacent country are now supplied with excellent water. To the North as far as Sauchiehall Road, Cowcaddens and Port Dundas to the South including Gorbals, Hutchestontown and Tradestown and to the East reaching the extremities of Calton Bridge, Bridgeton, Carnluckie and even to Haghall. The water is conducted both for families and public works. To the West the Pipes are carried no further than York Street and will be subject of further consideration whether they should not be extended the length of Anderston.' (Glasgow City Archives, F13/1)*

106. Problems were beginning to arise. The Duke Street Reservoir was beginning to leak, and there were disputes by the local police force over whether monies should be paid to mount a nightly watch over premises – something which Denny considered to be wholly unnecessary in the case of a reservoir. There were also disputes with rent collectors working for the rival Cranston Hill Water Company, who were trying to poach clients in Bridgeton, and instances of water being drawn off the main illicitly without the Committee's knowledge: Denny writes to the Provost of Calton, Nathaniel Stewart Esq., on the 22nd May 1820, to complain the following:

> *'On going through Crosstone street this afternoon along with our foreman, we were much surprised to find that our main pipe had been cut, a branch put on and a pipe led from it to supply the Calton Jail with our water, and all this done by some person or persons entirely out of our knowledge.' (Glasgow City Archives, F13/1)*

107. At the same time, there was considerable investment in infrastructure, with some indication that Denny and the Committee were interested in trying out alternative technologies. A letter sent by him to the Secretary of the Lambeth Water Works dated 24th June 1814 asks for advice on the use of ceramic pipes as an alternative to cast iron, just over month after a letter had been sent to the Nine Elms Pottery, near London, asking for samples of ceramic pipes to be sent to Glasgow for trials.

108. By 1816, four men were permanently employed by the Glasgow Works. In a letter dated 15th October, 1816 (Glasgow City Archives, F13/1), Denny listed their names and job titles as follows:

- Donald Fraser – Clerk in the Office
- Basil Aitcheson – Collector of Water Rents
- William Urquhart – Porter & Collector of Water Rents
- Robert Rowlands – [?] and Overseer of the Works

109. Additional ground was purchased at Cuningar on the 24th March 1819, and the expansion of the city into the area around Blytheswood and Garnethill in the 1820s resulted in the construction of additional engines on the south bank of the river in order to cope with the extra demand for water. Thus began a long association between the Glasgow Water Works and the lands of Dalmarnock.

110. The exact nature of this association is unclear. An account of the City of Glasgow's water supply, issued by the Corporation in 1914, suggests that it was the Cranstonhill Company that first established works there (Glasgow Corp. 1914, 271), stating that:

> *'In 1819 the Cranstonhill company, owing to the polluted condition of the river at that part now known as Anderston quay obtained powers to remove their pumping works to Dalmarnock, a short distance below the works of the Glasgow company, and to construct an additional reservoir at Garnethill.'*

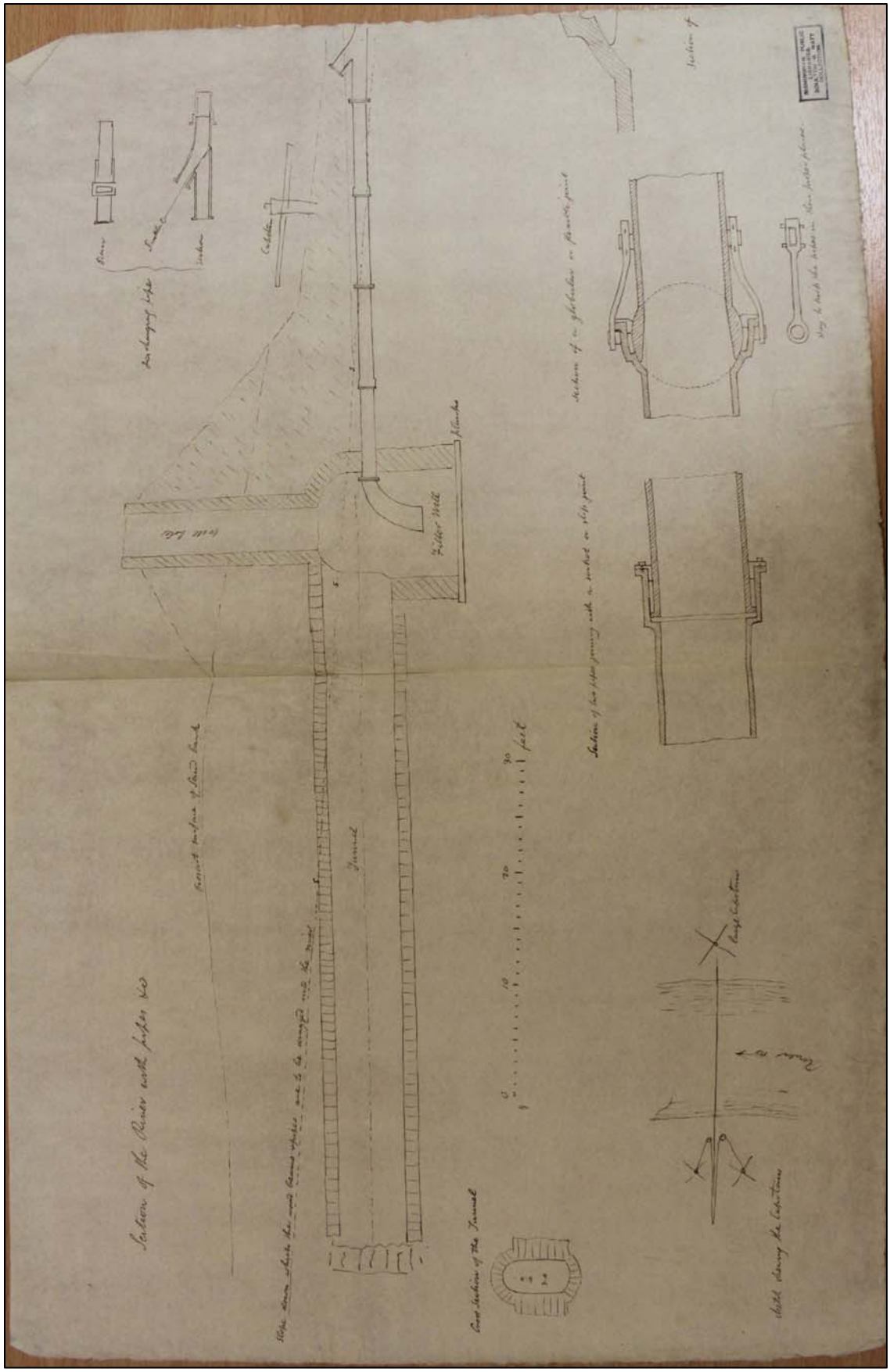

Figure 8: Boulton & Watt Engineering Drawing Showing Well & Tunnel
Boulton & Watt Coll. MS3147/5/1095

111. However, letters written by Denny to Boulton Watt & Co. in his guise as Secretary for the Committee refer to the 'Works at Dalmarnock', and the relevant engineering drawings and other material at Boulton Watt & Co. make reference to the Glasgow Water Works, with an entry in the Engine Order Book dated 2nd June 1815 referring to 'No. 4 54U' [54U being the internal serial number given by the manufacturer]. As a result, this discrepancy cannot be easily resolved (Glasgow City Archives, F13/1). It seems likely that the drawing featured here (Figure 9) was produced at the behest of the Glasgow Water Works, with the Cranstonhill Company occupying land immediately to the west.

