Archaeology Wales

Llanishen Reservoir, Cardiff

Building Recording Level 2

By
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Report No. 1742

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Non-Technical Summary

This report results from a Level 2 Building Survey carried out by Archaeology Wales Ltd (AW) on the Grade II Listed Llanishen Reservoir Dam in Llanishen, Cardiff (LB 87591) produced at the request of WSP. The work was undertaken prior to redevelopment work on the reservoir and associated buildings. This report documents the condition of the reservoir dam and curtilage structures as observed during the building survey in October 2018.

Llanishen Reservoir Dam is overall very well preserved and retains within its curtilage the original operational features of the reservoir, as well as a number of later additions. The majority of the structures are in a very good state of preservation, although the gauging chamber building is missing its roof. The state of the waterworks engineering features is less clear, as many of them are held within structures which could not be accessed. Generally, where there was visibility, it appeared that pipes and valves were still present, and despite being somewhat corroded they seemed to be in a reasonable state of preservation. The reservoir has five main phases from its construction in 1886 to its draining in 2012.

The building recording was undertaken in accordance with the Chartered Institute for Archaeologists Standards and Guidance for the archaeological investigation and recording of standing buildings or structures *and with* Historic England Understanding Historic Buildings.

1. Introduction

In October 2018 Archaeology Wales Ltd (AW) carried out a Level 2 building survey (in accordance with English Heritage guidelines), in advance of the proposed redevelopment of the Grade II listed Llanishen Reservoir Dam in Llanishen, Cardiff (centred on NGR ST 18734 81864) (Figure 1). The Glamorgan Gwent Archaeological Trust – Planning Division (GGAT-PD) made recommendations to WSP that a Level 2 building recording program would be a likely requirement at the planning stage and so WSP have requested this work be undertake at this pre-planning stage.

As a consequence, a Written Scheme of Investigation was prepared by Susan Stratton (AW) prior to the work taking place. This was subsequently approved by the GGAT-PD (Appendix 3).

This report has been produced at the request of WSP. All work was undertaken by suitably qualified staff and in accordance with the standards and guidelines of the CIfA at Historic England.

2. Location and Geological Background

The reservoir is located on the north-east edge of Llanishen, a northern district of the City of Cardiff (Figure 1). Immediately to the north is the smaller Lisvane Reservoir. Both reservoirs are surrounded by a band of grass and trees, beyond which to the east, south and west are the residential streets of Llanishen and Lisvane, and to the north are pasture fields. The reservoir lies at approximately 45m OD.

The underlying geology is interbedded argillaceous rocks and sandstone of the St Maughans Formation. No superficial deposits were recorded for the majority of the area of the reservoir. On the northern and western edges there are deposits of Devensian Till laid down in ice age conditions, and to the south are alluvial clay, silt, sand and gravel deposits (BGS 2018).

3. Building Recording Methodology

The archaeological works were conducted according to the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for the archaeological investigation and recording of standing buildings or structures (2014), Standard and Guidance for Historic Environment Desk-based Assessment (2014).

The survey took form of a Level 2 building survey as defined by English Heritage (May 2016) *Understanding Historic Buildings: a guide to good recording practice.* This level of survey was intended to create a descriptive record of the building, and included:

- Description and photographic record of the exterior and the interior [1]
- Account of type, construction, form, function
- Phasing[2]
- Past and present use and relationship with setting
- Identification and recording of original fixtures and fittings
- Conclusions regarding the building's development and use

Photography

- Views of elevations
- Views of external appearance
- External structural detail
- Fixtures, fittings, machinery, related contents

[1] Due to health and safety concerns it was not possible to access the interior of some of the structures
[2] See above

The Level 2 Archaeological Building Survey was undertaken by a suitably experienced Building Recording Archaeologist who can understand and interpret the structure and record the important details.

4. Historical Background

Llanishen Reservoir Dam is situated in the Cardiff suburb of Llanishen, to the north-west of Cardiff (Figure 1). It sits within the Landmap Historic Landscape Area of Llanishen Reservoirs (CRDFFHL014), which encompasses Llanishen Reservoir and neighbouring Lisvane Reservoir. They are considered to be of high heritage value as examples of Victorian public engineering. The Reservoir Dam and curtilage structures are Grade II Listed, with some curtilage structures specifically noted in the listing text (Figure 2).

Llanishen and Lisvane reservoirs were part of the Taff Fawr Water Supply Scheme for the City of Cardiff. With the opening of West Bute Dock and the Taff Vale Railway Cardiff's population expanded rapidly from 1839. Previous reliance on wells for water supply was no longer sufficient. In the 1850s a private company, Cardiff Waterworks Company, supplied Cardiff water from the River Ely via a pumping station at Ely. In 1860 the Company received Parliamentary authority for a storage reservoir at Lisvane with intakes from Llanishen, Nant Mawr, Nant Draw, Nant Felin and Nant Dulas. It is not clear exactly when Lisvane Reservoir was completed. It is not shown on the Tithe map of 1845 but it is depicted on the First Edition Ordnance Survey County Series of Glamorganshire from 1875 (Figure 3). The earlier field boundaries are still shown on the map. The map also shows filter beds associated with the function of the reservoir to the south, in the area where Llanishen Reservoir was later built. These beds appear to have survived within Llanishen Reservoir, as they are noted on an original plan (Figure 4) as Old Filter Beds, and they can also be seen on modern aerial photographs of the site after it was drained.

The City of Cardiff continued to expand with the opening of Rhymney Railway and Bute East Dock in the late 1850s and so did the demand for water, but the water supply continued to rely on the River Ely until the mid-1880s. In the late 1870s the Company put forward a proposal for an expansion of their Ely works and a new reservoir at Llanishen to feed to the districts of Whitchurch and Llandaff, but the plans were opposed by Cardiff Corporation on the basis that "the new works were not designed on a sufficiently comprehensive scale to meet future requirements" (Williams 1896).

In 1879 Cardiff Corporation bought the Waterworks Company. They commissioned a report by their engineer, John Avery Williams, to find suitable water sources for the future supply of Cardiff. Williams presented his recommendations in 1881. It recommended a scheme of reservoirs in the Taff Fawr Valley. However, the earlier plans for a reservoir at Llanishen were also approved to act as further storage from the Taff Fawr Valley. The work on the Llanishen reservoir was started before the rest of the scheme so that the increased storage capacity could be used to maximise the

Lisvane watershed supply for the city while the Taff Fawr scheme works were completed (Williams 1896).

Llanishen Reservoir was constructed immediately to the south of Lisvane Reservoir in 1886. It began taking water from the Taff Fawr Scheme in 1891 (Williams 1896). As the site was flat it required the construction of a continuous encircling dam, which utilised the southern bank of Lisvane Reservoir on the north side. A number of the original architect's plans for the Cardiff Corporation Waterworks from 1884 are available. They show that as well as the dam itself the original reservoir features included the outflow control valve platform, scour channel, 'SEMD' bridge, by-wash channel, stepped weir, inlet gauge chamber, gauge basin to Lisvane Reservoir, and isolated valve chambers. These features can also be made seen on the Second Edition Ordnance Survey map of the area from 1900-1901 (Figure 5).

Works on the three impounding reservoirs of the Taff Fawr Valley scheme commenced in 1886 with Cantref Reservoir near the head of the river, some 38km to the north-north-west of Llanishen. Cantref Reservoir, which held 1,401 million litres of water, was finished in 1892. The second impounding reservoir, Beacons Reservoir, with a capacity of 1,577 million litres, was started in 1893 and finished in 1897. This reservoir was the furthest away from Llanishen at a distance of 41km to the north-north-west. Construction of the third and by far the largest impounding reservoir at Llwyn On with a capacity of 5,728 million litres was started in 1911. This reservoir was the most southerly, located at a distance of 35km from Llanishen. Work was suspended during the war, and not finished until 1926. During this period Llanishen Reservoir remained largely the same. There are plans showing alterations to the Valve Tower shaft from both 1918 and 1929.

Plans from 1936 show a new outlet chamber located on the west bank of the reservoir (Figure 6). At a similar time, a new inlet, the Cipoletti Weir, and screening chamber were added on the west bank. Unfortunately, although there are architect's plans of the screening chamber, they are not dated. We can however narrow the date of their construction to between the publication of the Third Edition County Series map of 1920 (Figure 7) and the fourth in 1940-1941 (Figure 8). A further addition noted on the Fourth Edition map was a tank at the location of the gauging station, just to the north-east of the screening chamber. The associated building, which housed a 'Venturi' water meter, first appeared on the 1952-1953 Ordnance Survey Plan (Figure 9).

The reservoir continued to supply water to Cardiff until the mid-1970s, when both Lisvane and Llanishen Reservoirs were declared redundant. Llanishen was utilised as a sailing lake, and a jetty and slipway were constructed in the north-west corner of the embankment in the late 1970s. Lisvane Reservoir has been used to supply non-potable water to the CELSA steel works in the Tremorfa and Eastmoors areas of Cardiff.

Llanishen Reservoir Dam, with associated operational curtilage features, was Grade II listed in 2009 as part of the Taff Fawr water supply scheme.

5. The Building Recording Results

5.1. General

Llanishen Reservoir Dam is a Grade II Listed Building (LB 87591) dating to the late 19th century, which formed part of Cardiff's Taff Fawr water supply scheme. The listing includes not only the reservoir dam itself but also associated buildings within the curtilage. The building recording included all structures located within the curtilage, not just those specifically mentioned in the listing text (Figure 2).

A detailed description of these structures can be found below, ordered as they were encountered when proceeding around the reservoir in a clockwise direction from the location of the former Keeper's Cottage at the south-east corner of the site.

5.2. The Reservoir Dam (Plate 1 – 14; Figures 4, 10 and 11)

The reservoir dam is a continuous encircling earth bank constructed with a clay core (Figure 10). The bank is an irregular shape in plan, the northern bank being formed by the earlier Lisvane Reservoir. The dam encloses an area of 238,000 square meters (Figure 4).

The exterior bank is turfed (Plates 1 and 2). The interior of the bank is faced with pitched stone bedded into the earth bank below with no bonding material. This can be seen clearly where the embankment has been cut into in places, such as by the creation of the 1970s Jetty (Plate 3). The stones are roughly shaped and varying in size, with no regular bonding (Plates 4, 5 and 6). A band of rectangular stones runs around the interior of the southern bank of the reservoir 15m from the top of the bank (Plate 7), but this detail does not extend around the rest of the embankment.

At the top of the stone embankment is a rim, consisting of a single course of large rectangular blocks (Plate 8). The stones are of roughly similar sizes, averaging 0.25m deep, 0.3m wide and 0.8m long. The stones are roughly finished, and in places it is possible to see quarry marks on them (Plate 9). The rim runs around the whole of the reservoir apart from where it is interrupted by other structures. A number of outlet pipes are located just below the rim at various points around the embankment (Plates 10 and 11).

In the south-east corner of the reservoir, by what was the Keeper's Cottage, are steps that runs down the interior of the bank (Figure 11; Plate 12). Original plans from 1884 indicate that these were part of the original reservoir construction. It is currently being used as pedestrian access for the works. The steps consist of single stone slabs, lined

on either side by an ashlar stone curb. The stones are well-dressed with bevelled edges. On the northern curb water depth measurements have been carved into the stonework (Plates 13 and 14).

5.3. Outflow Control Valve Platform (Plates 15 - 21; Figures 12 – 14)

This valve platform is specifically noted in the listing text as part of the original reservoir operation. The original architect's drawings, dated in 1884, show the internal workings of the shaft as well as the external elevations (Figure 12). There are also architect's plans dating to 1929 for alterations to the valve shaft (Figure 13).

The structure is located at the south-eastern corner of the reservoir, at the east end of the southern bank, which is where the bank is highest. The main structure extends out from the top of the reservoir, so that its top is level with the top of the bank. The tower is octagonal in plan, but extended on the southern and northern sides (Figure 13). It is constructed of ashlar blocks, and at its highest, on the northern elevation, it is nine courses high. The blocks are 0.23m high and vary in length from 0.35m to 0.52m. The walls are topped by bevelled coping stones. On the north-east corner there is a metal depth gauge attached to the stonework.

Below the platform structure are three outflow inlets (Plate 15). They are rectangular basins, which are sunk into the reservoir bank so that they open on to the reservoir. The interior walls, on the east and west, are lined with rough-faced random courses ashlar stone. In the interior northern elevations of each is a circular inlet pipe (Plate 16). These are surrounded by rough-faced ashlar stonework. The bases of the inlets consist of large well-dressed stone slabs. The basins have an edging of rough-faced rectangular stone blocks. The pitched stonework of the interior was extended to include the lowest basin (Figure 14; Plate 17).

Access to the outflow control valve platform was restricted due to Health and Safety concerns over the internal depth and confined space. The structure was enclosed by Heras fencing on the site visit. Specialist sub-contractors took photographs of the interior.

The interior elevations comprised machine made brick laid in English bond (alternating stretchers and headers) (Plate 18). The total height of the structure is c.15m. The original structure had four layers of steel girders providing floor levels and anchor points to hold the valve equipment. The original girders can be identified where they are keyed into the brick wall (Plate 19). The brickwork accommodates the girder without a break in the bond and a large stone block is positioned below it. The later additions, made in 1929, are clear as newer bricks are inserted where a hole has been created to accept the girder (Plate 20). Stone blocks were not placed below the later additional girders. At the base of the structure a double brick arch was built into the south elevation to accommodate the large diameter pipes (Plate 21).

5.4. Scour Channel (Plates 22 – 25; Figure 15)

The scour channel is specifically noted on listing text. It is situated to the south of the southern bank of the reservoir (Plate 22). It runs roughly north-east to south-west to empty into the by-wash channel (see below), and carried water from the outflow control valve into the by-wash channel.

The channel emerges from under the embankment to the south-east of the outflow control valve platform (Figure 15; Plate 23). The interior of the channel could not be accessed, but it can be seen to have been lined with red brick laid in a stretcher course (Plate 24). The outlet is surrounded by a retaining wall of rough-faced ashlar blocks with an arch with a slightly protruding keystone. The channel itself is a wide U-shape lined with roughly shaped stones.

Towards the south-western end of the channel is a stone basin, which was fenced off at the time of the site visit (Plate 25). The walls of the basin are lined with rough-faced ashlar blocks.

5.5. 'SEMD' Bridge (Plates 26-29)

This bridge is not specifically mentioned on the listing text. However, it is considered part of the curtilage listing as an integral part of the reservoir operation, constructed in a similar style to the other original structures. The bridge provides access to the reservoir over the by-wash channel.

The bridge crosses the by-wash channel at an oblique angle (Plate 26). It has stone abutments to either side of the channel, constructed in rough-finish ashlar with chiselled margins. The bridge is spanned by cast iron edge beams (Plate 27) with intermediate iron rails that support three brick jack arches (Plate 28). This was all topped by a concrete slab. Three of the four corners have pillars capped with a bevelled rough-finish cap stone with chiselled margins (Plate 29). The pillar on the north-east corner is missing, but it would originally have stood the same as the others. The stone from the now collapsed pillar has been recovered during recent clearance work around the bridge. The sides of the bridge have green painted galvanized steel railings that are likely modern additions.

5.6. Stepped Weir (Plates 30-34; Figures 16 and 17)

The stepped weir is situated outside the current site boundary fence and was inaccessible on the site visit. It is specifically noted in the Listing text as part of the original operation of the reservoir, and the original plans are available (Figure 16). The fish hatcheries also noted on this plan now lie outside the site boundary.

The weir is situated to the south of the reservoir in the open section of the by-wash channel. It consists of three stepped sections across a 140m stretch of the by-wash channel (Plate 30). Each stepped section itself consists of four steps within a vertically sided channel (Plate 31). The sides of the channel are constructed from rough-finished randomly coursed ashlar blocks. The coping stones are well-dressed stone with a rough-finish to the sides, chiselled margins and bevelled edges.

The in-wash from the by-wash channel is edged by large well-dressed stone blocks which follow the curve of the by-wash channel (Plate 32). The weir steps are flat based, constructed from well-dressed stone. The downstream edge of each step is edged by a raised well-dressed stone step which is slightly curved so that the concave edge faces downstream. At the downstream end of each stepped section the main by-wash channel is edged by curved stones in the same style as the upstream end (Plate 33). The upstream edge has notches in the stone which would have supported in-wash screens (Plate 34), similar to those depicted in the drawings for the by-wash screens (Figure 17).

5.7. By-Wash Channels (Plates 35-38)

The by-wash channel runs down the western edge of the reservoir (Plate 35), from where Nant Fawr is diverted towards the inlet tank at the north-west of the reservoir, then east along the southern edge where it is joined by the scour channel, before turning south and re-joining the original course of Nant Fawr. For the majority of the route the channel is open, but in three stretches it runs underground.

