



Internal Briefing Note

Options to Extend Glasgow Subway



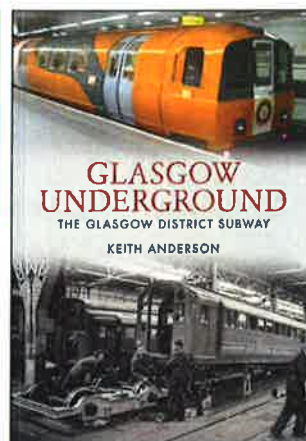
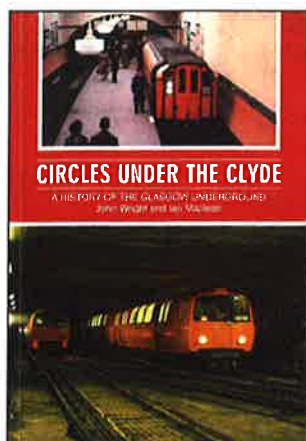
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Purpose and Content of this Briefing Note

The purpose of this paper is to provide a summary for SPT Partnership Board members of the various studies and investigations into extending the Glasgow Subway system since its opening in 1896.

In considering potential options to extend the Subway, it is important to understand the key technical decisions made in the design of the original system. This note therefore firstly provides a brief history of the development of the Subway followed by a description of the key technical issues. The note then provides a summary of the various studies that have examined the feasibility for expanding the Subway. These studies range from 1937 through to the most recent considerations in 2010.

It is also worth highlighting that the various previous studies mentioned in this paper focus mostly on the technical issues with only the latter studies examining the transport "need" or "demand" via a full transport options appraisal methodology. This note should therefore be read with that context in mind.

A Brief History of the Glasgow Subway

The history of the Glasgow Subway has been well documented and in particular "Circles under the Clyde" by John Wright and Ian Maclean and "Glasgow Underground: The Glasgow District Subway" by Keith Anderson (above) both provide a rich and detailed description of the development of the Subway.

The initial evolution of the Subway is intrinsically linked to the growth of Glasgow during the time when it was known as 'second city of the Empire' and saw massive population expansion from 77,000 in 1801 to 760,000 in 1901. This brought a resultant need to improve the city transport infrastructure to support this population.

This growth was happening at the same time as the 'railway boom' across the whole of the UK, and which brought significant private company investment in rail transport in and around Glasgow. However, during these early stages of railways, the lines tended to focus on more medium and longer distance connections. Local public transport was in its infancy and was generally limited to horse drawn omnibuses and Clyde ferries – known as the 'Cluthas' – with the river also acting as a "superhighway" for the transport of goods to and from the city.