112. With both companies actively competing for customers, it is perhaps not surprising that neither of them proved particularly successful in a financial sense (Glasgow Corp. 1914. 271). As a result, a merger was agreed by the respective committees. This was, however, strongly opposed by the Town Council, but eventually agreement was reached and the two companies were combined in 1838. Indeed, they continued to provide the city with water until 1855.

113. The New Statistical Account of 1834-43 is lavish in its praises of the Water Company's achievements, stating that '*The working-classes are better lodged, clothed and fed than formerly, and since the formation of the Water Companies, they are more cleanly in their houses, and healthy in their persons'*. The benefits stretched beyond the needs of the domestic households, with the conditions in the public jails now much improved in terms of sanitation:

> *'As there is a water-closet in every gallery, every individual prisoner, debtor and delinquent, has access to one of them, and to an unlimited supply of pure filtered water for the Water Company, pipes, and pipes are introduced into each court from which they are daily washed, and the air in them frequently cooled in hot weather.' (MacFarlan et al 1834-43).*

114. Prior to the writing and publication of the New Statistical Account, Glasgow had suffered from outbreaks of typhoid and cholera. McFarlan *et al* note that there had been a major outbreak of typhoid in 1818, with a major cholera outbreak taking place in 1832. Both of these diseases are waterborne, but a connection between these epidemics and the inadequacies of the water supply was never made. Instead, other factors were considered more likely causes, such as the squalid living conditions of the lower classes. Disease at this time was thought to be caused by breathing in a foul-smelling mist or *miasma*, rather than by the spread of micro-organisms. It was not, in fact, until 1854 that the physician John Snow first identified the water supply as the vehicle by which the disease was spread during London's Broad Street outbreak.

115. Glasgow's 1832 epidemic was characterised by a series of outbreaks, the first of which took place in June of that year. It confirmed expectations, with '*persons poorly fed, of irregular habits, and dwelling in the crowded ill-aired parts of the city'* the most badly affected (McFarlan *et al* 1834-43, 128). Later outbreaks were more widespread, affecting more affluent areas, a situation which left the authorities puzzled as to the likely cause. At this time, much of the city's water was still supplied from the well on the lands of Cuningar, but issues of quality and quantity were still posing problems, with the mains network growing ever larger.

116. In 1838, further efforts were made to address these problems. Following a Parliamentary Act passed in this year (Aird, 1894), a series of filtration beds was built on Cuningar, associated with a reservoir, and fed by three wells located at various points around the peninsula (Figure 10). Two roofed buildings located immediately to the north-northeast and south-southwest of the reservoir can be interpreted as engine houses, built to house the engines used for pumping water between the various elements of the system.

117. It seems likely that the engine house shown at the north end of the Cuningar peninsula is the same one featured on a Boulton & Watt drawing of 1828, predating the rest of the complex (Figure 9). We also have a clear picture of how the reservoirs were constructed, from a description of the Duke Street reservoir written by Denny in 1820:

> *'One of our reservoirs is 480 feet long, 90 feet broad and 6 feet deep, inside*

measurement. It is constructed with an outer stone wall of rubble work 2½ feet at the base, tapering a little upwards an inner wall at the base, tapering to 2 feet is built 3½ feet distant from the other, and the space between is puddled with good clay, joined to the natural clay at the bottom. The side of the inner wall next the water is polished ashlar.' Denny also notes that they have been *'much troubled with leaks in this Basin'.*

118. The second reservoir, located at the 'highest point' (i.e. High Street), is described as being:

> *'47 feet 6 inches long, 28 feet 3 inches wide and 13 feet 4 inches deep inside measurement. This is also constructed with an inner and outer wall. The outside wall is very strong, being 4 feet at the base, tapering outside to 2 feet 9 inches at the top, inside perpendicular. The inner wall or lining is 12 inches thick, of polished ashlar chequed at both ends, and set in Roman… cement, distant from the other only one inch and a quarter. The space between is run full of Roman cement mixed up, into a liquid state, and wrought down with great care by a flat stick made for the purpose, one cope covers both walls, so that they are in fact one solid wall. There is a strong bar of iron across the bason, built in when carrying up the walls, in order to prevent the height of water from pressing out the sides…' (Glasgow City Archives, F13/1)*

119. Together, the Boulton Watt & Co. drawings and Denny's descriptions can be used to obtain a clear picture of the structures occupying the Cuningar peninsula by 1858. It should be noted that by this time, Telford's original tripartite system, located on the north bank of the Clyde, had fallen entirely out of use, and the land already reclaimed. The function of the filtering ponds shown on the north bank of the Clyde is unknown – at this point in time, the disposal of the city's sewage was still a subject of debate and discussion, and it was still presumably being discharged directly into the river. A role in waste disposal seems unlikely, their purpose perhaps being linked instead with industry.

The Cuningar Loop Today

The replacement of river water

120. The complex of features shown on the 1st edition Ordnance Survey map (Figure 10) represents the last attempt to draw water for human consumption direct from the gravels adjacent to the River Clyde. Despite endless efforts to address the problem, and a vast amount of expenditure on the mains network, the basins, the filtration beds and the steam engines, the issue of water quality had re-emerged, with the existing supply being stretched once again by the continuing growth of the city. The creation of the Gorbals Gravitation Water Company in 1846 further exacerbated the issue: supplying the south side of the city, the quality of the water provided by this company far surpassed that provided by the Glasgow Water Corporation (Aird, 1894, 139). Rather than being drawn directly from the River Clyde, the Gorbals Gravitation Water Company obtained its supply from the Brock Burn, a tributary of the River White Cart. Perhaps with the success of this venture in mind, more ambitious schemes were subsequently proposed: these involved the large-scale movement of water from rural areas outwith the city. Instead of raising the water and purifying it on-site, the water would be pure from source.