In its open sections the channel has a wide U-shaped profile. It is lined by rough-finished roughly squared blocks of varying size arranged in random coursing (Plate 36). Where the channel enters and exits the closed sections there are stone built elevations (Plates 37 and 38). They are all in the same style, constructed from rough-finished randomly coursed ashlar blocks with an arch over the outlet. The elevations were topped with rough-finished coping stones with chiselled margins and bevelled top edges.

5.8. Cipoletti Weir (Plates 39-47; Figures 4, 8 and 18)

The Cipoletti Weir is situated on the internal bank on the west side of the embankment (Plates 39 and 40). It is not specifically noted in the listing text. The structure is not depicted 1900-1901 or 1920 Ordnance Survey County Series maps, but does appear on the 1940-1941 map (Figure 8), and it therefore seems to be a later addition to the reservoir operation. It is labelled on a plan of the reservoir basin (Figure 4, unfortunately un-dated) as “New Inlet,” while the Nant Fawr Inlet is labelled “Old Inlet.” It also appears on the Screening Chamber plans, again un-dated (Figure 18).

The structure has two walls, on the south-west and north-east sides, with the rear (north-west) being built into the bank and the front (south-east) having a trapezoidal shaped opening between two low ramps. The two walls of the structure (south-west and north-east elevations) extend 1.3m above the ground level at the top of the reservoir bank, and extend south-east into the reservoir so that at their south-eastern ends they are 3m high from the embankment slope.

The structure comprises roughly-finished ashlar blocks, 0.23m high and varying in length, averaging 0.7m in regular courses. The two parallel walls have rough-finished coping with chiselled margins which protrudes 0.05m out from the wall, with a central band in the same style running horizontally four courses below the coping (Plate 41). At the walls' bases, on both the south-west and north-east sides, there are a number of exposed bricks (Plate 42) which indicates that the below-ground part of the structure is brick built.

The interior of the weir was not accessible due to Health and Safety concerns. It could be seen to consist of a large central chamber (Plate 43 and 44) to the front (south-east) with a narrow chamber around the outside on the south-west, north-west and north-east (Plate 45). The whole of the interior, including the floor, is tiled in white enamel tiles in an English garden bond style. In the centre of the floor of the main chamber is a small square hole (Plate 46).

On the top of the north-eastern ramp at the front of the structure is a large vertical galvanised steel pipe leading to a rectangular box which would have housed a water meter (Plate 47). On the north-west side there is an access door with the following embossed on it:

GOWN
GEO KENT LTD
LONDON & LUTON

This refers to the company George Kent Ltd an engineering firm established in London in 1838. The meter was accessible from the exterior of the weir structure by a wrought iron ladder attached to the north-east wall.

5.9. Old Screening Chamber (Plates 48-53; Figures 8 and 18)

The old screening chamber is located to the exterior of the reservoir embankment, immediately north-west of the Cipoletti Weir. It is not specifically noted in the listing text but is considered to be curtilage listed due to its direct link to the operation of the reservoir. Like the Cipoletti Weir, it first appears on the 1940-1941 map (Figure 8), and it therefore seems to be a later addition contemporary with the Weir.

The chamber is situated in an earth bank spur which extends north-west from the main reservoir bank. The original plans, unfortunately un-dated, (Figure 18) show the extent of the underground workings.

Above ground the only structure visible is the metal lifting frame consisting of iron girders forming a cross beam supported by a kind of tripod arrangement to either end with vertical posts and a cross beam to the centre (Plate 48). These are set within a concrete base.

The majority of the screening chamber is below ground, and the above ground structures were fenced off during the site visit due to the danger of the depth of the underground chamber. Specialist sub-contractors have provided photographs of the interior.

The chamber is accessed by wrought iron hatches set into the concrete base (Plate 49), and an access ladder is still present (Plate 50). The iron is in a reasonable condition, with some rusting in the interior. An iron hook was attached below some of the access hatches (Plate 51). The interior chamber is rectangular in plan, and approximately 6m deep. The interior elevations consist of machine-made brick in an English bond. The screening chamber screen is still in situ, and consists of an iron frame with a fine wire mesh, which extends the full height of the chamber (Plate 52). At the base of the chamber there are original pipes, with a square surround (Plate 53).

5.10. Steps (Plate 54)

The steps are not noted in the listing text. It is first depicted on the 1920 Ordnance Survey County Series map, with a footpath leading from it to the track which encircles the two reservoirs. It is situated on the external bank of the embankment (Plate 54).

It is made of concrete, 1.2m wide, with 17 steps. The edges have been shaped with bevelled corners to match the Victorian stonework used on the original features of the reservoir.

5.11. Tank (Figure 8)

The tank is not noted in the listing text. It is first depicted on the 1940-1941 Ordnance Survey County Series map (Figure 8) and is likely associated with the Gauging Station constructed at a similar time (see below). The tank is currently very overgrown with brambles. It is constructed in stretcher coursed red brick with concrete coping with bevelled edges in keeping with the earlier building style used at the reservoir.

5.12. Gauging Station (Plate 55-64; Figures 8, 9 and 19)

The gauging station is not specifically noted on the listing text. It was a later addition to the reservoir. A tank was first depicted there on the 1940-1941 Ordnance Survey County Series map (Figure 8), with the associated building noted on the 1952-1953 Ordnance Survey Plan (Figure 9). The original architect's drawings for the building,

which houses the Stream Flow Controller, are dated to 1938 (Figure 19). It is situated on the south-east bank of the by-wash channel on the north-west side of the reservoir.

The walls of the building are still standing to full height but the roof is missing (Plate 55). The doorway has been blocked off with a metal grill. Access to the rear of the building was restricted by the by-wash channel and undergrowth on the bank behind.

The building is constructed throughout from red brick, in stretcher coursing above ground level and English garden bond below ground level but visible in the section of the by-wash channel. The bricks measured 0.08m x 0.23m x 0.11m. The loss of the roof means it is possible to see that the walls were constructed from two layers of bricks, the outer of which was a high quality well pointed brick while the inner was of less good quality with rough pointing (Plate 56).

Gauging station building exterior

South-east elevation
The front (south-west) elevation is a single storey gabled end (Plate 57). At its base the walls are slightly wider than the rest of the building. The dimensions of the walls change at the chamfered brick string course set at 0.3m above ground level. The string course brick tapers to the main width of the elevation, which is 2.93m. Above the sill the building stands 2.96m to the top of the gable.

A doorway is located to the centre of the elevation. It is 0.97m wide and 2.2m high from the current ground level. The doorway has no surround, but there is a concrete lintel flush with the walls above, measuring 1.2m long by 0.17m high. The door and frame are wooden, although a galvanised steel panel has been added to the front of the door more recently (Plate 58).

The base of the gable is found at 1.84m above the sill. At its base on either side there is a notch in the brickwork for the roof rafters.

South-west elevation
The south-east elevation (Plate 55) is a single storey above ground level, with a 'basement' storey extending to the rear of the building into the by-wash channel. In the centre of the elevation is a window with no surround but with a concrete lintel and sill, measuring 0.14m high by 0.9m wide. The lintel is flush with the wall while the sill protrudes 0.02m out. The window has been blocked up with a concrete brick panel (Plate 59).

At a distance of three brick courses below the window is a small metal vent the size of a single brick, and another is located five brick courses below the sill at the base. There are scars on the north-west of the wall where previous fittings were located. According to the architects' drawing this would have been for a drain pipe from the roof.

North-east elevation

The north-east elevation is a mirror image of the south-west, except that the 'basement' section is obscured by the concrete tank situated immediate to the north-west of the building.

North-west elevation
The rear (north-west) elevation was difficult to view due to access restrictions, but it could be seen to consist of a single storey gabled end above ground level and a 'basement' level which formed also the side of the tank in the by-wash channel behind the building.

Gauging station building interior

The interior of the gauging station consists of a single room. A brick sill (Plate 60) that runs along the sides of the walls at ground level indicates there was originally a floor, but the building now opens directly into the 'basement' tank. The architects' drawings confirm that there was originally a floor at ground level, consisting of wooden planks.

Below ground level the 'basement' level is bare, un-plastered brick in English garden bond. It functioned as a basin or tank, and is partially filled with water (Plate 60). A metal ladder provided access from the ground floor in the eastern corner of the building. Three large metal cylinders are visible above the water level, and further parts of the meter mechanism can be made out below the water.

The ground level room had plastered walls, and the remains of yellow paint can be seen throughout (Plate 61). A number of fittings relating to the function of the building are still present. Two metal brackets on the rear wall would have originally supported the 'Venturi' water meter. Between these brackets is a small cylindrical device which would also have been part of the meter, with G. KENT LTD, LONDON & LUTON embossed on it. A down-pipe leads from under the left-hand bracket into the 'basement' below.

Gauging station tank
On the north-east side of the gauging station building was a tank, which was depicted on the 1940-1941 Ordnance Survey County Series map (Figure 8). The tank has now been covered by a wire mesh grid (Plate 62). The tank is constructed from concrete, and leads from the by-wash channel into the gauging station.

By-wash channel
The by-wash channel flows behind (to the north-west) of the gauging station building. The section behind the building has been modified, so that instead of the wide U-shape of the rest of the by-wash channel this section has vertical sides and a flat base (Figure 19). The sides are constructed from brick in an English garden bond. The sides of the inlet taper in from the main channel and the base of the channel is sloping brick work (Plate 63). The brickwork at the outlet is squared off rather than tapered, and the base has a small stone weir before flowing into the main channel again (Plate 64).

The walls are capped by concrete in the style of the bevelled coping stones used on the Victorian features of the reservoir.

5.13. New Outlet Chamber (Plate 65; Figure 6)

The outlet is not mentioned specifically in the listing text. It was a later addition to the reservoir, and detailed plans for it, dated to 1936, are available (Figure 6; Plate 65).

It is a rectangular chamber cut into the embankment, 1.4m wide and 4.9m long, and a maximum depth of 1.4m. It opens directly onto the reservoir interior. The outlet chamber is constructed from concrete blocks in the same style as the original stonework used for other reservoir features, including chamfered coping stones. It still retains the original cast iron gratings which covered the chamber.

5.14. Inlet Gauge Chamber – Nant Fawr Inlet (Plates 66-72; Figures 20 and 21)

The inlet gauge chamber is specifically mentioned in the listing text. It is one of the original features of the reservoir, and is shown on architect's plans from 1884 (Figure 20). It is situated in the northern corner of the reservoir, and functioned to control the water flow into the reservoir from Nant Fawr. Access to the chamber was restricted on the site visit.

The structure is built into the interior of the reservoir embankment. It consists of two parallel walls extending into the reservoir with an internal perpendicular wall that forms a deep chamber (Figure 21). The exterior walls are constructed from randomly coursed roughly-finished ashlar blocks. These external walls initially extend out at the ground level of the top of the reservoir, before stepping down three steps and then continuing into the reservoir as a low sloping wall following the slope of the pitched stone embankment (Plate 66). The walls are topped by coping stones of rough pointed work with chiselled margins and chamfered edges (Plate 67). Diamond-shaped holes to the top of the coping stones were for vertical cramps or dowels used in the placement of the stones (Plate 68). The wall is topped by a cast iron fence of the design shown in the original architect's drawing.

The interior chamber was inaccessible due to depth. The walls on the south-west, north-west and north-east sides were constructed in stone as described above to a depth of 2m from the top of the walls, and below this they were brick built in an English garden bond (Plate 69). The whole of the south-east wall was brick built. Towards the base of this wall was a large outlet pipe. In the bottom of the chamber is a large metal cover over the inlet pipe rising from the floor. The base of the chamber was not visible due to standing water.

The south-east wall of the chamber was much thicker but also lower than the other walls (Plate 70). It was topped by brick with stone edging. A metal bracket indicates

there may have been some kind of sluice gate or removable panel on the top. When viewed from the reservoir interior it is possible to see that this wall slopes at an angle of about 60^{o} from horizontal (Plate 71). The outlet pipe discharged from the base of this wall into the reservoir (Plate 72).

Immediately to the south-west of the south-western wall is a small platform two stone block courses high constructed from roughly-finished ashlar with rusticated coping stones (Plate 67). A large capped metal overflow valve is situated on top of it.

5.15. Jetty and Slipway (Plate 66; Figure 22)

The jetty and slipway are not noted in the listing text. Architects' drawings for both features date to 1977 (Figure 22) indicating they were built in the late 1970s. They relate to the reservoir's recreational use. The jetty is a rectangular, flat topped structure built into the reservoir embankment, constructed from concrete blocks (Plate 66). The slipway consists of a concrete surface made by pouring concrete on top of the pitched stone of the reservoir embankment.

5.16. Inlet and Gauge Basin to Lisvane Reservoir (Plates 73-4; Figure 21)

The inlet and gauge basin are situated on the north-west corner of Llanishen Reservoir just to the north of the embankment (Plate 73). Although not mentioned in the listing text they should be considered as Grade II Curtilage Listed due to their operational link to the Reservoir. They are both key components of the original reservoir, with architect's drawings available from 1884 (Figure 21).

The gauge basin is a simple rectangular basin sunk into the ground, measuring 2.65m by 4.29m. It is now covered by a metal mesh which makes visibility difficult. The chamber is stone lined by well finished ashlar blocks (Plate 74). The chamber's north-east side is open to an inlet channel from Lisvane reservoir. The coping stones have vertical dowel holes visible to the top.

5.17. Isolated Valve Chambers (Plate 75; Figure 23)

On the northern bank of the reservoir, situated where the bank follows the southernmost extent of Lisvane Reservoir, is an isolated valve chamber (Plate 75). The chamber is not specifically noted in the listing text but is considered curtilage listed due to the operational link to the reservoir. An architect's drawing dated to 1884 shows that this is an original feature of the reservoir (Figure 23). All that is visible above ground is a well-dressed stone surround flush with the ground surface, and a large cast iron cover. The architect's plans show the extent of the underground shaft.

5.18. Embankment Pipe Penetration (Plates 76-7)

The pipe penetration is located at the north-east of the reservoir (Plate 76). It extends from the top of the interior embankment into the reservoir. It is not specifically noted in the listing and is clearly a later addition.

The structure is a single piece of poured concrete which had been poured directing onto the pitched stone (Plate 77). It extends 3.36m into the reservoir from the edge of the embankment, is 1.6m wide, and at its highest point is 1.47m from the pitched stone surface. The concrete bears the impression of the wooden slats used to form it. It has chamfered edges in the style of the Victorian stonework. The pipe exits into the reservoir. It is capped with a circular plate attached with bolts that is 0.83m in diameter and is slightly off centre.

6. Discussion and Interpretation

Overall interpretation

Llanishen Reservoir Dam is overall very well preserved and retains within its curtilage the original operational features of the reservoir, as well as a number of later additions. The majority of the structures are in a very good state of preservation, although the gauging chamber building is missing its roof. The state of the waterworks engineering features is less clear, as many of them will be within structures which could not be accessed. Generally, where there was visibility, it appeared that pipes and valves were still present, and despite being corroded to a degree they seemed to be in a reasonable state of preservation. The gauging station interior had brackets which would have originally supported a water meter.

The building survey and associated record search demonstrates that the reservoir had at least five main phases of use:

1) The original construction of the reservoir in 1886 and its initial function as a storage reservoir during the construction of Taff Fawr Scheme. The features dating to the original construction of the dam are the dam embankment, outflow control valve platform, scour channel, 'SEMD' bridge, by-wash channel, stepped weir, inlet gauge chamber, gauge basin to Lisvane Reservoir, and isolated valve chambers;
2) Connection with the Taff Fawr Valley reservoirs in 1891. There are no discernible architectural changes associated with this phase;
3) The opening of the largest Taff Fawr impounding reservoir, Llwyn On, in 1926. Additions were made to the Valve Tower shaft in around 1928, and the construction of the Cipoletti weir, old screening chamber, valve chamber and gauging station between 1920 and 1940 is likely associated with the increased output from the impounding reservoirs;

4) Redundancy as a water supply, and use as recreational space for sailing from the 1970s. A concrete jetty and slipway were added at this time;
5) A final phase of disuse after the water was drained in 2012.

Reliability of field investigation

Despite the very good state of preservation of the reservoir it was not possible to fully access a number of the curtilage structures due to health and safety concerns. The interior of shafts and chambers have therefore not been recorded in this report, although they are represented in most cases in the form of their original plans. This means that is not possible to comment on the preservation of the waterworks engineering features.

In some cases, such as the outflow control valve platform and the old screening chamber, above ground exterior elements were also inaccessible, limiting the ability to take photographs and measurements.