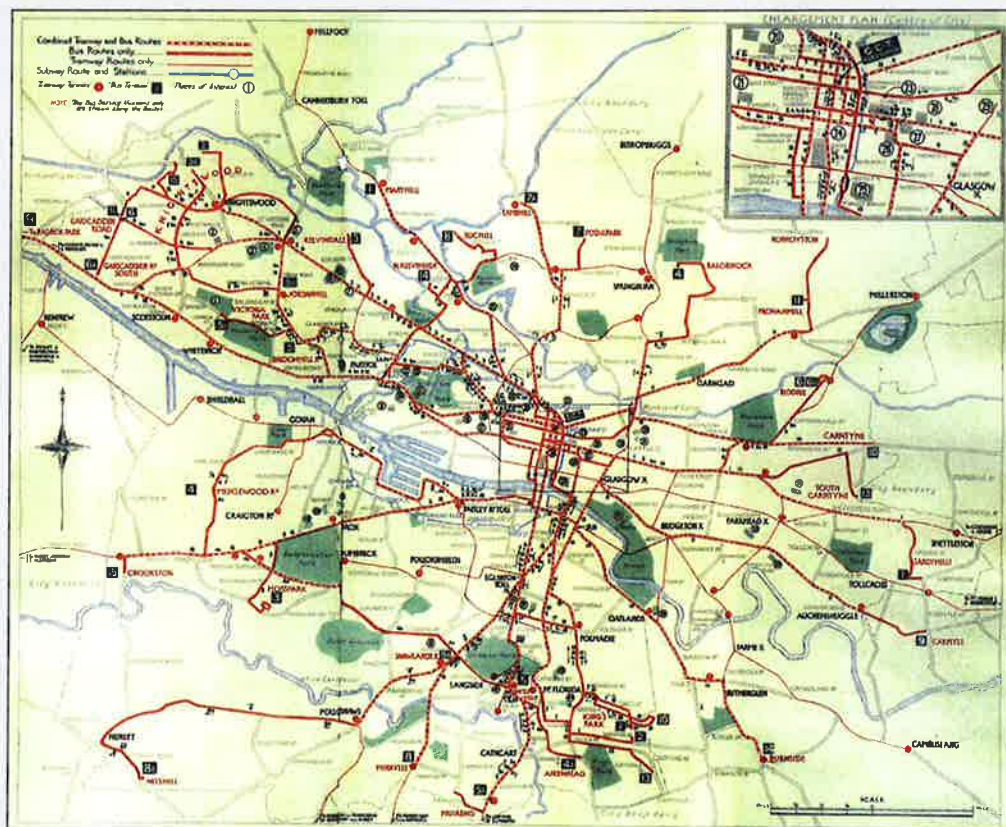
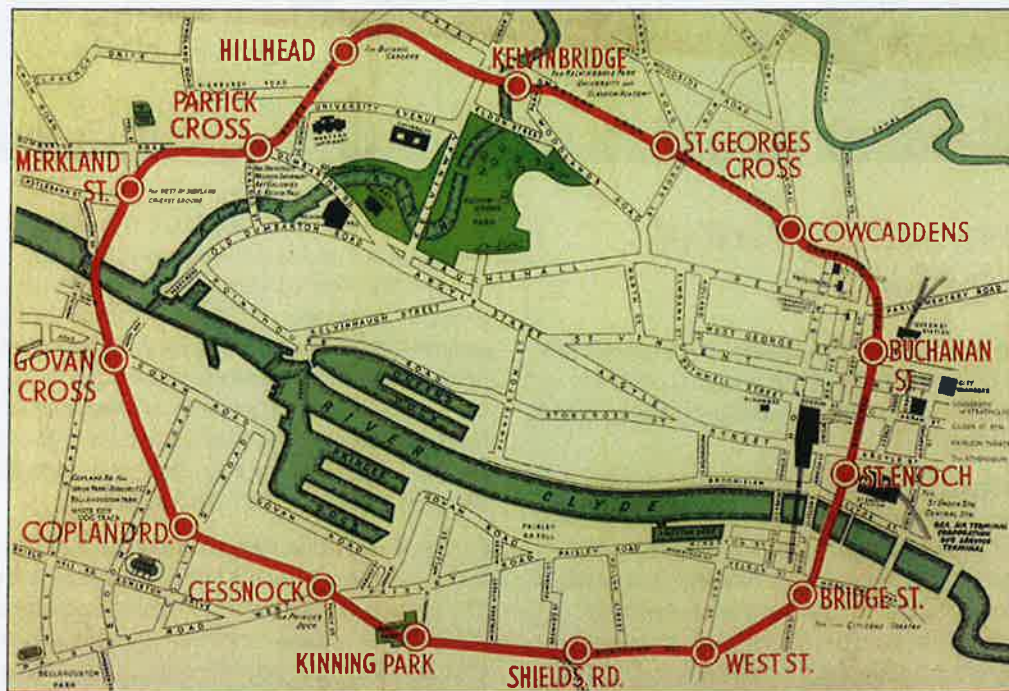
As the city transport system developed, horse drawn tramways emerged in the late 1870s, with the subsequent electrification of the tramway network commencing in 1898. The horse drawn trams were withdrawn in 1902, and the electrified tram system expanded to cover over 160 kilometres with over 1000 vehicles. However, in the late 1880s and prior to the electrification of the tramways, the city was suffering from significant congestion which was also apparent across many other UK cities, no more so than in London.