121. A variety of sources were suggested, including the upper reaches of the Clyde, the North Calder, the river Avon, the waters of Loch Lomond (Glasgow Corporation 1914, 272). These proposals came from various sources, but only two ever progressed into concrete proposals. Lewis Gordon and Lawrence Hill, civil engineers resident in Glasgow, proposed to draw water down from Loch Katrine, while the Glasgow Water Corporation (reincarnated from the combined forces of the Glasgow Water Works Company and the Cranston Hill Water Company) proposed a source in Loch Lubnaig, Stirlingshire.

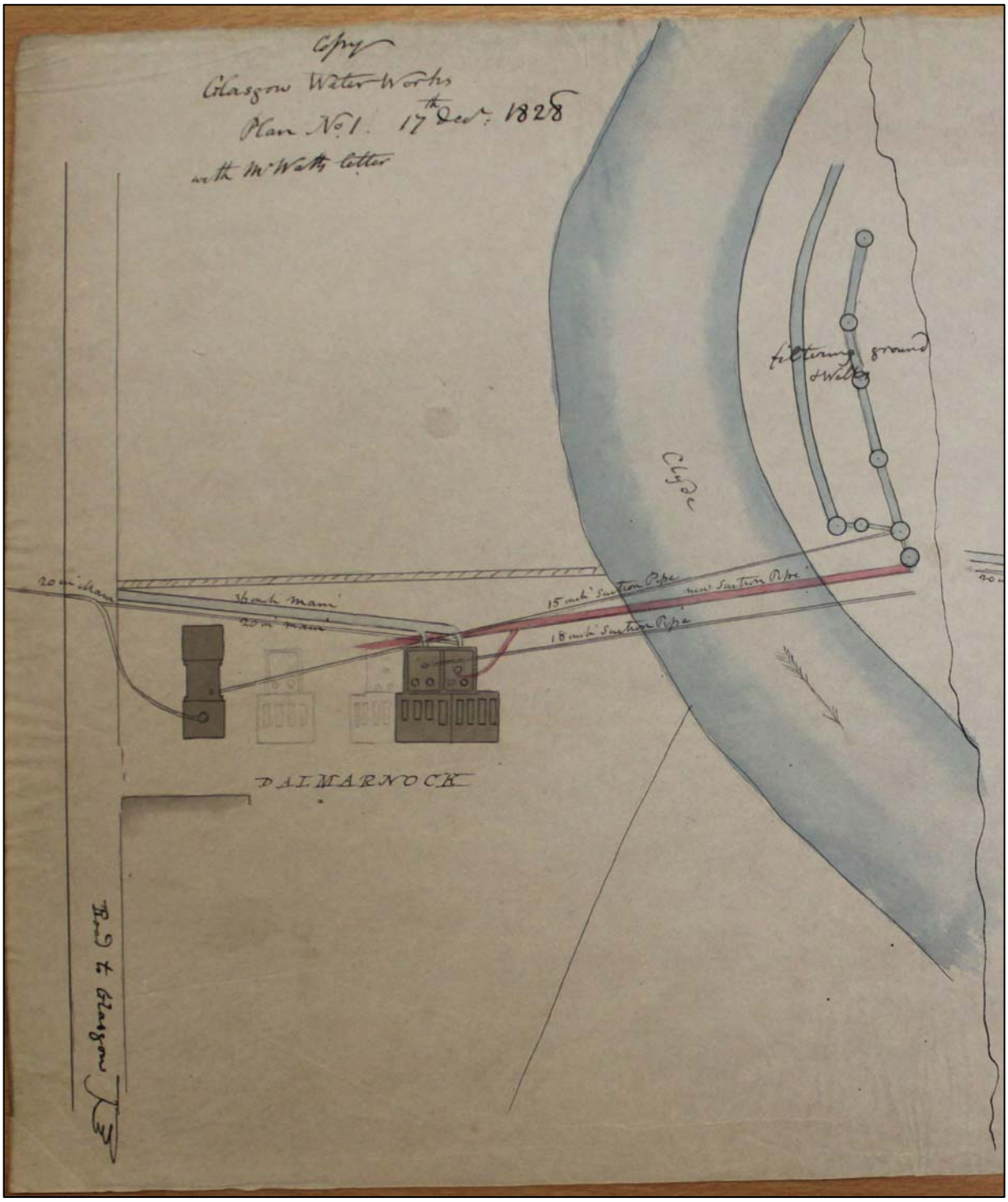

Figure 9: Plan of Dalmarnock Engine Houses, Pipes and Wells 1828
Boulton & Watt Coll. MS3147/5/1095

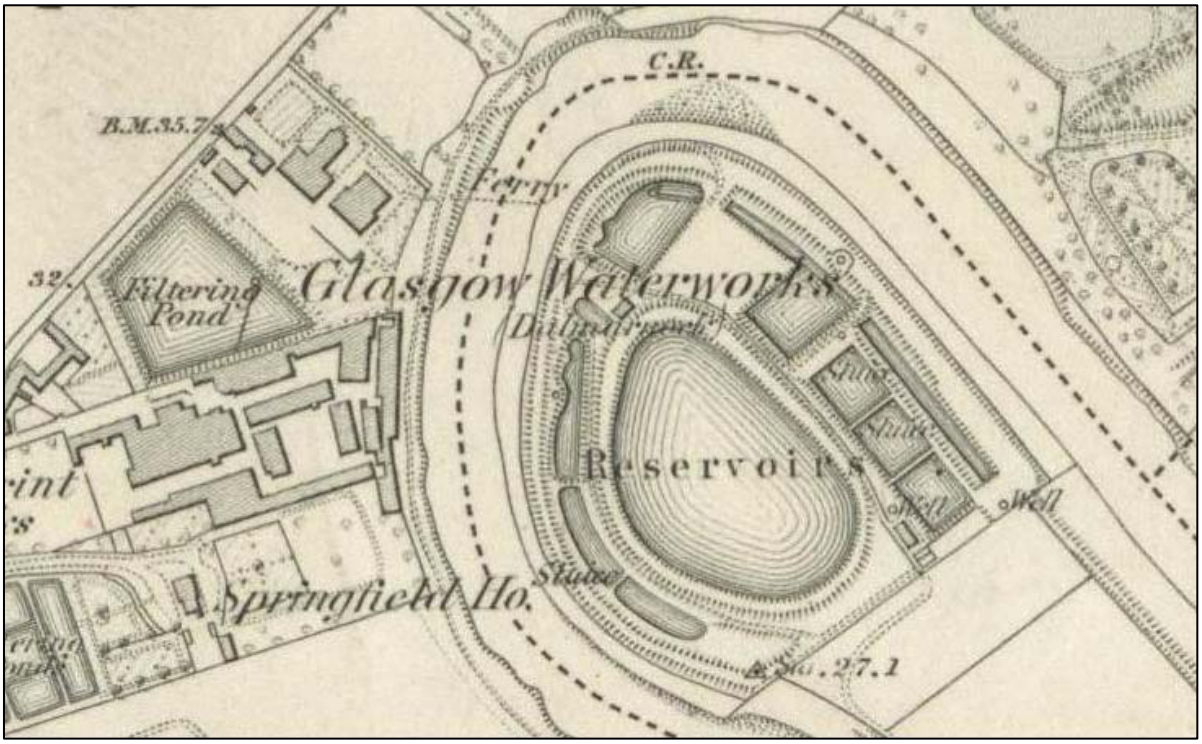

Figure 10: Extract from Ordnance Survey 1st Edition map of 1858 (Lanarkshire, Sheet VI)