7. Bibliography and References

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Maps

- OS County Series First Edition Glamorganshire 1875, 1:2500
- OS County Series Second Edition Glamorganshire 1900-1901, 1:2500
- OS County Series Third Edition Glamorganshire 1919-20, 1:2500
- OS County Series Fourth Edition Glamorganshire 1940-41, 1:2500
- OS Plan 1953, 1:2500

Websites

www.bgs.ac.uk (accessed 05/10/18)

www.engineering-timelines.com (accessed 05/11/18)

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APPENDIX I:

Figures

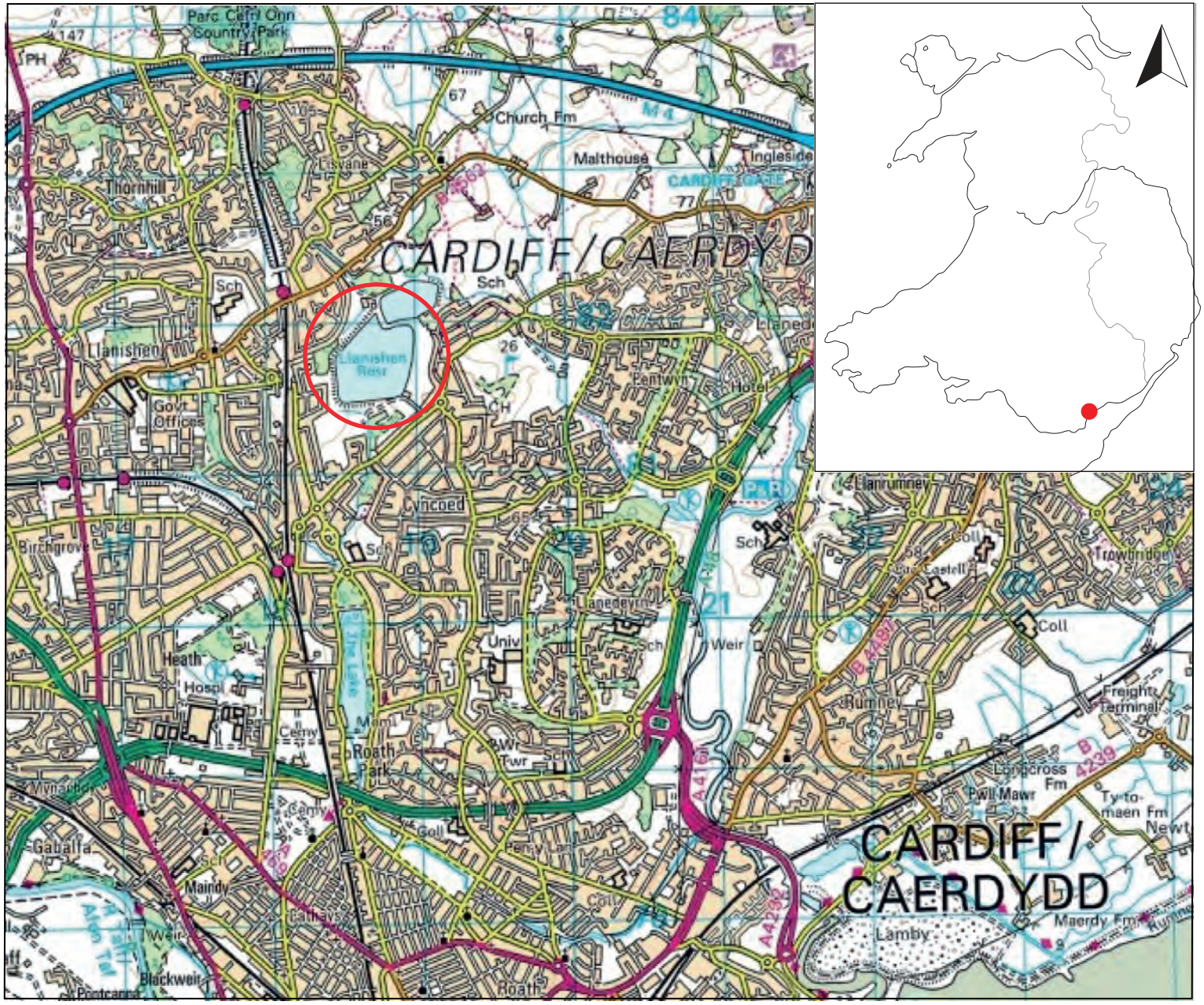

Figure 1
Location map

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Revealing the past, informing the future

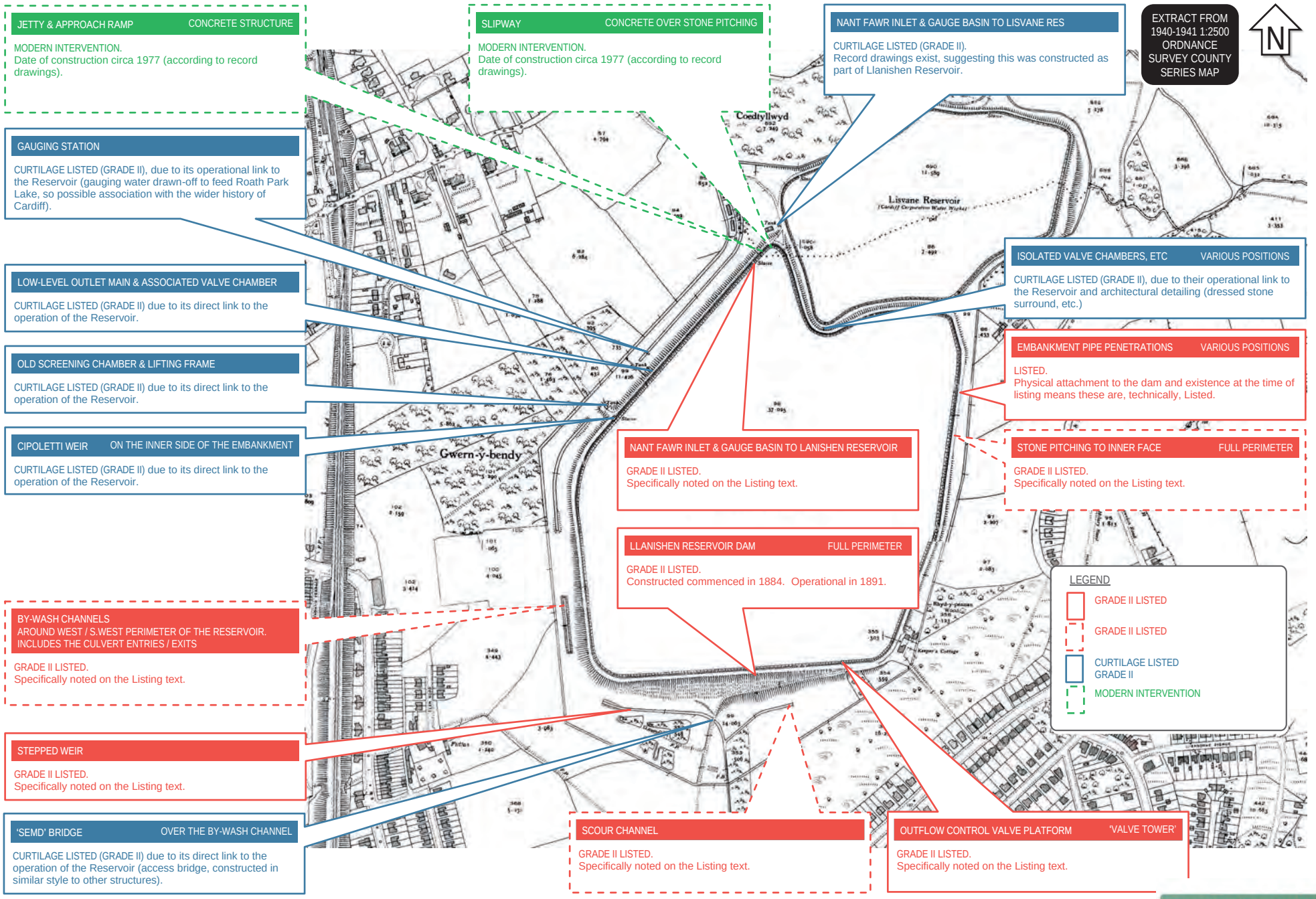

Figure 2. Llanishen Reservoir Dam and curtilage structures (image supplied by WSP)

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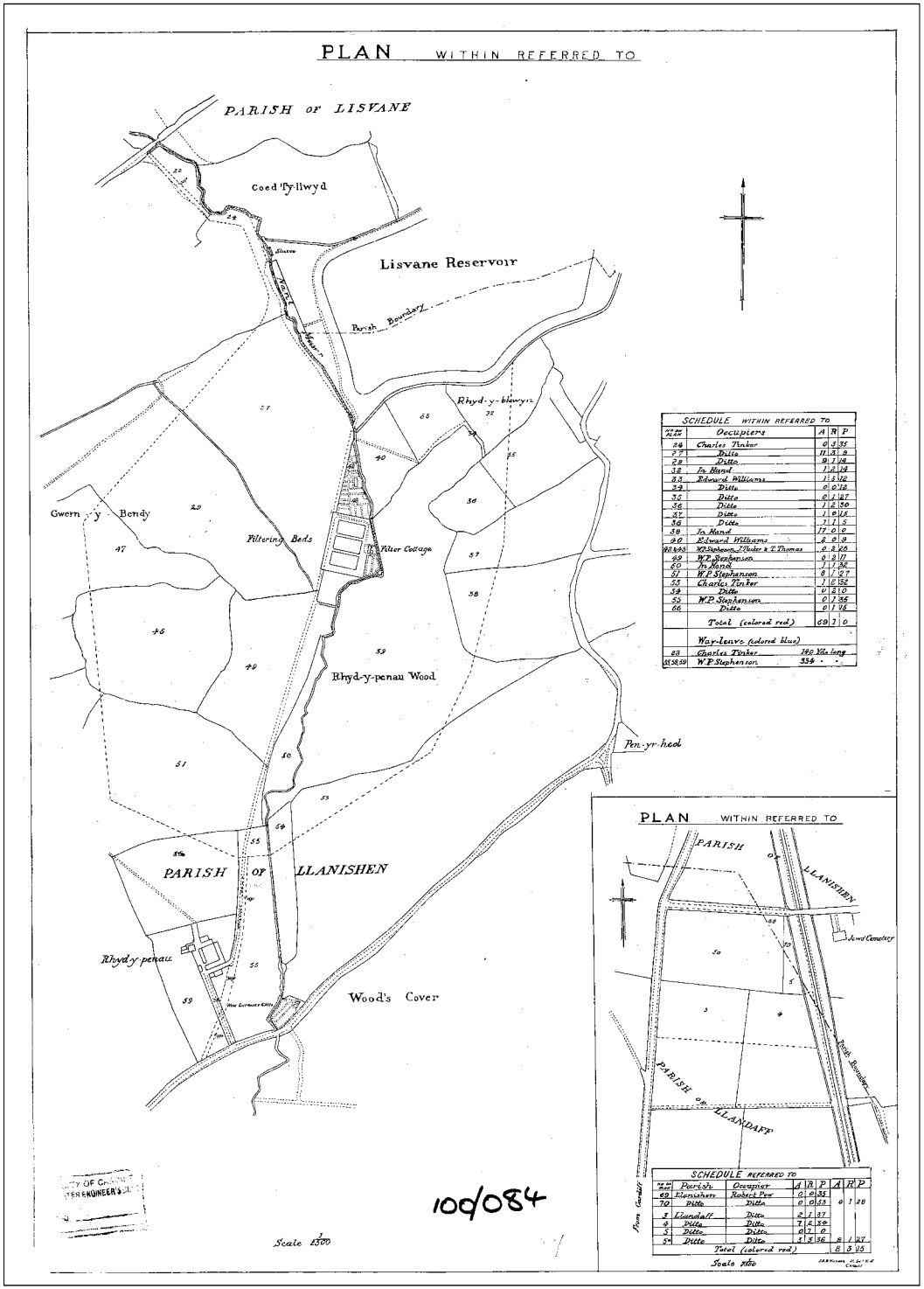

Figure 3.
Plan of Lisvane before the construction of Llanishen Reservoir, based on the 1975 First Edition OS map (original scale 1:2500)

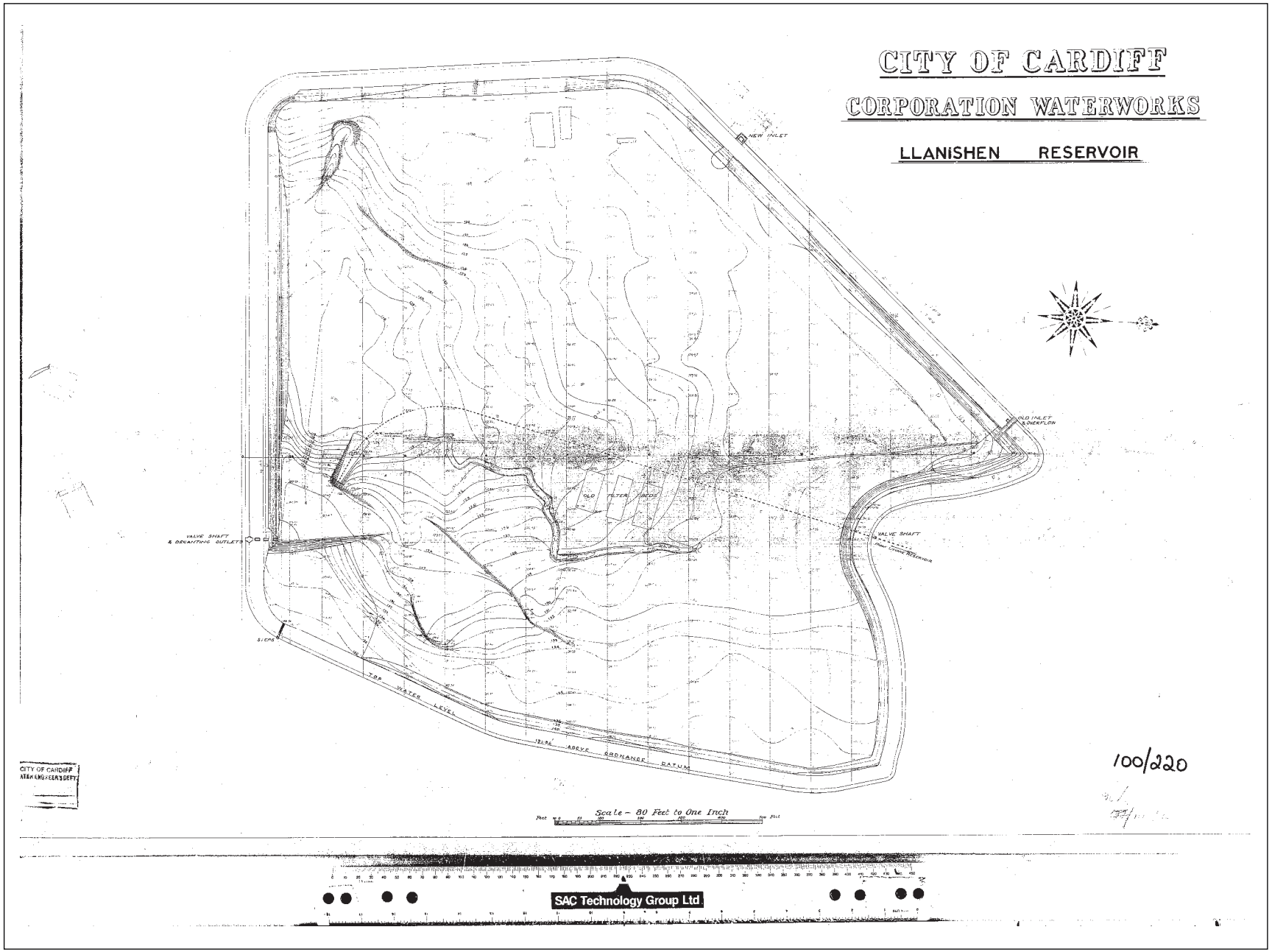

Figure 4.
Plan of Llanishen Reservoir, un-dated.