At that time, London took a new and novel approach to solving the problem by providing an underground Metropolitan railway. This idea ignited a group of civic-minded Glasgow citizens and in 1887 a similar proposal for an underground railway in Glasgow emerged. Following two failed attempts in 1887 and 1888 to bring such a proposal to fruition, the proposals for an underground railway (to be known as the Glasgow District Subway) were finally approved by Parliament and construction began in 1891.

Original route

The Subway was constructed fully underground in a twin tunnel arrangement and opened in 1896 as a cable hauled railway, serving fifteen stations. A plan from that time of the original route and station locations is shown (below).

In developing the original plans, the Glasgow District Subway Company did not consider any further expansion to include some of the other highly populated eastern or northern suburbs, and hence retained a west and south bias. The main mode of public transport for other parts of the city was mainly tramways. A map of the extensive tram network circa 1934 is shown (bottom).





Key Technical Features of the Glasgow Subway

The design of the Subway system had to consider a number of technical aspects such as the type and method of powering the trains, type and dimension of the track, size of tunnels and methods of construction. Of all of these technical aspects, the choice of track gauge and tunnel size are the two most significant factors when considering any extension of the system. This is explained in more detail in the following sections.

Track gauge

The original Subway Act of Parliament envisaged the use of standard track gauge¹, which is 4ft, 8.5 inches (or 1435mm) between each rail. This standard dimension was dictated at the time by the Gauge Act of 1846 which specified that new passenger carrying railways in Britain should all be built to this gauge. This was to allow inter-connectivity and interoperability across different privately owned railways. However, this ruling did not apply to so-called "narrow gauge" or light railways.

Despite the specification of a standard gauge within the original Subway Act, it was later amended to be "no less than 3ft 6 inches" and eventually the company decided to adopt an unusual gauge of 4ft (1.220m). The rationale for this is subject to much debate and there remains no definitive record of the decision making at the time. It has been suggested that the choice of gauge was directly related to the choice of tunnel size of 11ft, discussed in the following section.

¹ Track gauge is the width between each rail and the standard track gauge was set by the Gauge Act of 1846



Tunnel size

The reasoning for the tunnel size of 11ft (3.4m) being chosen is not clear from the various historical records available. It has been suggested that as the first London underground tunnel size was 11ft 6 inches, the Glasgow Subway selected a slightly smaller size for cost and construction reasons leading to the maximum possible track gauge being 4ft. This means the current Glasgow Subway tunnels are too small to fit a standard gauge track.

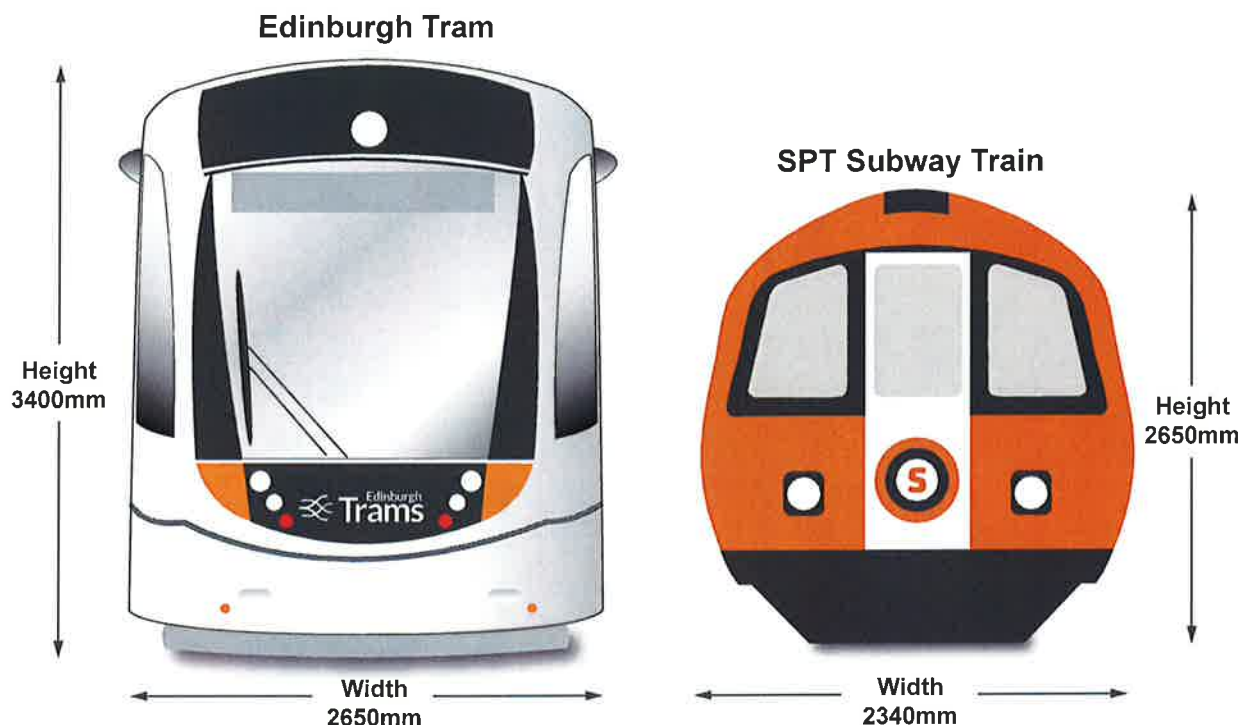
However, it is not only the track gauge that is restricted by the tunnel size but also the trains themselves. The space available within the Glasgow Subway trains is extremely limited, particularly in headroom with the internal height from floor to ceiling being just over 1.9m at the highest point.