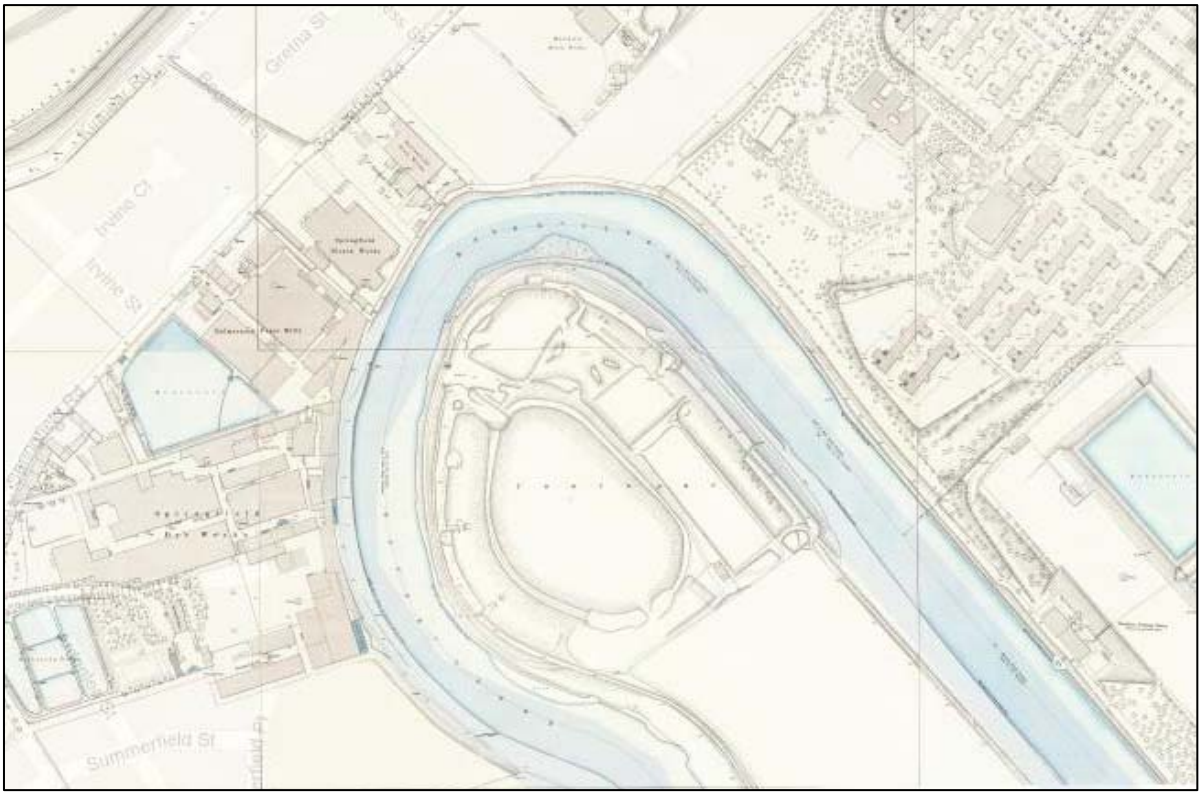

Figure 11: Extract from Ordnance Survey 1898 Town Plan of Glasgow

122. With the weight of experience behind them, it was perhaps not surprising that the Glasgow Water Corporation proposal was chosen in preference to Loch Katrine. The Loch Lubnaig scheme was put before Parliament and subsequently passed in 1846, but it proved impossible to implement, as the quantity of compensation water required to supply the River Teith far surpassed the storage facilities built to hold it. The scheme was then abandoned, and the act became inoperative (Glasgow Corporation 1914, 272).

The Loch Katrine Scheme

123. In 1852, another proposal to utilise the waters of Loch Katrine was proposed by Professor Macquorn Rankine and John Thomson, civil engineers. John Frederic Bateman (1810-89), whose name has become synonymous with the Loch Katrine scheme, was approached to carry out the initial investigations and submit a report to the corporation in 1853. Even at this time, the Glasgow Water Corporation were still proposing to draw water from Loch Lubnaig, but Bateman's scheme won approval, and in 1854, a bill was presented to Parliament outlining a proposal to draw water from Loch Katrine. It failed, in part due to opposition by the Admiralty, who thought it might impede the navigation of the river Forth, and also on account of a report by a Professor Penny, who stated that the action of water on lead would prove hazardous.

124. Faced with this disappointment, Glasgow Corporation once again enlisted the help of the most noteworthy engineers of their generation – Robert Stephenson and Isambard Kingdom Brunel – instructing them to prepare a report which supported Bateman's proposal. This report successfully negated the Admiralty's objections, while Professor Penny's doubts were discounted after a series of experiments demonstrated that *'the passage of Loch Katrine water through lead pipes speedily sets up an insoluble scale in the interior of the pipes, which effectively prevents any dissolution of the lead'* (Glasgow Corporation 1914, 274) thereby negating lead poisoning.

125. The bill was passed by Parliament on 2nd July, 1855, and the work proceeded at an impressive speed, opening in the autumn of 1859 with an official visit by Queen Victorian. Under this same act of parliament, the earlier works of the combined Glasgow Water Company and Cranstonhill Company were purchased and subsequently dismantled: thankfully, this process of demolition had not taken place prior to the surveying of the 1st edition Ordnance Survey map, leaving us with a detailed plan of the final phase of a long series of successive attempts at water provision.

126. Born in Halifax in 1810, Bateman served as an apprentice to a surveyor and mining engineer before establishing himself as a civil engineer at the age of 23 (Binnie 1981, 159). From 1834 onwards, he became heavily involved in water engineering, and was appointed Engineer to the Bann Reservoirs Company, Northern Ireland in 1836.

127. The Loch Katrine scheme required water to be moved over a distance of some 36 miles. The method of transportation varied: over 13 miles, the water is carried via a tunnel, with 9 miles via an open cut and raised aqueducts, and the remainder via pipelines. The water was moved first to a reservoir with 548 million gallons capacity at Murdock, then carried via two 36" diameter pipelines to the city (Binnie 1981, 192).