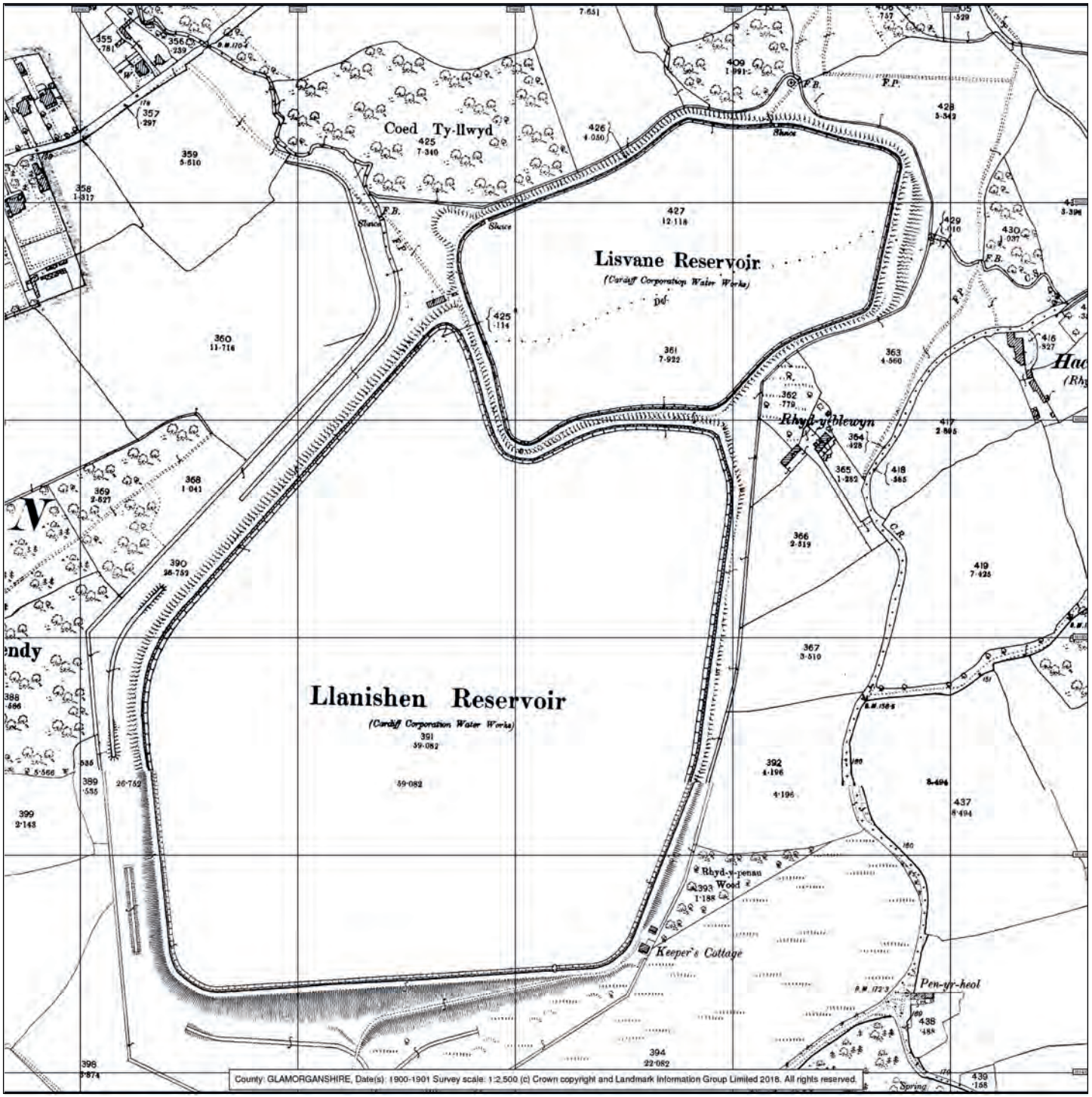

Figure 5.
Second Edition Ordnance Survey County Series map, 1900-1901.
(Originally plotted at: 1:2,500)

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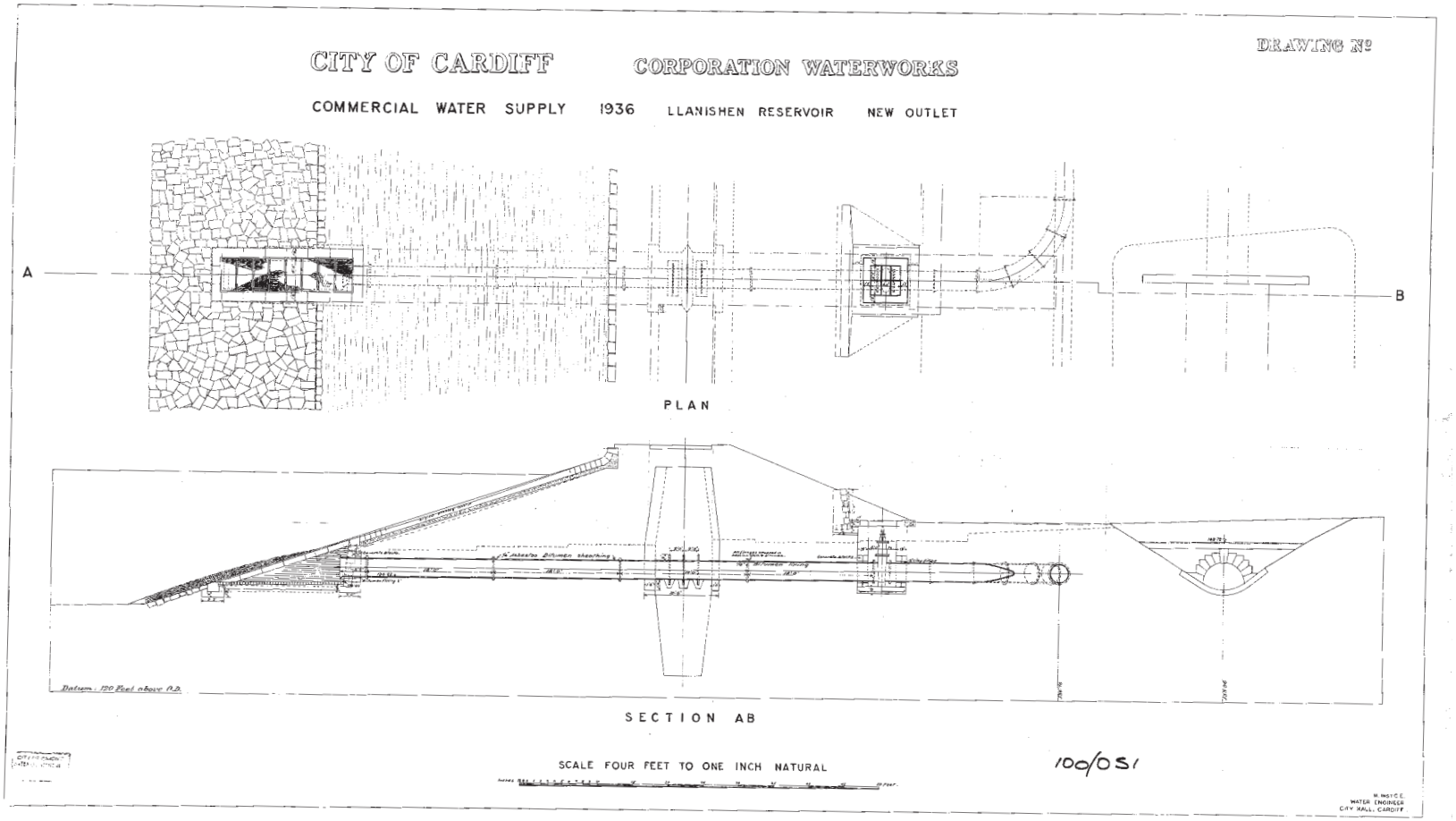

Figure 6.
Plans for a new outlet chamber, 1936

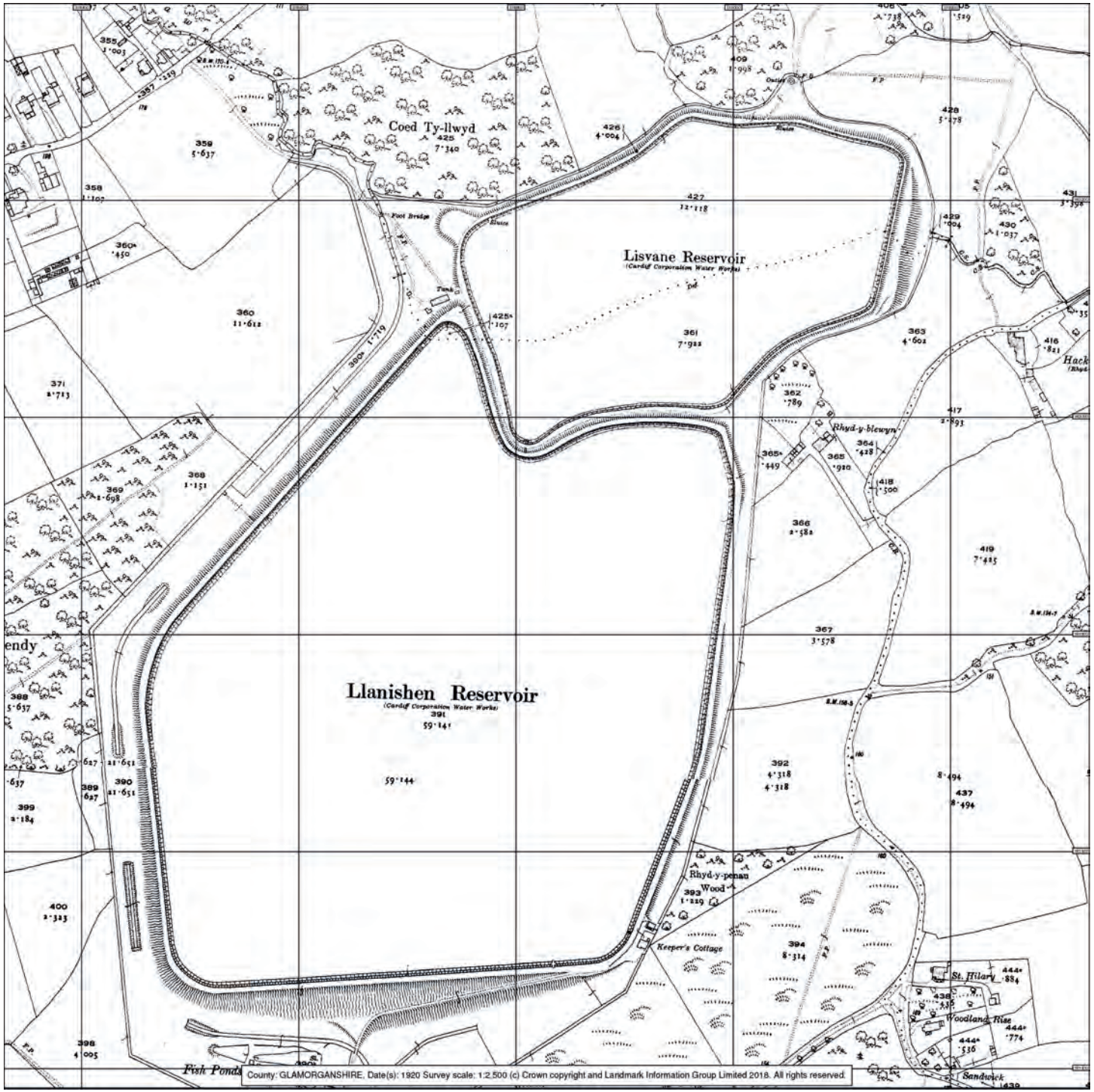

Figure 7.
Third Edition Ordnance Survey County Series map, 1920.
(Originally plotted at: 1:2,500)

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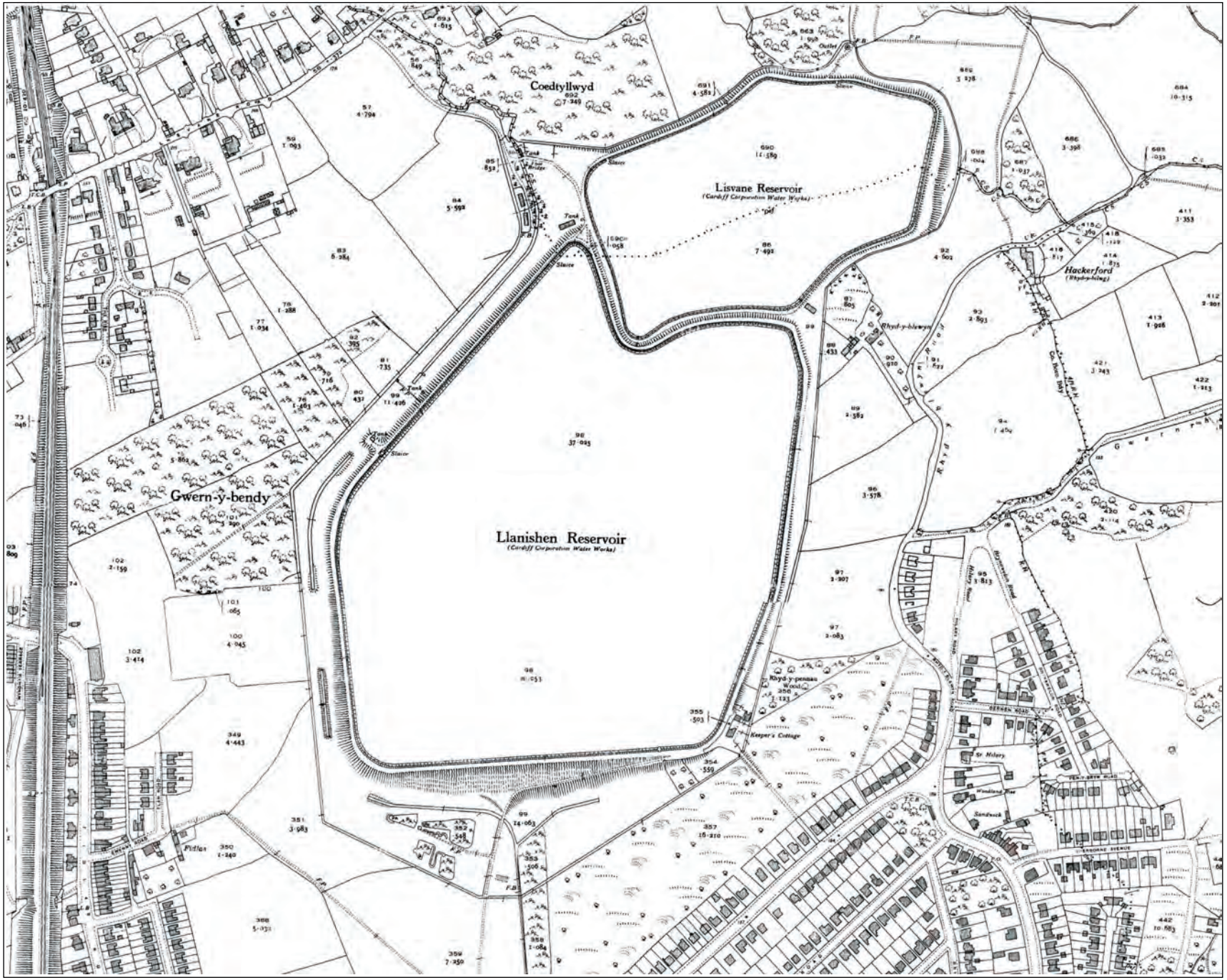

Figure 8.
Fourth Edition Ordnance Survey County Series map, 1940-1941

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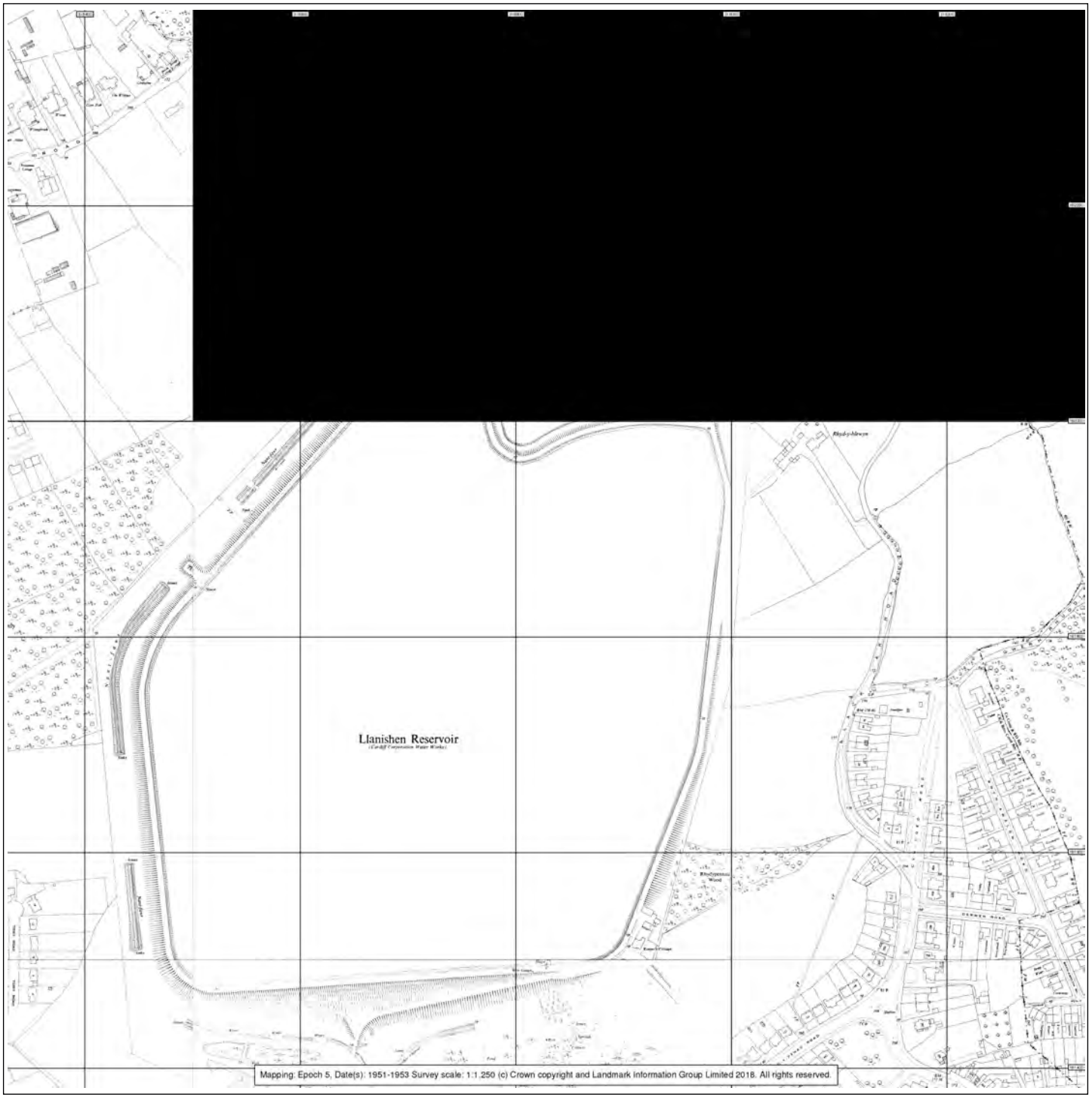