The Westthorn River-Supply Works

128. By the time the 2nd edition Ordnance Survey map was surveyed in 1898, the Glasgow Water Corporation complex at Cuningar had fallen into disuse, its facilities rendered superfluous by the Loch Katrine supply. The outlines of the various elements are still visible as earthworks (Figure 11): it must be assumed that some infilling of the features will have taken place in the intervening decades. The site remained in use for the pumping of water for industrial use, becoming known as the Westthorn River-Supply Works (shown on the 3rd Edition Ordnance Survey map of 1914 – see Figure 12). New engines were erected there, comprising two compound-tandem horizontal engines (approximately 100 horse power each) with double-acting pumps and four Lancashire boilers (Glasgow Corporation 1914, 280).

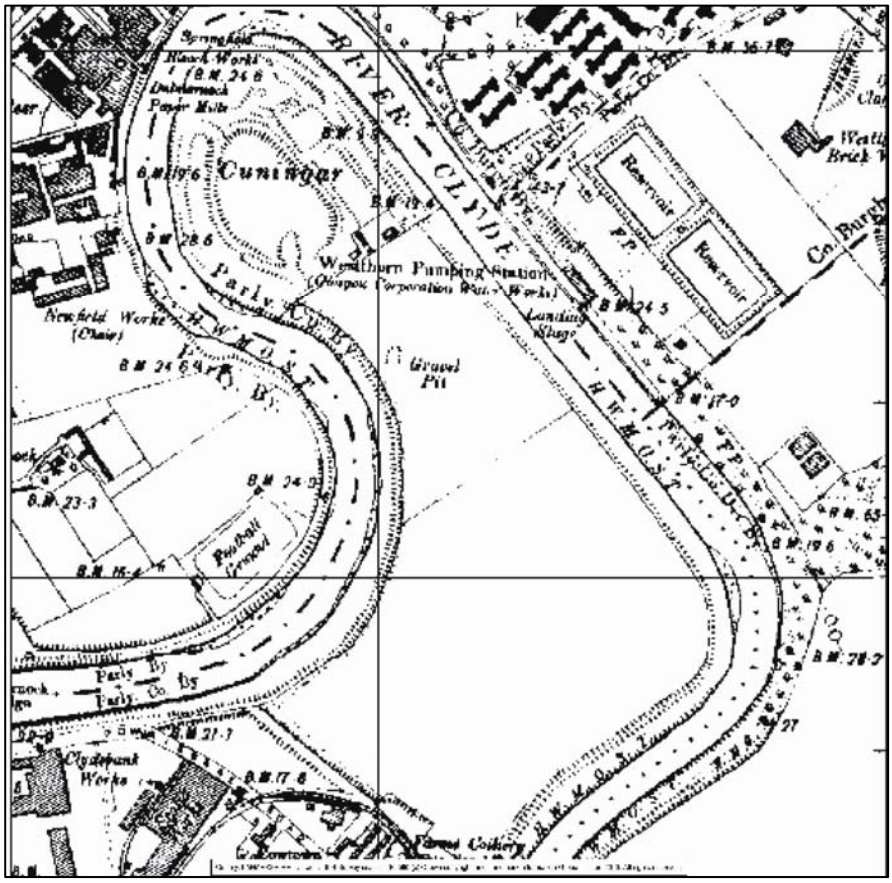

Figure 12: Extract from Ordnance Survey 1:10560 map of 1914

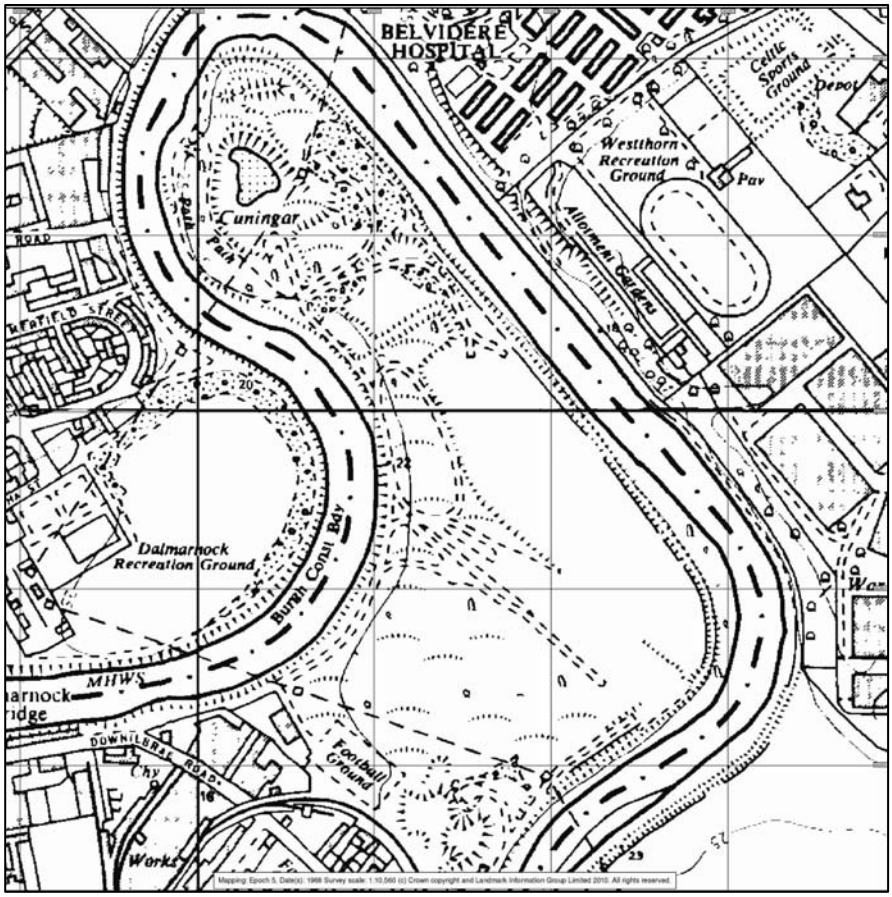

Figure 13: Extract from Ordnance Survey 1:10560 map of 1968.

129. The removal of coal from beneath the site of the pumping-station led to a catastrophic collapse in 1911-12, though after the cessation of mining operations in the area, the original engines were reinstated. The water pumped from the Clyde was stored in reservoirs located to the east, on the east bank of the Clyde opposite Cuningar. In the Summary of Capital Expenditure of Glasgow Corporation Water Works as of 31st May, 1913, the cost of creating the Westthorn had totalled £104,199 14 shillings and 8 pence.

Abandonment and Current Condition

130. By the 1960s, even the River-Supply Works had fallen into disuse, with the remaining features becoming infilled around this time with large quantities of rubble removed from the Gorbals during the City's slum clearance programme (Figure 13). The area was subsequently landscaped, and virtually every trace of the earlier structures obscured by these recent landfill activities.

131. Although the 1968 mapping clearly shows traces of earthworks that can be tied in with individual features shown on the 1st edition Ordnance Survey map, none such features can be identified today, as aerial photographs of the site clearly demonstrate (Figure 17). This would suggest that there has been further large-scale dumping on the site in the previous forty years or so.

132. A site walkover, carried out on 7th December, 2012, supported this possibility. Throughout much of the peninsula, two separate terraces were evident, overlying the original landform (Figures 14 & 15). Both measured approximately 1.5 to 2m in depth, with localised concentrations of demolition debris evident on the surface of the upper terrace. These included unworked rubble blocks, fragments of sandstone ashlar, and bricks marked *'Adam Rutherglen'*. All this debris was consistent with buildings of late nineteenth or early twentieth century date, though the rubble masonry could conceivably have originated in an earlier building.

133. The second phase of dumping on the site, represented perhaps by the upper terrace, appears to have taken place during the 1980s. A walkover survey carried out immediately prior to this second phase of large-scale deposition upon the site revealed that the outlines of the 1838 features shown on the 1898 and 1914 maps still survived as grass-covered earthworks (McBrien, pers. comm.) This second episode succeeded, however, in obscuring all traces of the mid-nineteenth century reservoirs and accompanying filtration beds, resulting in the relatively featureless landform that we see today (Figures 16 & 17).

Analysis

134. Despite having been obscured beneath 3m of more of building debris through dumping activities which took place in the late twentieth century, map evidence and observations obtained in earlier fieldwalking actitivities by West of Scotland Archaeology Service (then Strathclyde Regional Council) staff suggests that the remains of a complex of reservoirs and filtration beds survives as buried features on the site. In addition, the recent excavation of footings associated with an original 1806 engine house on the north bank of the Clyde (Figure 19) would strongly support the possibility that traces of individual structures, i.e. engine houses, and also the associated infrastructure (pipework & tunnels) will survive.

135. These buried structures will be dominated by features associated with the mid-nineteenth century use of the Cuningar site, namely the intensification of Watt's earlier attempts to counteract the perceived failings in the earlier Telford-designed system. However, it is entirely possible that elements of Watt's earlier works, which first utilised the Cuningar peninsula, will survive.

136. The importance of these buried features can only be established by placing them within their wider landscape – and also historical - context. The establishment of a reliable, plentiful, and preferably pure, water supply was becoming a matter for increasing concern for the inhabitants of Britain's ever-expanding cities.

Figure 14: View of Terracing, east side of Cuningar Loop

Figure 15: View of Terracing & Demolition Debris, west side of Cuningar Loop

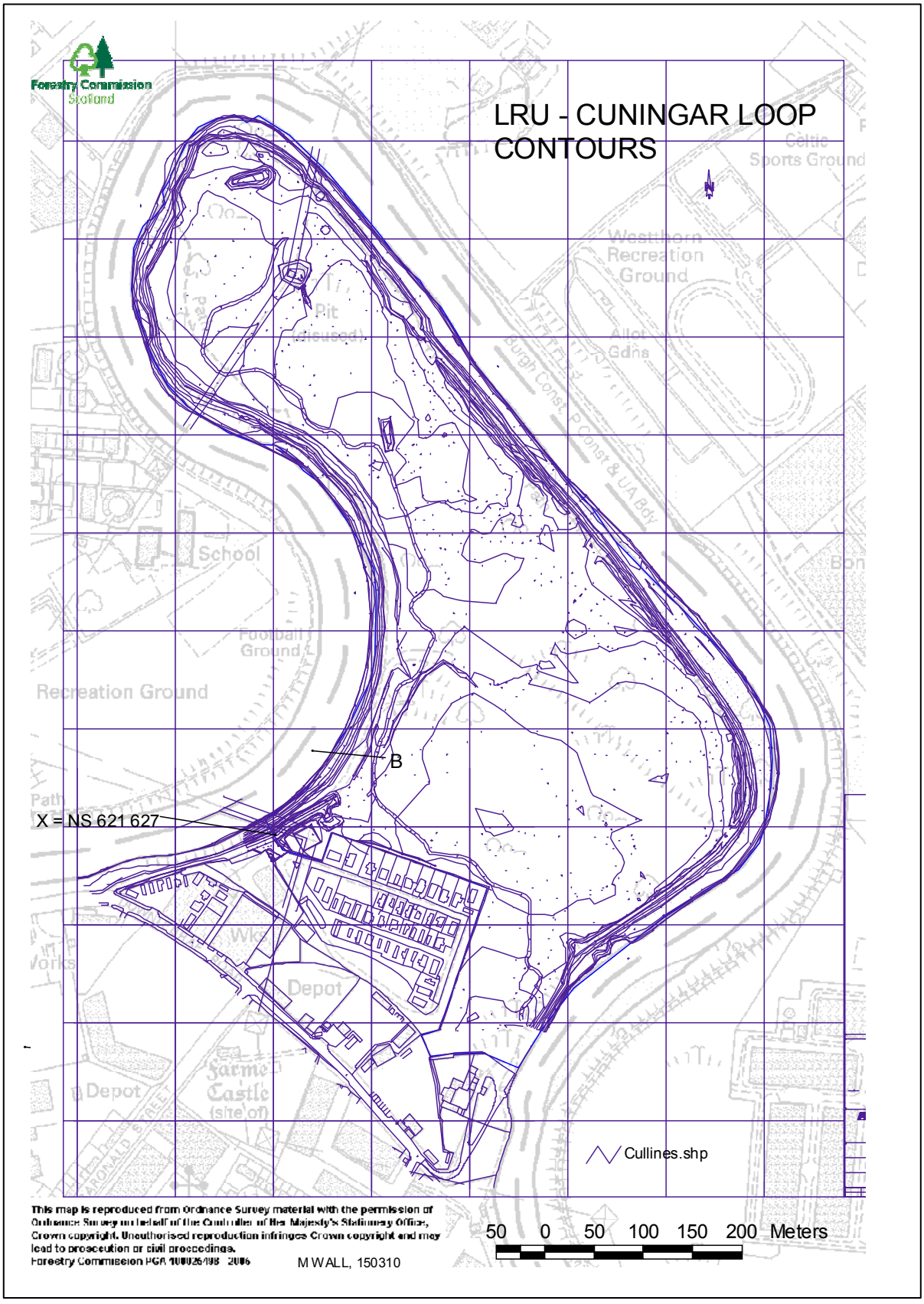

Figure 16: Modern Topographic Survey Showing Current Landform

Figure 17: Modern Aerial Photograph of the Site, showing Current Landform, with area once occupied by Telford's 1806 Water Works located to northwest (prior to redevelopment for 2014 Commonwealth Games)

Figure 18: View Towards Site of Telford's 1806 Water Works, Seen from Cuningar Loop

137. Some cities had relied on water piped in from the surrounding countryside, a system first used in the Classical world and developed to a fine art by the Romans: in Edinburgh's case, the introduction of such a scheme took place in 1676, and it would indeed have been created 50 years earlier, had it not been for a disagreement about funding.