Figure 9.
Ordnance Survey Plan, 1952-1953. (Originally plotted at: 1:1,250)

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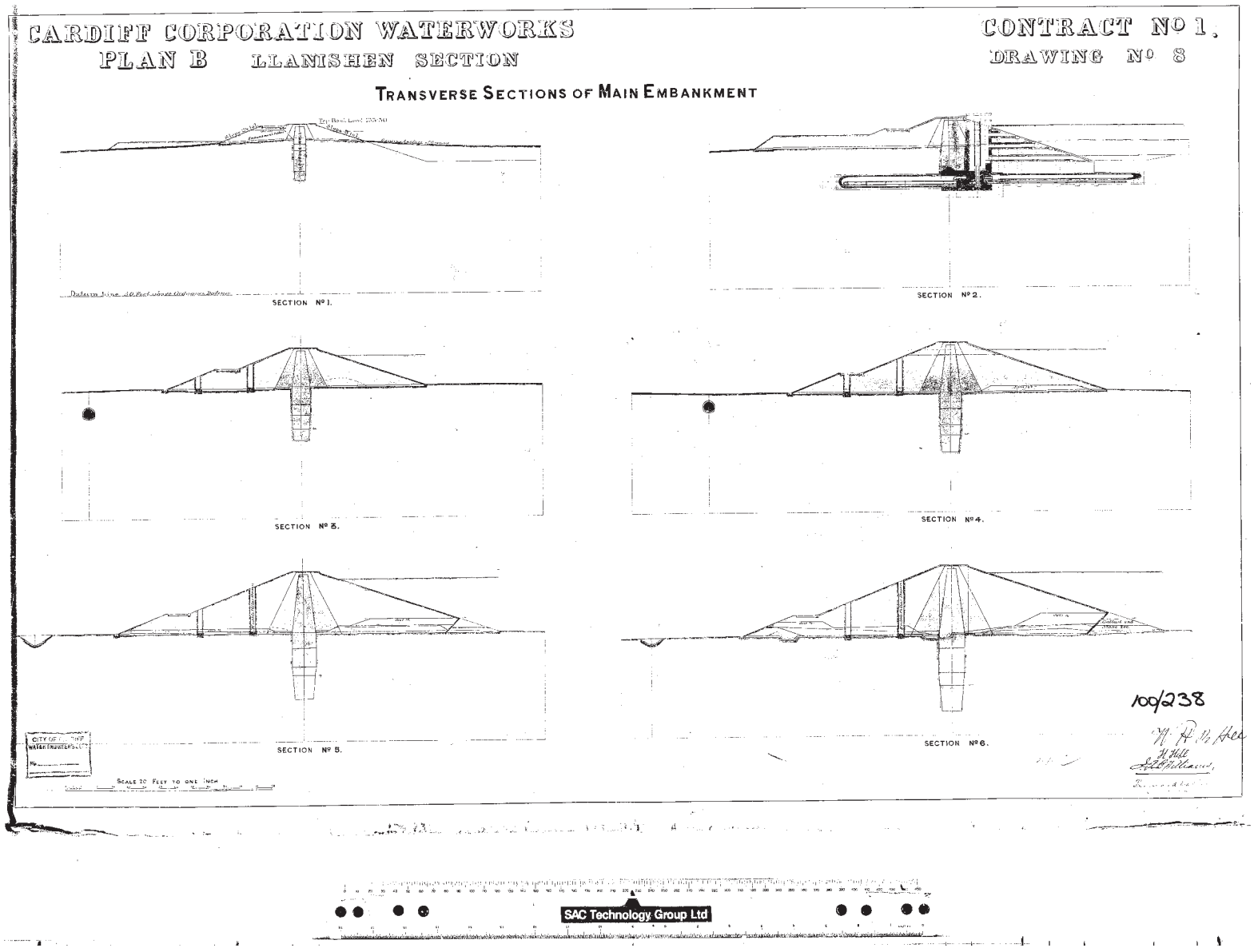


Figure 10.
Sections of the main embankment, 1888

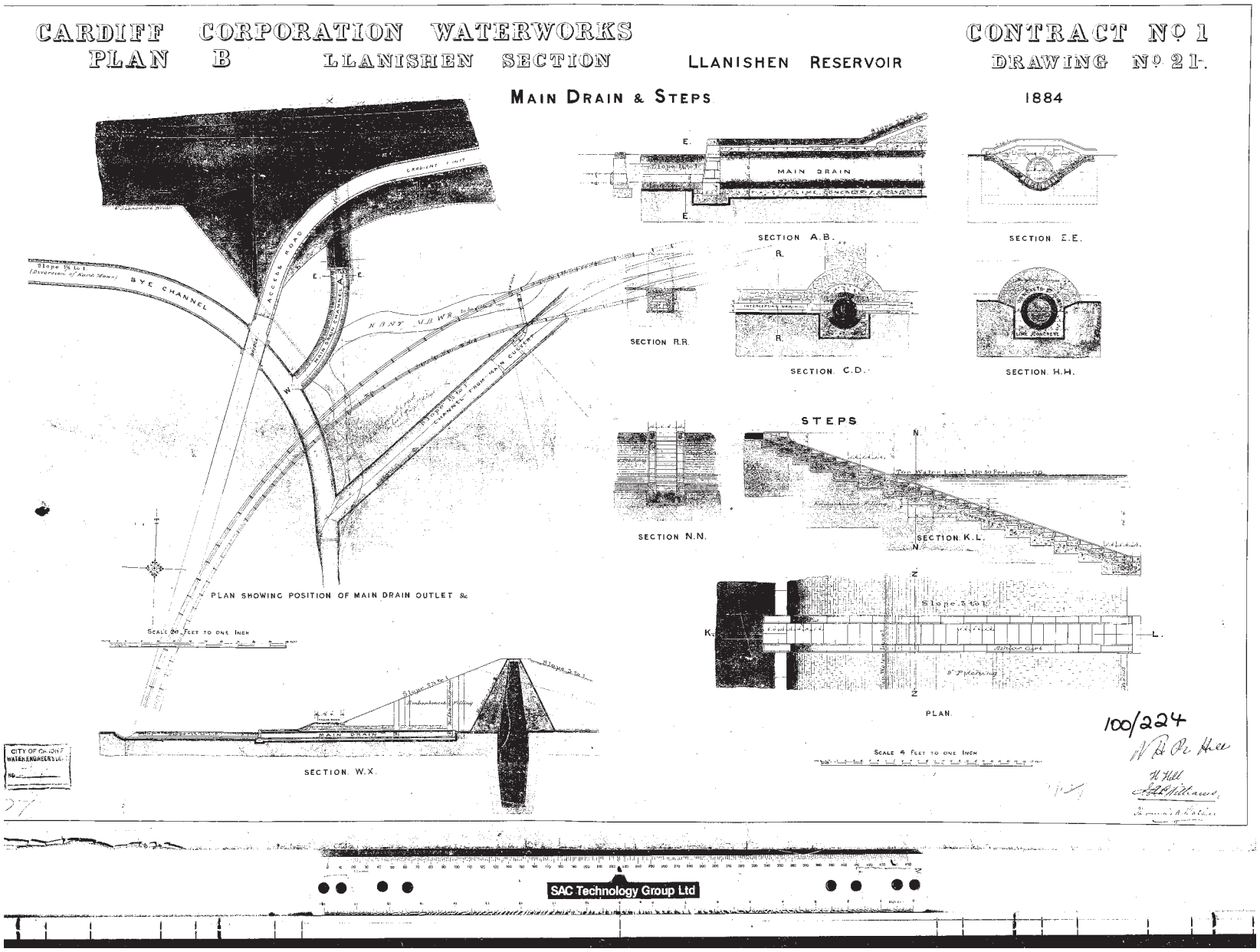
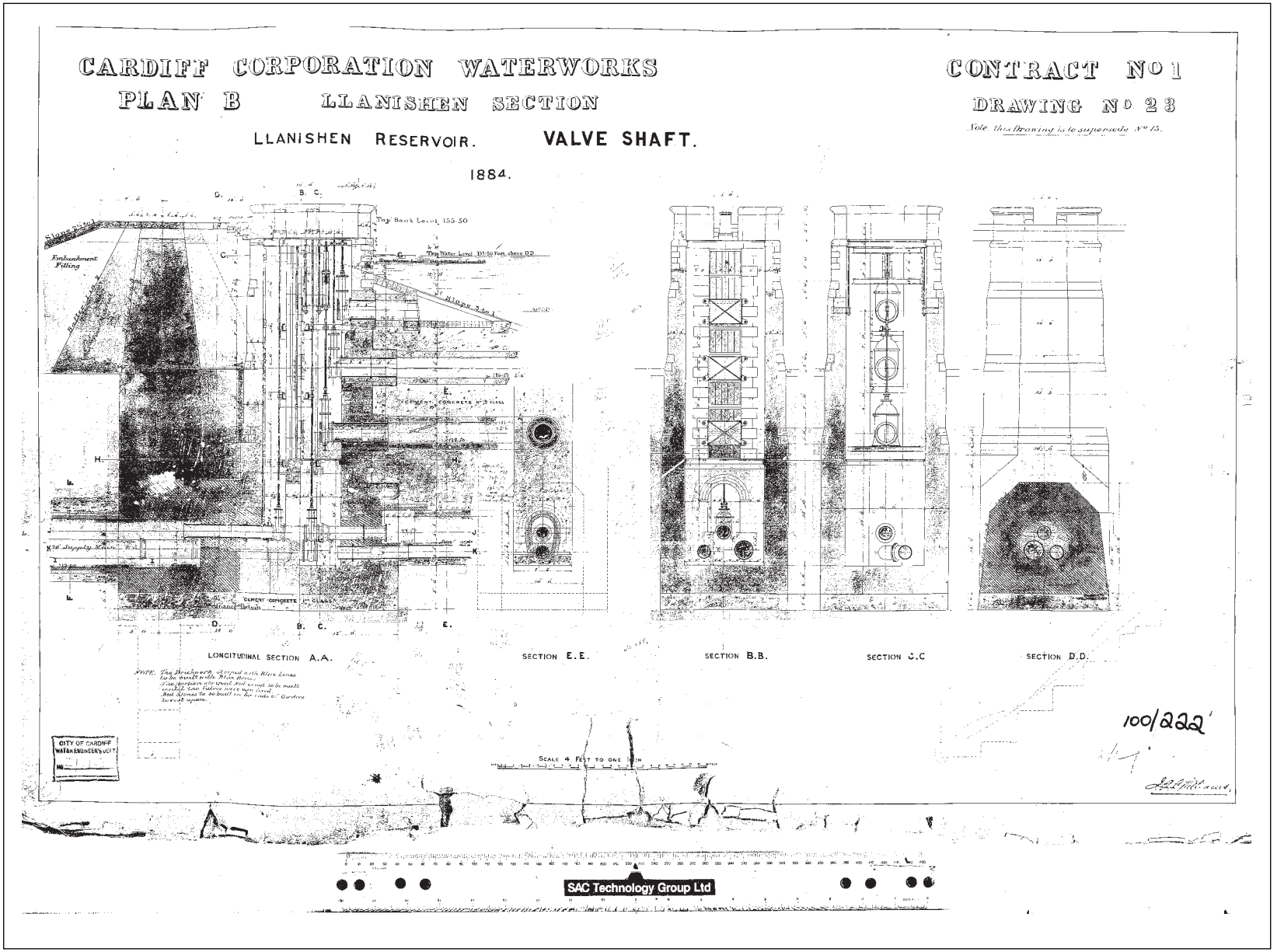


Figure 11.
Plans for the main drain and steps, 1884



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Original plans of the Valve Shaft (Outflow Control Valve Platform), 1884

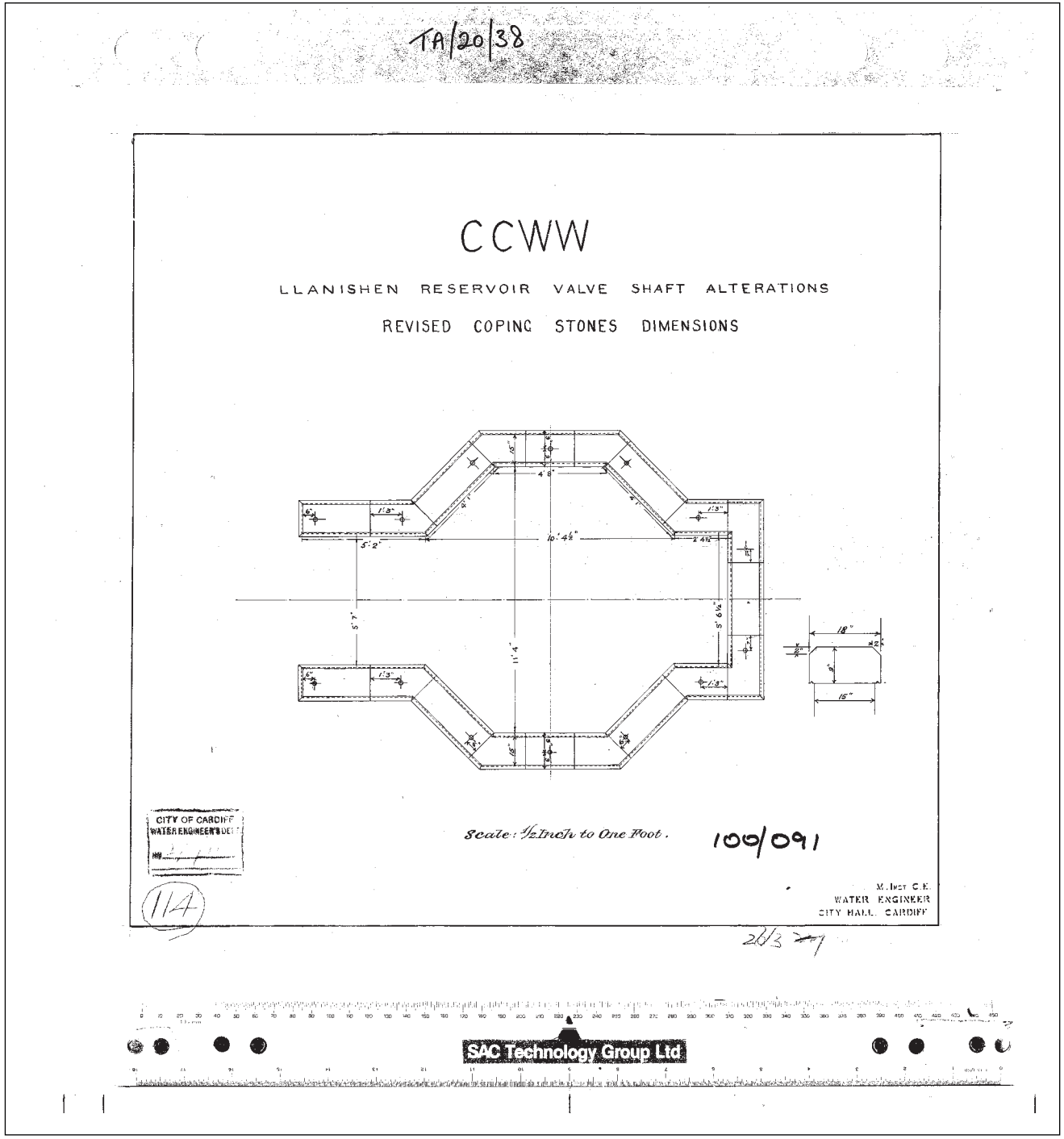


Figure 13.
Plan of the Valve Shaft (Outflow Control Valve Platform) alterations, 1936

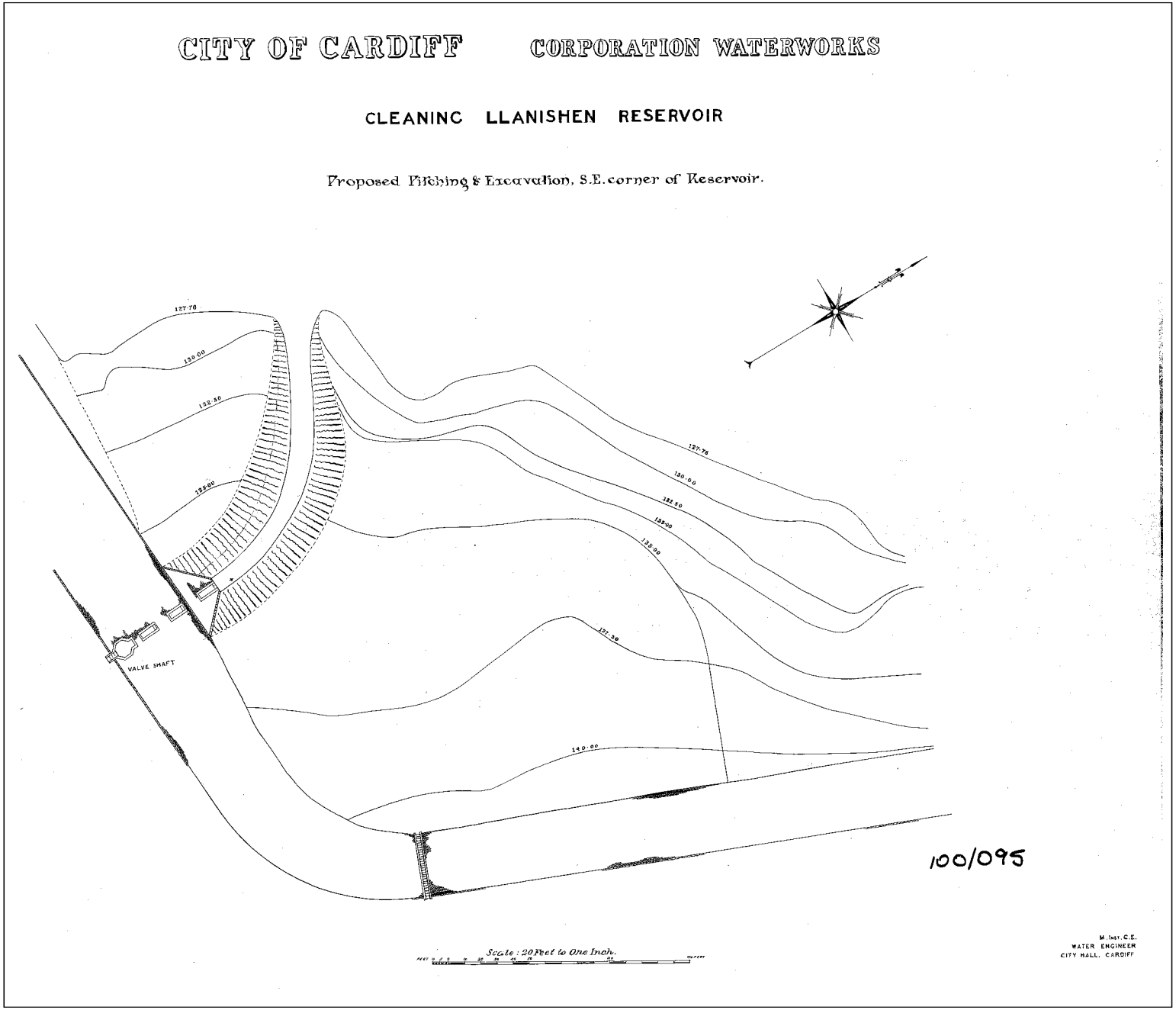


Figure 14.
Plan of the south-east corner of the reservoir, showing the Valve Shaft, 1936

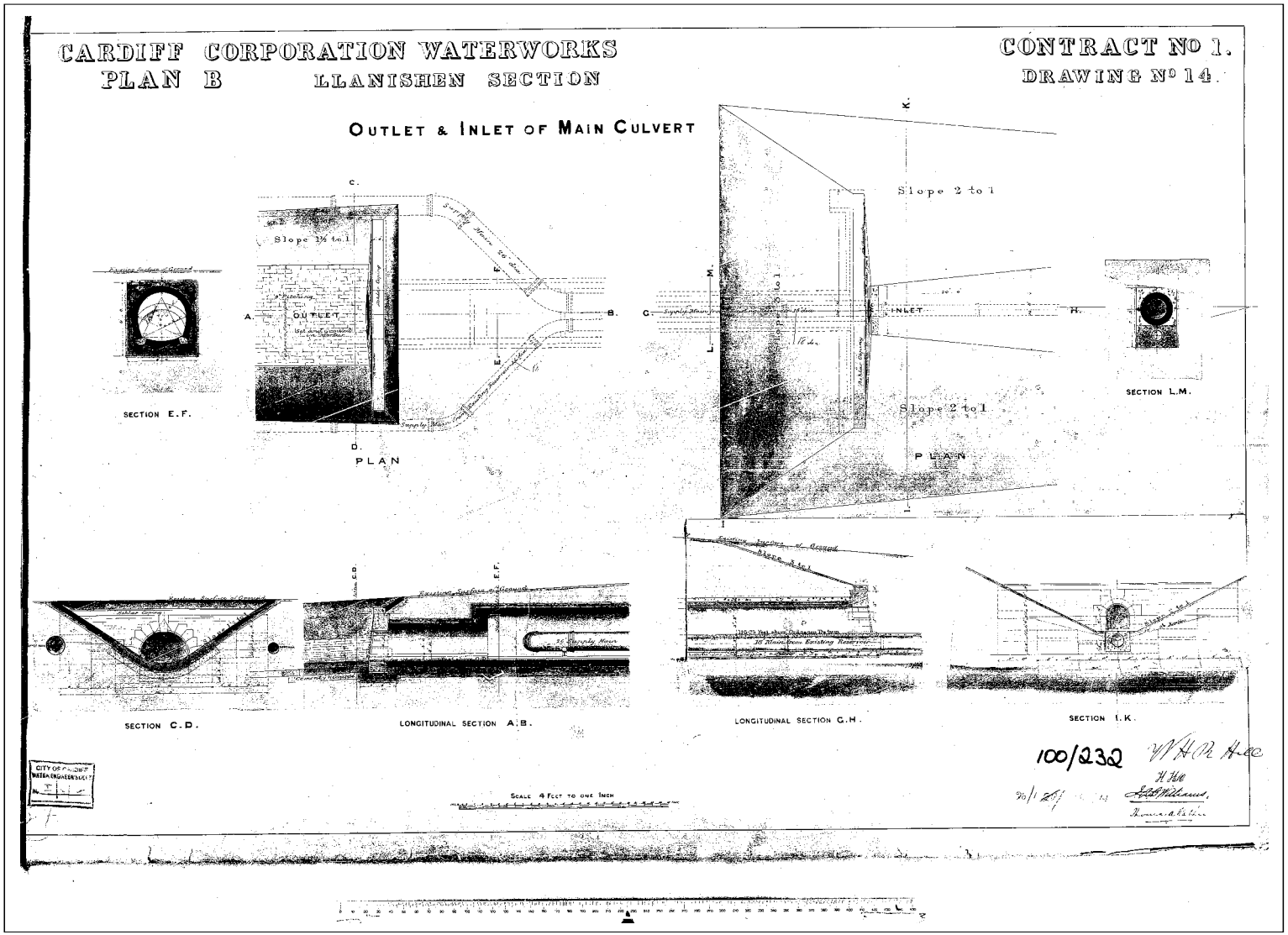
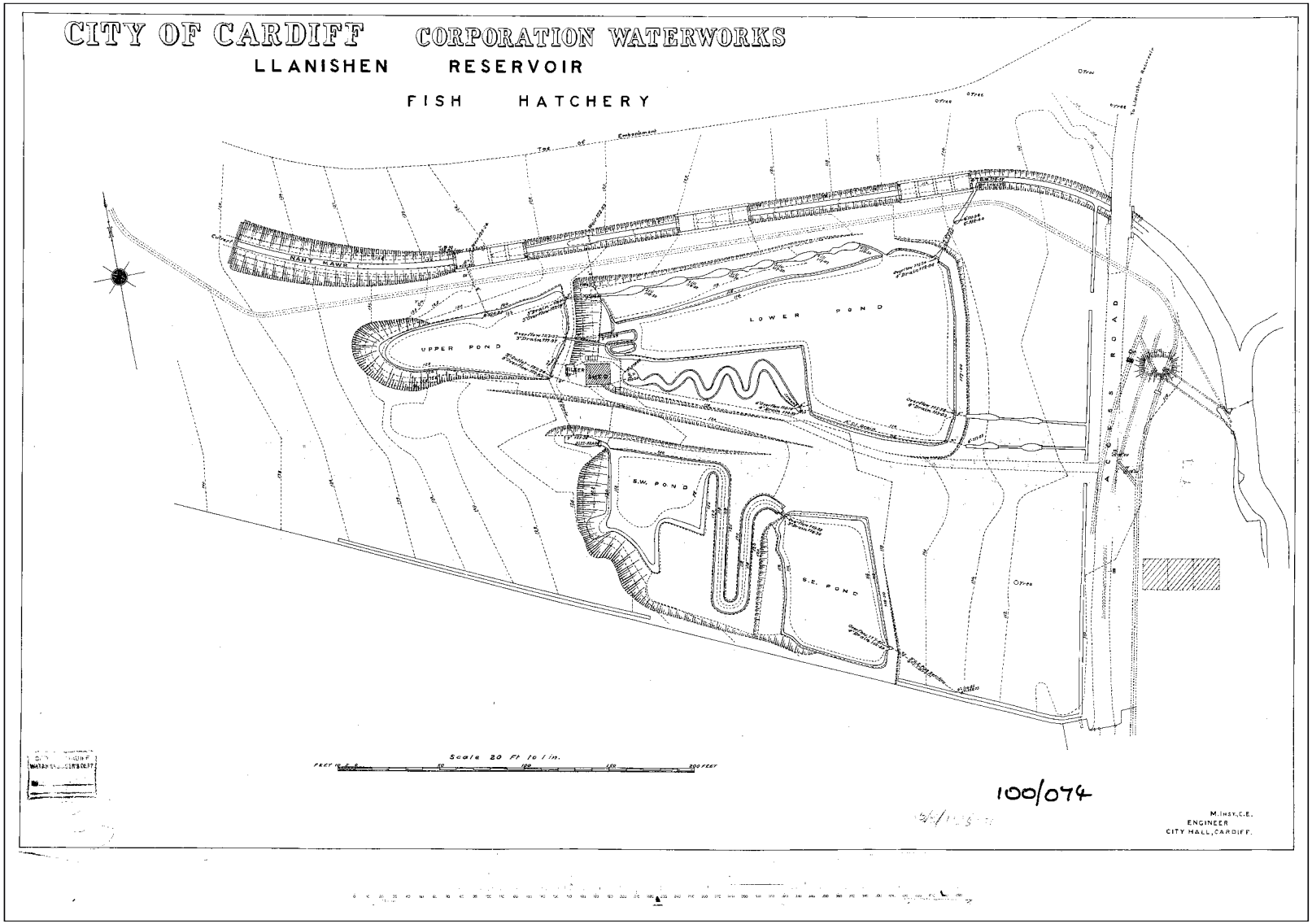


Figure 15.
Drawings of the outlet and inlet of the Scour Channel culvert, c. 1884-1888



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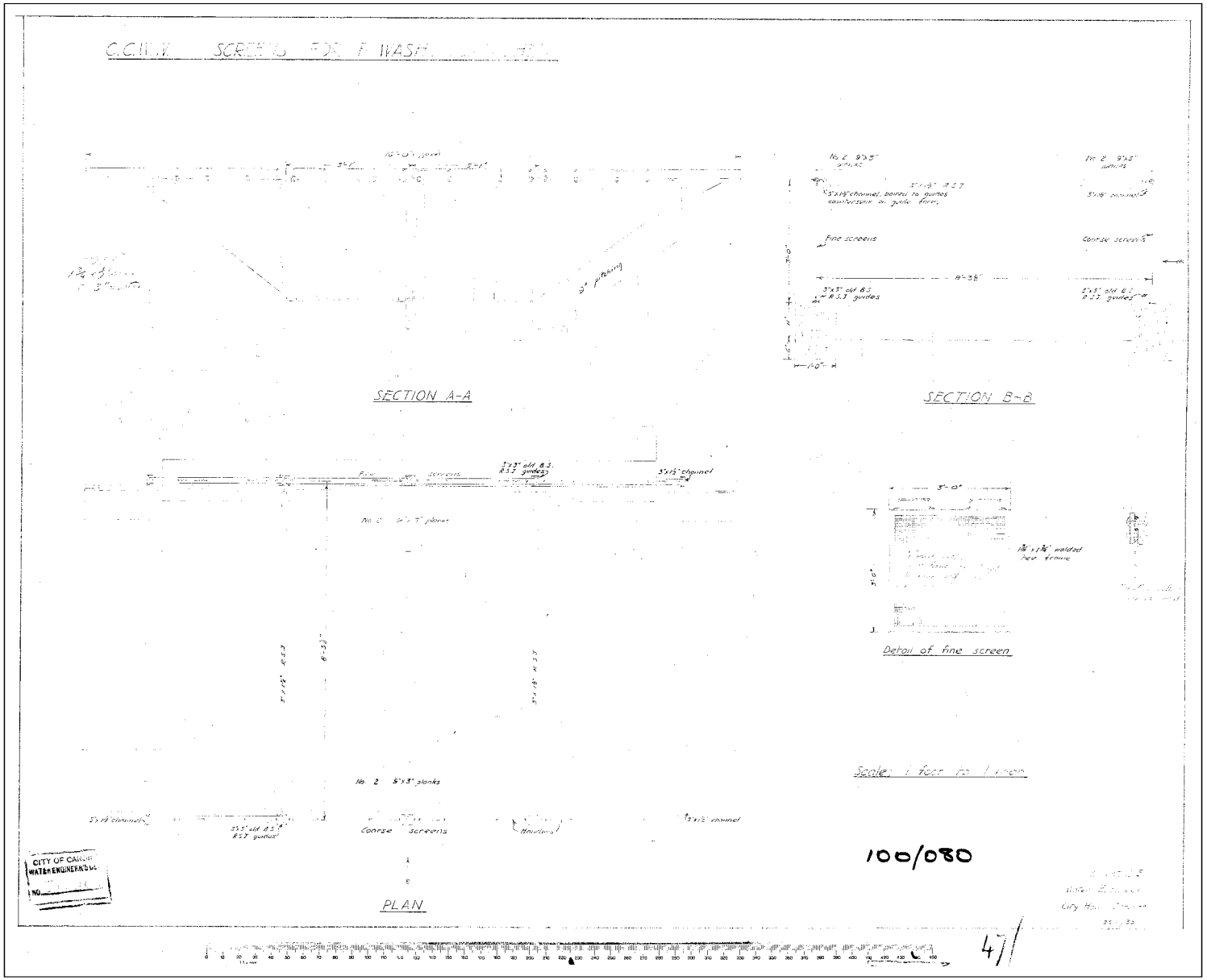