138. From the mid-eighteenth century onwards, new methods were being introduced, shaped by the technological advances which were transforming civil engineering at this time. It is perhaps not surprising that London was at the vanguard of such improvements, which took place, albeit on a comparatively small scale, from the early eighteenth century onwards. The Chelsea Waterworks was established in 1723 (providing water for Westminster) and Lambeth Waterworks founded in 1785. Both Chelsea and Lambeth merited a mention in correspondence relating to the Glasgow Water Works: Telford refers to '*an apparatus as employed at Chelsea*' (Birmingam City Archives, MS 3147/3/525) while Denny is in correspondence with the Lambeth Waterworks in 1814.

139. These early examples remained isolated and unusual until the end of the eighteenth and the early years of the nineteenth century. This period saw a spate of new water supply schemes in London, as well as improvements to the existing schemes. Two more British cities - Liverpool and Glasgow – saw ambitious attempts to improve their water supplies at this time, with Thomas Telford involved in both.

140. Such schemes tended to follow a similar model. They were fairly small scale enterprises, intended to serve individual boroughs or districts. Such enterprises were founded by committees made up of influential citizens, and were funded initially by subscription, with investors hoping for some return funded by the water rates that would be levied upon customers following the scheme's completion. There was also a regular methodology employed, which made heavy use of the improved technologies which had been implemented in recent years, relying in particular upon the steam engine. Water was invariably pumped by a steam engine from a nearby river, purified via the filtration process in a series of basins or reservoirs, before being distributed via a mains network. Early water supply companies, such as Lambeth and Chelsea, used wooden pipes for the mains network, but from 1800 onwards, these were being replaced by cast iron pipes.

141. This method formed the template followed by Telford in his initial plan. While it appears to have served its purpose for a limited period, the constant expansion of the scheme to cope with ever-increasing demand (both from increasing population and industrial use) and with the loss of its monopoly following the creation of a rival company – the Cranstonhill Company – exposed shortcomings in both the quantity and the quality of the supply.

142. An alternative proposal was put forward less than a decade later by Watt, which refined the earlier Telford scheme. This still relied on water drawn from the vicinity of the river, but made use of natural filtration mechanisms – the sands and gravels of the Cuningar loop – to further purify the water and ensure a plentiful supply.

143. Once again, the initial results appear to have been more than adequate for the city's needs, but the subsequent creation of surface filtration beds and a reservoir on the Cuningar peninsula following the 1838 Act suggests that in the following decades, as the city further expanded, attempts were made to increase water provision and improve water quality. The amalgamation of the Glasgow Water Works and the Cranstonhill Company into the Glasgow Water Corporation resulted in the return to a water supply monopoly, and this change appears to have preceded a new phase of capital expenditure. This began with the construction of the reservoir and filtration bed complex at Cuningar, built in response to an Act of Parliament passed in 1838. Presumably this marks the point where the extraction of water from the river gravels was being carried out at such a rate that the water was no longer purified by natural filtration processes – hence the return to surface, engineered filtration, which can be interpreted as a return to the original surface purification model as utilised first by Telford prior to Watts improvements.

144. Once again, further expansion of the city exposed shortcomings in the existing supply, but this time, alternative sources were explored. The river water was no longer seen as a

viable option, with sources being sought instead in the rural areas beyond the city's limits. Two competing schemes were proposed in the 1850s: one, using water from Loch Lubnaig, was never realised, while the other, using the waters of Loch Katrine, resulted in a solution for the long-running problem which has remained in use until the present. This involved the transportation of water over a distance of 36 miles from a reservoir in Perthshire, carrying it via a combination of pipeline, covered aqueduct and tunnel. It is a scheme reminiscent of the early piped water supplies as illustrated by Edinburgh's 1676 pipeline, and their Roman predecessors of the Classical World: Glasgow's Loch Katrine scheme was, however, built upon a larger scale, and using an entirely different range of technologies.

145. With the exception of the Loch Katrine scheme, which remains in use today, the various elements which plotted the evolution of Glasgow's water works have fallen into disuse and now survive in varying stages of decay. The site of the Telford scheme was abandoned by the early twentieth century, and though recent excavations on the site (which is currently being developed for the forthcoming 2014 Commonwealth Games) revealed evidence for some of its structural elements, only vestigial traces remained and these will now have been destroyed following excavation and recording. There is strong evidence, by contrast, that the structures built later at Cuningar, associated with both the 1817 Watt scheme and the later reservoir complex, will still survive as buried features on the site. The important role these played in the wider history of Glasgow's municipal water supply - which was itself one of the earliest 'modern' water supply schemes, in that it employed state-of-the-art civil engineering techniques pioneered by Telford, Watt, Rennie and their contemporaries - cannot be underestimated.

Recommendations

Reality

146. David Denny's invitation to Thomas Telford to submit plans and estimates for a new water supply scheme for Glasgow in 1806 marked the beginning of a fifty year period in which repeated efforts were made to supply the needs of a modern, industrialised city via a tried and tested model – the purification of river water using the filtration method and its subsequent circulation by a mains network of iron pipes.

147. The constant expansion of the city placed constant strain upon the system, resulting in frequent attempts to apply new techniques and create new infrastructure which would increase the supply of pure fresh water, while retaining the same basic model for its generation.

148. In this fifty year period, a range of structures and associated infrastructure was created, in particular the following (Figure 19):

- three conjoined filtration basins, an engine house and associated infrastructure (i.e. iron pipes) at Telford's 1806 original site, which lies south of Springfield Road on a site now incorporated into the 2014 Commonwealth Games complex. Recent excavations on the site revealed the footings of an engine house, which has presumably now been destroyed;
- two reservoirs, located at Duke Street and High Street, which formed the supply points in Telford's scheme from which the various streets throughout the city were supplied via the mains network. These have now been removed;
- the mains network, which extended throughout the city and which included cast iron pipes ranging from 1 inch to 9 inches in diameter, with lead pipes supplying water to each individual household. These pipes have now largely been removed and replaced;
- the 1810 James Watt modifications to Telford's original design, which drew a supply of naturally filtered water via a series of wells and tunnels on the Cuningar peninsula. This water was pumped across the river via flexible-jointed

iron pipes, which were then tied in with the pre-existing mains network. The northern terminal of this pipeline was uncovered during recent excavations on the north bank of the Clyde;

- ❖ the reservoir and filtration beds, built on the Cuningar loop in response to the 1838 Act. These represent the final attempt to utilise locally-sourced water that required purification via the filtration method;
- ❖ The Westthorn River Water Supply Works, built after the 1870s as means of supplying local industries with water pumped directly from the river Clyde.

149. Of these various elements, only those located on the Cuningar Loop – namely Watt's wells, tunnels and its associated features and the later mid-nineteenth century scheme which comprised a reservoir and associated filtration beds – are likely to have survived, at least in vestigial form, but potentially in a reasonably well-preserved state. In addition, later elements which were integral to the site's long-term history – namely the engine houses associated with the Westthorn River Water Supply Works - are also likely to survive in some form.

Maintenance

150. Both the plot of the recent topographical survey carried out by the Forestry Commission Scotland and the recent walkover survey carried out by Rathmell Archaeology Ltd. confirm that the original landform has been buried under a layer of demolition debris, which could potentially reach 3m in depth in places, if not more. As a consequence, there are no upstanding features which can be linked in with the nineteenth century structures that once occupied the site.

151. It is evident, however, that the remains of these features were observed as upstanding monuments during an archaeological field survey undertaken in the 1980s, and therefore it should be assumed that structural elements of the reservoir, filtration beds and engine houses will still survive. Therefore, all groundbreaking works that have the potential to expose nineteenth century fabric should be subject to archaeological monitoring on account of this.

Interpretation

152. Though it is likely that remains associated with both Watt's 1817 modification to the original Telford scheme and the later mid-nineteenth reservoir and filtration bed complex survive at Cuningar, the site's importance extends beyond that. Regardless of the quality of its surviving features, its location places it at the heart of the innovations that transformed the city's water supply and paved the way for its growth and success throughout the nineteenth century and beyond.

153. The Cuningar Loop site is in a location which allows its place in the wider historical narrative to be appreciated, affording views to the site of Telford's initial 1806 scheme and also the later reservoirs which were supplied by the Westthorn River Water Supply Scheme. As such, it is uniquely placed to allow visitors to fully appreciate the importance both of the site itself, and the technological and engineering innovators – in particular Thomas Telford and James Watt – whose efforts were instrumental in delivering a scheme which could provide the city of Glasgow with a reliable source of pure, fresh water, and thus enable its continuing success as a centre for trade and industry throughout the nineteenth and early twentieth centuries.

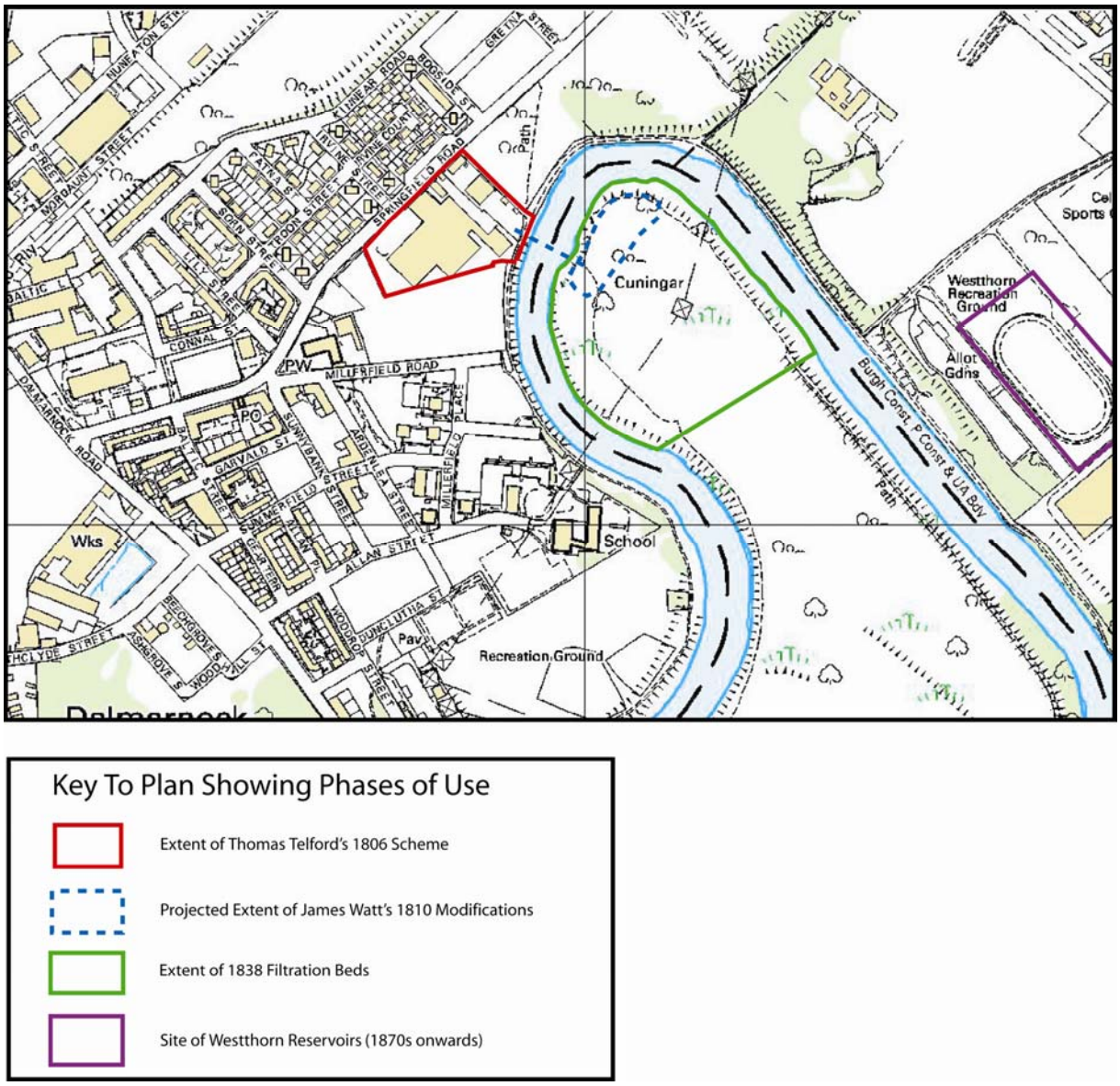

Figure 19: Location Plan Showing Various Elements of Water Supply Works (From 1806 onwards)

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