Figure 17.
Drawings of screens for Nant Mawr by-wash, 1938

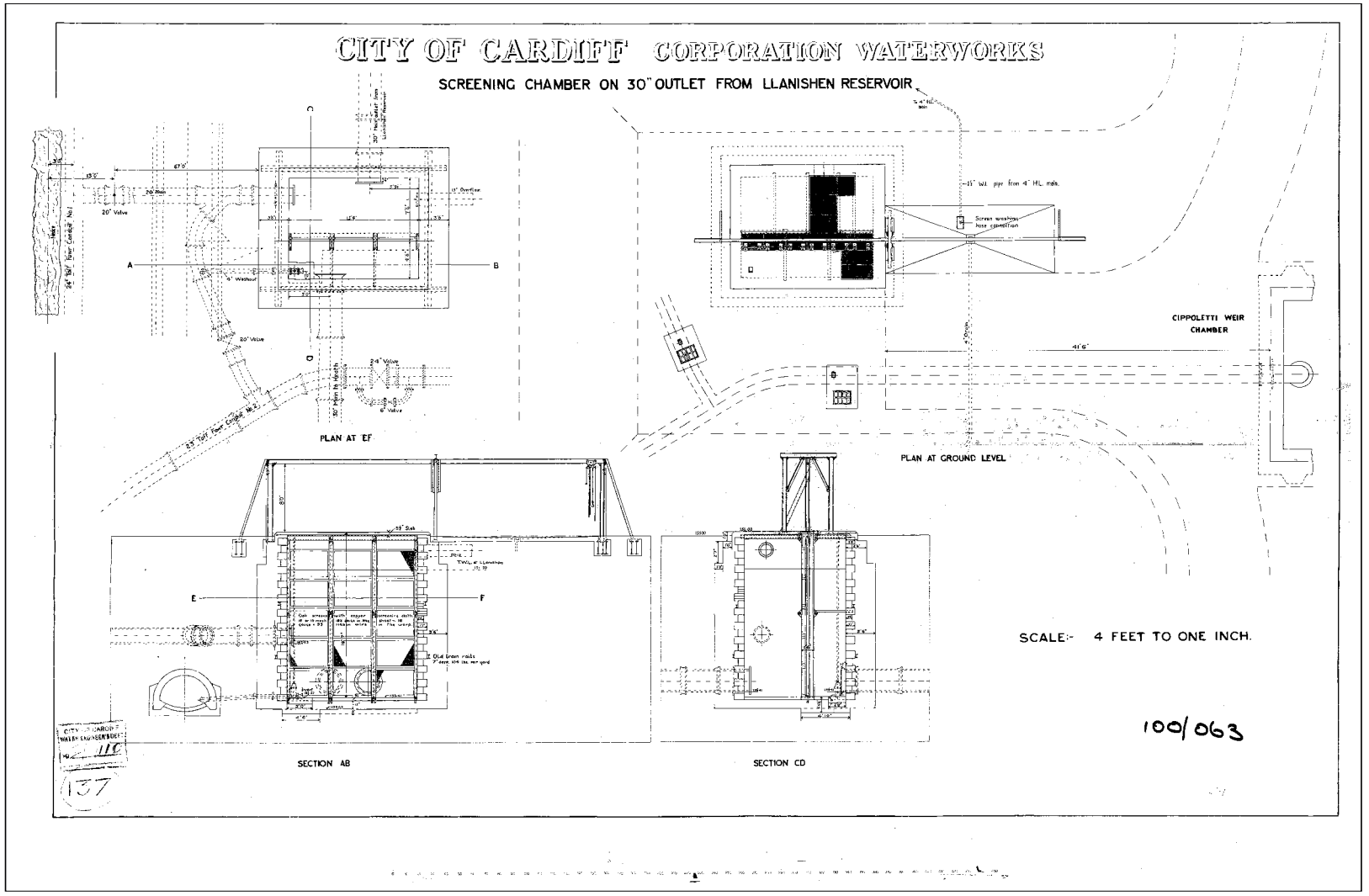

Figure 18.
Plans for the Screening Chamber, un-dated

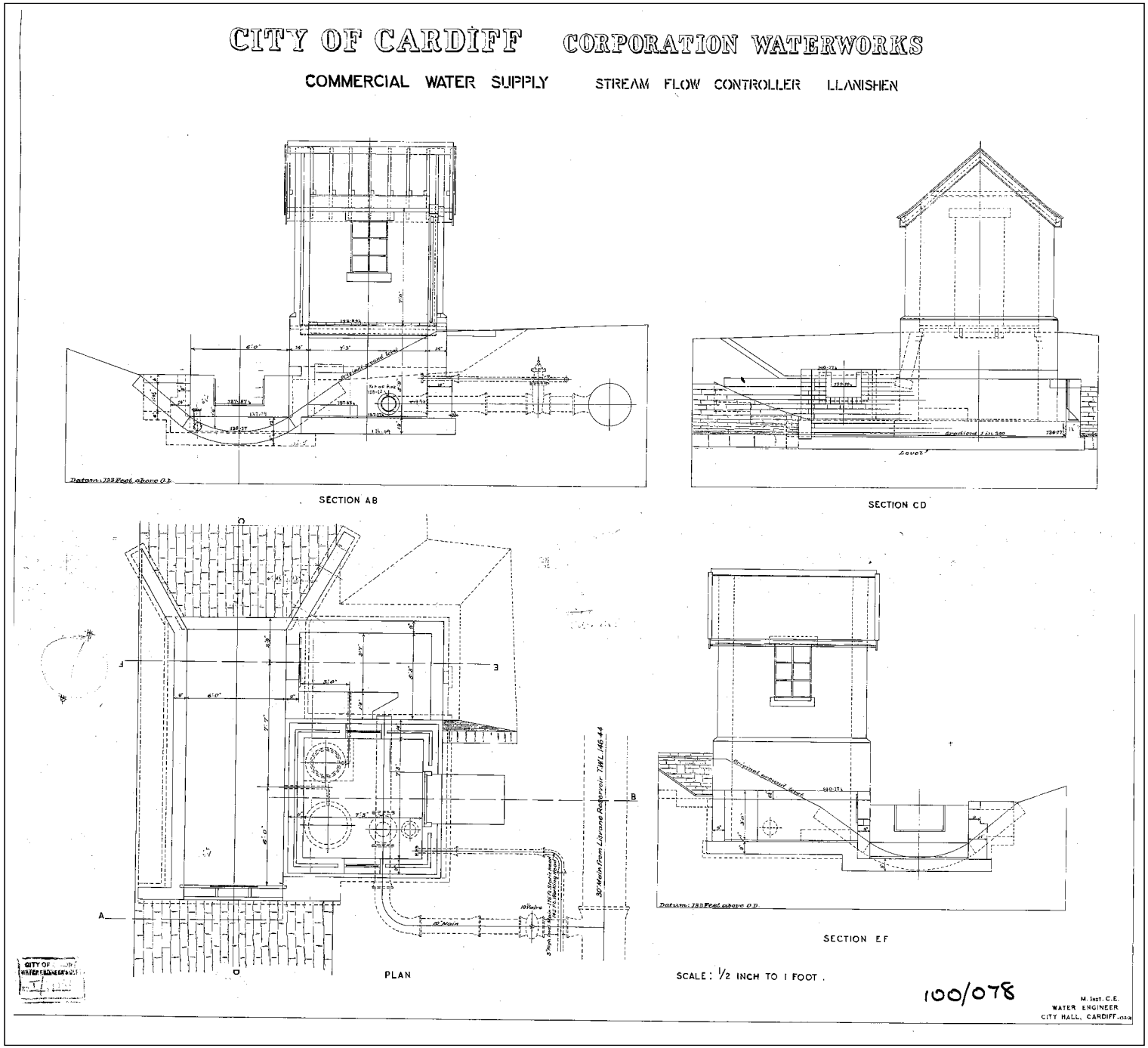

Figure 19.
Plans for the stream flow controller (Gauging Station), 1938

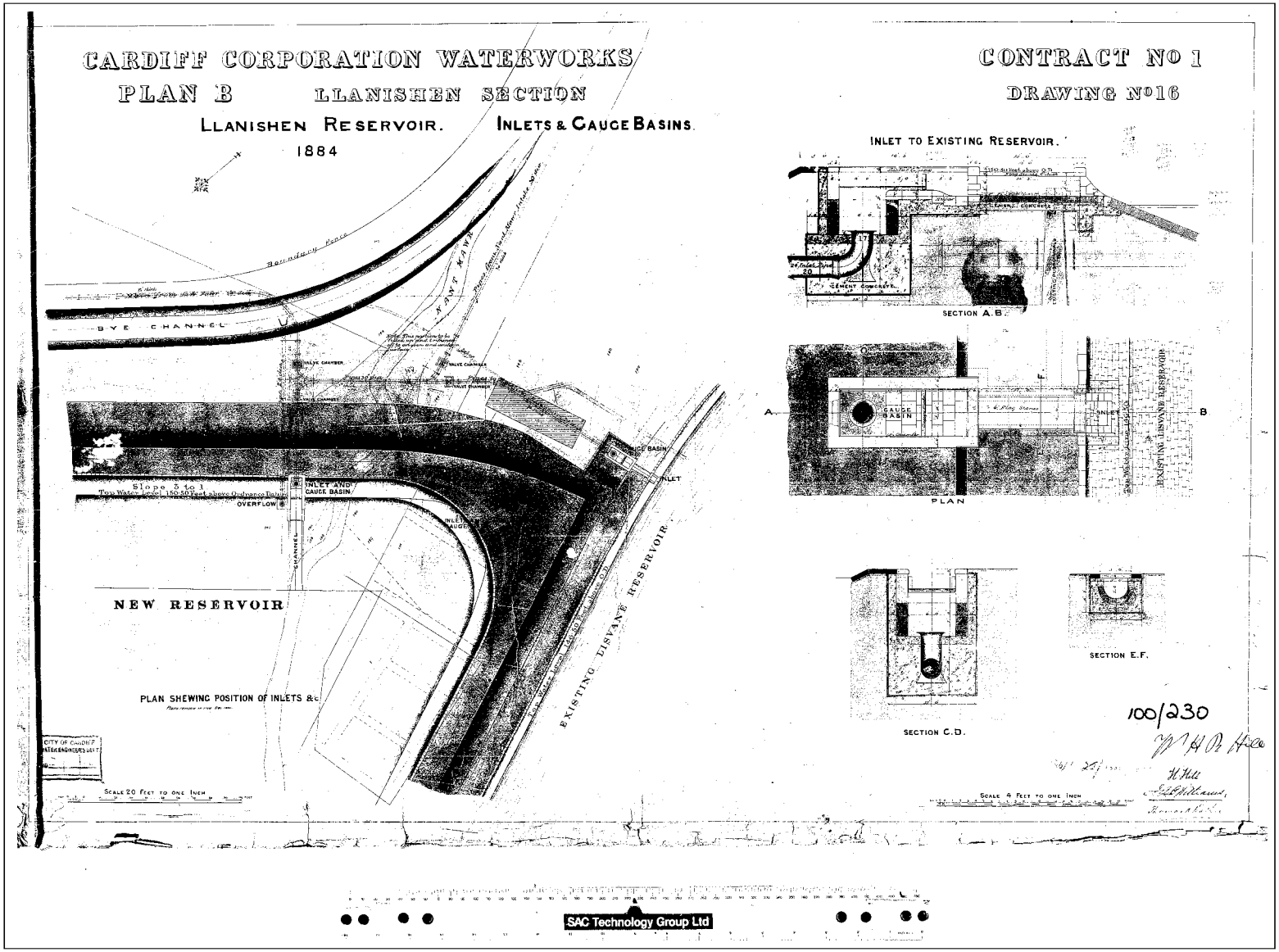

Figure 20.
Plans for the Inlet and Gauge Basin (Nant Fawr Inlet) from Lisvane, 1884

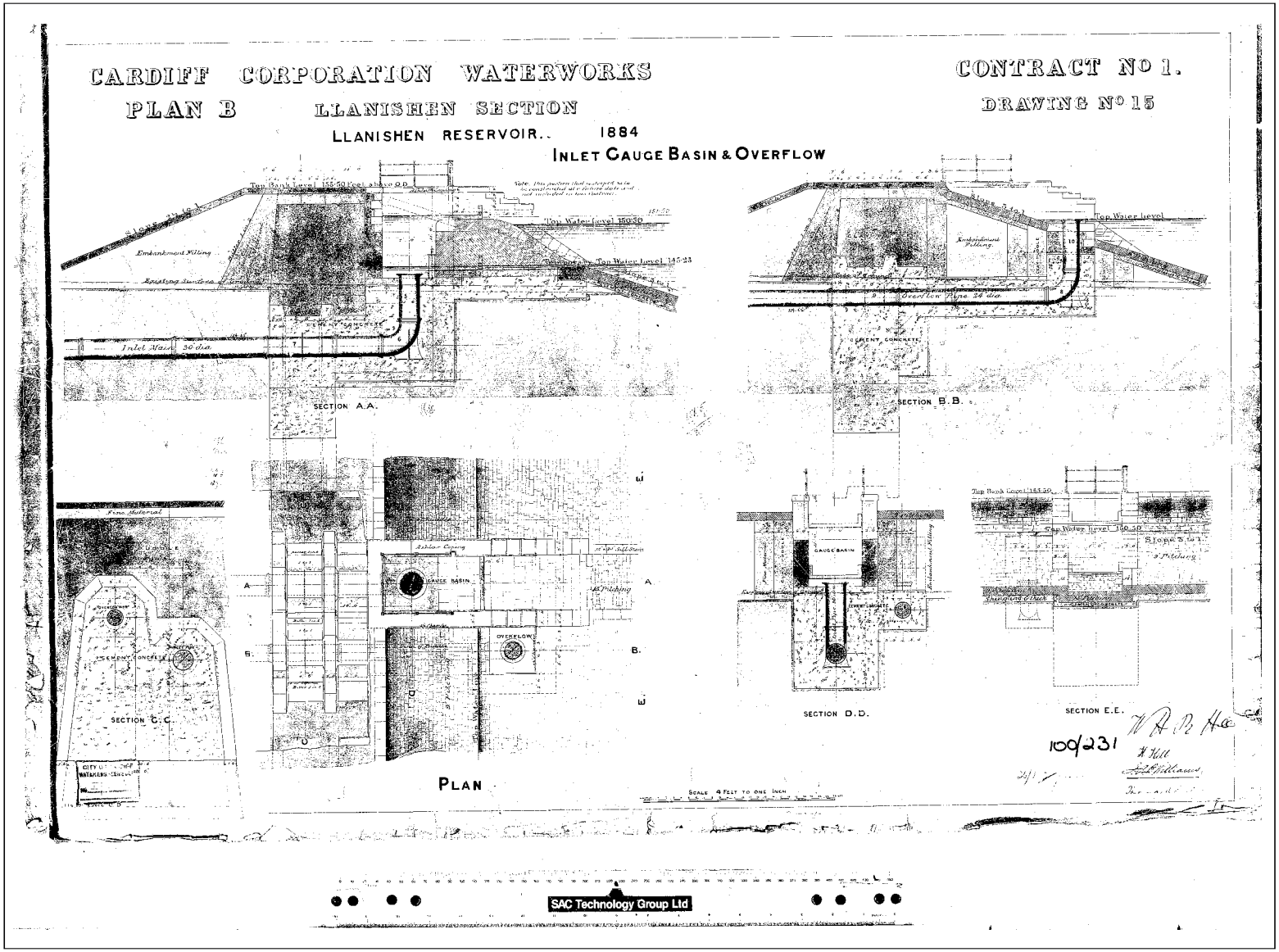

Figure 21.
Plans for the Inlet Gauge Basin and Overflow (Inlet Gauge Chamber), 1884

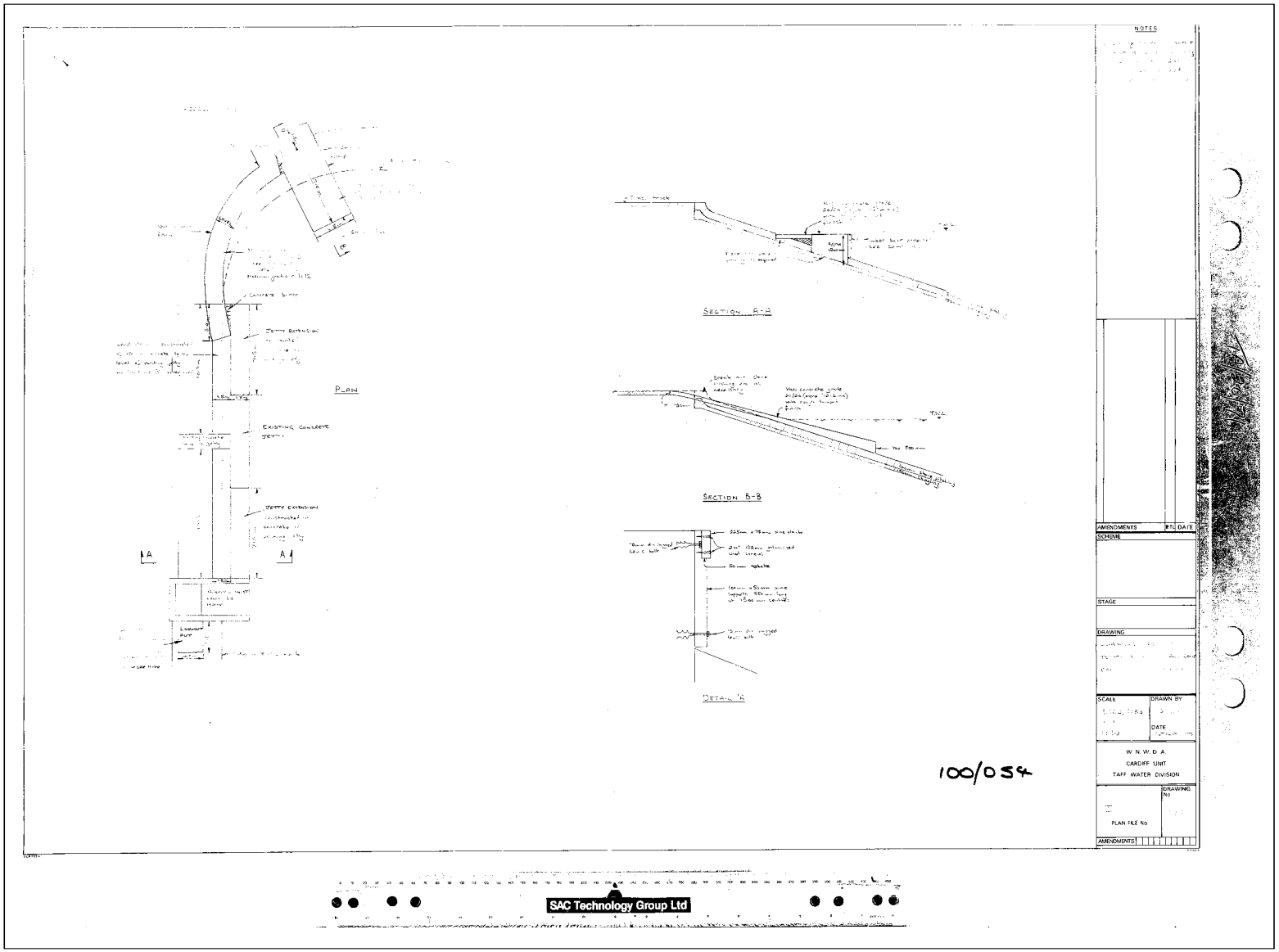

Figure 22.
Plans for the Jetty and Slipway, 1977

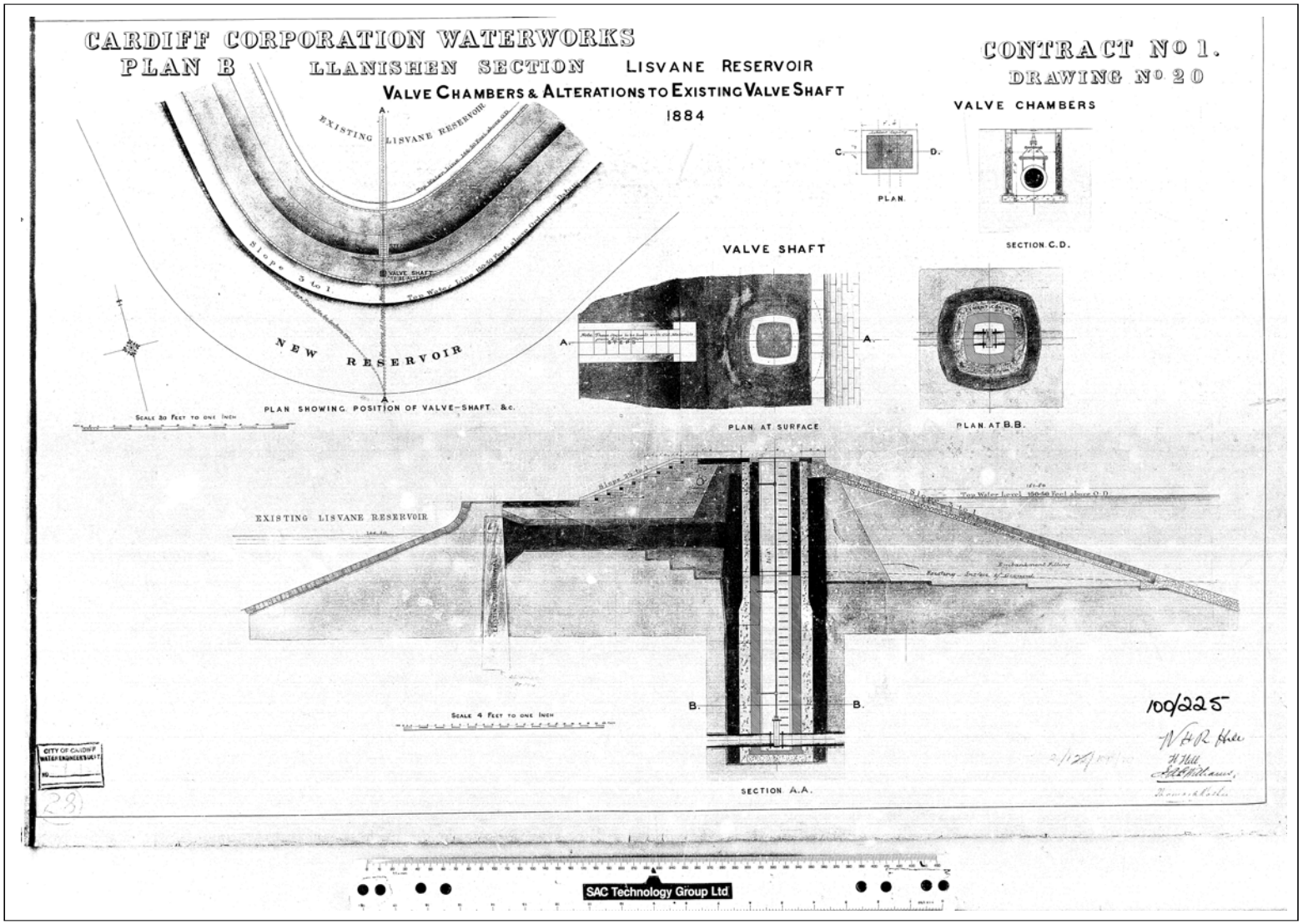

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Plate 77. Pipe penetration, looking east. Scale 2m.

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APPENDIX III:

Written Scheme of Investigation

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WRITTEN SCHEME OF INVESTIGATION

FOR A LEVEL 2 BUILDING SURVEY

AT LLANISHEN RESERVOIR, LLANISHEN, CARDIFF

Prepared for:

Opus International Consultants (UK) Ltd

Project No: 2652

September 2018

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NON-TECHNICAL SUMMARY

This Written Scheme of Investigations (WSI) details a proposal for a Level 2 Building Survey in advance of redevelopment work at Llanishen Reservoir, South Rise, Llanishen, Cardiff, centered at ST 18734 81864. The proposal is in the preplanning stages. This WSI has been prepared by Archaeology Wales Ltd for Opus International Consultants (UK) Ltd.

The proposed redevelopment will affect the reservoir dam, which is a Grade II Listed Building along with associated structures. It was part of Cardiff's 19th century Taff Fawr water supply system. It was designated as a virtually intact example of a major 19th century Welsh civic engineering project. GGAT-PD has advised that a Level 2 Building Survey should be carried out prior to any redevelopment work.

1. Introduction

This Written Scheme of Investigations details a proposal for a Level 2 Building Survey in advance of redevelopment work at Llanishen Reservoir, centered at ST 18734 81864. The proposal is in the preplanning stage. It has been prepared by Archaeology Wales Ltd for Opus International Consultants (UK) Ltd.

This document provides information on the methodology that will be employed by Archaeology Wales during an Archaeological Building Investigation and Recording at the 'site', consisting of a Level 2 Building Survey. The project will be managed by Rowena Hart, Archaeology Wales Regional Director.

The proposed redevelopment will impact on the Grade II Listed reservoir dam and associated structures. GGAT-PD has advised that a Level 2 Building Survey should be carried out prior to any redevelopment work.

All work will be undertaken by suitably qualified staff and in accordance with the standards and guidelines of the CIfA.

2. Location and geological background

The reservoir is located on the north-east edge of Llanishen, a northern district of the City of Cardiff. Immediately to the north, separated by the reservoir embankment, is the smaller Lisvane reservoir. They are surrounded by a band of grass and trees, beyond which to the east, south and west are the residential streets of Llanishen and Lisvane, and to the north are pasture fields. The total

circumference of the reservoir is approximately 2.1km, and the structures to be recorded include the reservoir dam itself as well as associated structures such as outlet pipes around the circumference (Figure 1). It lies at 45m OD.

The underlying geology is interbedded argillaceous rocks and sandstone of the St Maughans Formation. No superficial deposits were recorded for the majority of the area of the reservoir. On the northern and western edges there are deposits of Devensian Till laid down in ice age conditions, and to the south are alluvial clay, silt, sand and gravel deposits (BGS 2018).

3. Historical and archaeological background

Llanishen Reservoir, along with neighboring Lisvane, was part of Cardiff's nineteenth century Taff Fawr water supply system, constructed by Cardiff Waterworks Company. Work on the reservoir started in 1882 and was completed by 1886. The reservoir dam is a Grade II Listed Building. It is a continuous encircling embankment of clay and earth with a pitched stone interior. The reservoir was in use until the mid-1970s, while Lisvane Reservoir remains in use today.

4. Objectives

This WSI sets out a program of works to ensure that the Archaeological Building Recording Level 2 will meet the standard required by The Chartered Institute for Archaeologist's *Standard and Guidance for Archaeological Building Investigation and Recording* (2014) and according to Historic England's *Understanding Historic Buildings: A Guide to Good Recording Practice* (2016).
The primary objective of the Building Recording will be to describe and record, by means of high-resolution digital photography and measured drawings, all of the key internal and external components of the affected building(s) so that a permanent record survives prior to renovation. This will be completed by means of an English Heritage Level 2 Building survey.

Level 2 is a descriptive record, and will comprise an introductory description followed by an account of the building's origins, development and use. It will include all drawn and photographic records that may be required to illustrate the building's appearance and structure and to support an historical description.

Other recent structures existing on the site will be recorded by means of digital photography.

The work will result in a report, which will provide a comprehensive record of all the work undertaken.

5. Timetable of works

5.1. Fieldwork

A date for carrying out the building recording has not yet been finalized. Archaeology Wales will update GGAT-PD when a date is known.

5.2. Report delivery

The report will be submitted to the client and to GGAT-PD within three months of the completion of the fieldwork. A copy of the report will also be sent to the regional HER (see section 8.2 for details).

6. Details of work

6.1. Desktop research phase

The archaeological works will be conducted according to the Chartered Institute for Archaeologists' (CIfA) *Standard and Guidance for the archaeological investigation and recording of standing buildings or structures* (2014), *Standard and Guidance for Historic Environment Desk-based Assessment* (2014).

Building Survey

The survey will take the form of a Level 2 building survey as defined by English Heritage (May 2016) *Understanding Historic Buildings: a guide to good recording practice*. This level of survey is intended to create an analytical record of the building, and will include:

- Description and photographic record of the bank of the dam and associated structures within the curtilage
- Detailed account of type, construction, form, function
- Phasing
- Past and present use and relationship with setting
- Identification and recording of original fixtures and fittings
- Conclusions regarding the building's development and use

The drawn record will be created using either conventional measured survey or total station surveying as appropriate. The end result will include:

- Accurate, measured ground plan, elevations and cross-sections as appropriate
- Phase plans showing the development of the structure as appropriate

Photography

A number of the associated structures are confined spaces and accessible only with specialist equipment. Photographs of the interior of these structures have already been taken by Lewis Civil Engineering.

AW will photograph:

- Views of elevations
- Views of external appearance
- Views of internal rooms
- Internal and external structural detail
- Fixtures, fittings, machinery, related contents

7. Monitoring

GGAT-PD will be contacted approximately five days prior to the commencement of archaeological site works, and subsequently once the work is underway.

Any changes to the WSI that AW may wish to make after approval will be communicated to GGAT-PD for approval on behalf of Planning Authority.

Representatives of GGAT-PD will be given access to the site so that they may monitor the progress of the building recording. GGAT-PD will be kept regularly informed about developments.

8. Archive and Reporting programme

8.1. Archive

Site archive

An ordered and integrated site archive will be prepared in accordance with: Management of Research Projects in the Historic Environment (MoRPHE) (Historic England 2006) upon completion of the project.

The site archive will be will be prepared in accordance with the National Monuments Record (Wales) agreed structure and deposited with an appropriate receiving

organisation, in compliance with CIfA Guidelines (Standard and guidance for the creation, compilation, transfer and deposition of archaeological archives', 2014). The legal landowners consent will be gained for deposition of finds.

The paper and digital archive will be deposited with the National Monuments Record, RCAHMW including a copy of the final report. This archive will include all written, drawn, survey and photographic records relating directly to the investigations undertaken. NMR Digital archives will follow the standard required by the RCAHMW (RCAHMW, 2015). A copy of the digital archive only will also be lodged with the Historic Environment Record, Glamorgan Gwent Archaeological Trust.

8.2. Analysis

Following a rapid review of the potential of the site archive, a programme of analysis and reporting will be undertaken. This will result in the following inclusions in the final report:

- Non-technical summary
- Location and NGR
- Statutory designations
- Date of record, recorder and archive deposition
- Introduction
- Site location
- Topography and Geology
- Methodology
- Summary of the form, function, date and development of the building
- Desk-based study, including copies of historic maps and photographs where permitted
- Summary description of the building
- Past and present usage
- Evidence for former existence of demolished structures, removed fittings etc
- Site Plans and Elevations (annotated architects plans may be used where they are seen to be an accurate representation of the existing building/s)
- Conclusions
- References

8.3. Reports and archive deposition

Report to client

Copies of all reports associated with the building survey, together with inclusion of supporting evidence in appendices as appropriate, including photographs and illustrations, will be submitted to the client, the Local Planning Authority and the Development Control Archaeologist at Glamorgan-Gwent Archaeological Trust. On approval the final report should be submitted in high resolution PDF format to the Historic Environment Record Officer, Glamorgan-Gwent Archaeological Trust for inclusion within the Historic Environment Record.

Archaeology Wales will obtain copies of the HER Deposition Guidance and HER Depositor Licence from the HER Officer before any reports or archives are submitted to the Glamorgan-Gwent Archaeological Trust Historic Environment Record.

Additional reports

After an appropriate period has elapsed, copies of all reports will be deposited with the relevant county Historical Environment Record, the National Monuments Record and, if appropriate, Cadw.

Summary reports for publication

Short archaeological reports will be submitted for publication in relevant journals; as a minimum, a report will be submitted to the annual publication of the regional CBA group or equivalent journal.

Notification of important remains

Where it is considered that remains have been revealed that may satisfy the criteria for statutory protection, AW will submit preliminary notification of the remains to Cadw.

Archive deposition

The final archive (site and research) will, whenever appropriate, be deposited with a suitable receiving institution, usually the relevant Local Authority museums service. Arrangements will be made with the receiving institution before work starts.

Although there may be a period during which client confidentiality will need to be maintained, copies of all reports and the final archive will be deposited no later than six months after completion of the work.

Copies of all reports, the digital archive and an archive index will be deposited with the National Monuments Record, RCAHMW, Aberystwyth.

Wherever the archive is deposited, this information will be relayed to the HER. A summary of the contents of the archive will be supplied to GGAT-PD.

9. Staff

The project will be managed by Rowena Hart (Regional Director) and the fieldwork undertaken by Susan Stratton, Archaeology Wales Ltd. Any alteration to staffing before or during the work will be brought to the attention of GGAT-PD and the client.

10. Health and Safety

10.1. Risk assessment

Prior to the commencement of work AW will carry out and produce a formal Health and Safety Risk Assessment in accordance with The Management of Health and Safety Regulations 1992. A copy of the risk assessment will be kept on site and be available for inspection on request. A copy will be sent to the client (or their agent as necessary) for their information. All members of AW staff will adhere to the content of this document.

10.2. Other guidelines

AW will adhere to best practice with regard to Health and Safety in Archaeology as set out in the FAME (Federation of Archaeological Managers and Employers) health and safety manual Health and Safety in Field Archaeology (2002).

11. Community Engagement and Outreach

Wherever possible, AW will ensure suitable measures are in place to inform the local community and any interested parties of the results of the site investigation work. This may occur during the site investigation work or following completion of the work. The form of any potential outreach activities may include lectures and talks to local groups, interested parties and persons, information boards, flyers and other forms of communication (social media and websites), and press releases to local and national media.

The form of any outreach will respect client confidentiality or contractual agreements. As a rule, outreach will be proportional to the size of the project.

Where outreach activities have a cost implication these will need to be negotiated in advance and in accordance with the nature of the desired response and learning outcomes.

12. Insurance

AW is fully insured for this type of work, and holds Insurance with Aviva Insurance Ltd and Hiscox Insurance Company Limited through Towergate Insurance. Full details of these and other relevant policies can be supplied on request.

13. Quality Control

Professional standards

AW works to the standards and guidance provided by the Chartered Institute for Archaeologists. AW fully recognise and endorse the Chartered Institute for Archaeologists' Code of Conduct, Code of Approved Practice for the Regulation of Contractual Arrangements in Field Archaeology and the Standard and Guidance for archaeological building investigation and recording currently in force. All employees of AW, whether corporate members of the Chartered Institute for Archaeologists or not, are expected to adhere to these Codes and Standards during their employment.

Project tracking

The designated AW manager will monitor all projects in order to ensure that agreed targets are met without reduction in quality of service.

14. Arbitration

Disputes or differences arising in relation to this work shall be referred for a decision in accordance with the Rules of the Chartered Institute of Arbitrators' Arbitration Scheme for the Institute for Archaeologists applying at the date of the agreement.

15. References

British Geological Survey:
http://mapapps.bgs.ac.uk/geologyofbritain/home.html accessed 25/09/18

Chartered Institute for Archaeologists, 2014. *Standards and guidance for the collection, compilation, transfer and deposition of archaeological archives*.

Chartered Institute for Archaeologists, 2014. *Standards and guidance for the archaeological investigation and recording of standing buildings or structures*.

Chartered Institute for Archaeologists, 2014. *Standards and Guidance for Historic Environment Desk-based Assessment*.

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