Comparison against current standards

The most recent construction in the UK of a new fully underground railway is London Crossrail². Whilst the city of London and volume of passengers is much greater than Glasgow, it is useful to illustrate this new tunnel size against the existing Glasgow Subway tunnels and as can be seen in this illustration (above).

A further point to note is that modern standards for the construction of new underground railways have increased the space required in tunnels to accommodate additional facilities for evacuation (e.g. side walkways) and fire and life safety and security systems (e.g. ventilation and CCTV systems).

² www.crossrail.co.uk/



Rolling stock

In terms of vehicle size, the illustration above usefully highlights the scale of a modern light rail vehicle (in this case, for the Edinburgh Tram) in comparison to a current Subway vehicle.

Key Technical Considerations When Examining Expansion of the Subway System

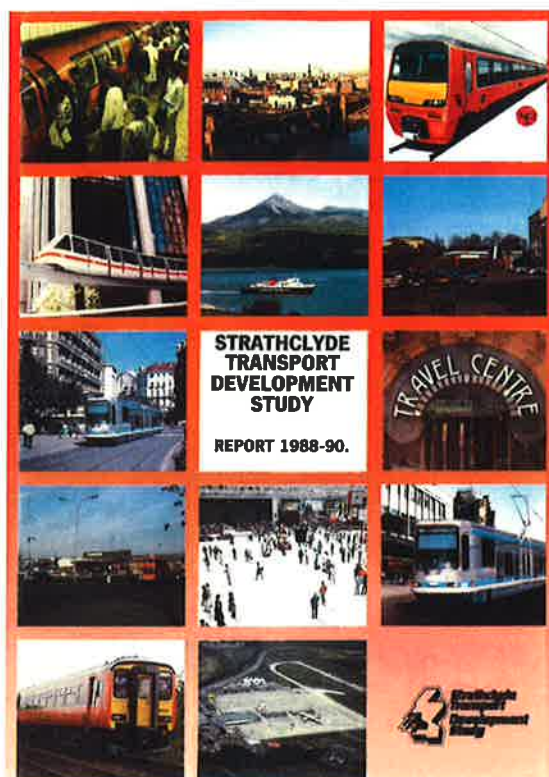
There is no other railway in the UK that operates with the same 4ft gauge as the Glasgow Subway and all new railways and tram systems are designed to use a standard gauge. This is a very significant and critical aspect that needs to be considered when looking at potential expansion of the Subway.

Any new Subway line would require to be built to a standard gauge and tunnel size. This would then leave the challenge that any new line would not be interoperable with the existing Subway, without the entire existing track and tunnel system being completely reconstructed, and the existing system being completely closed for a considerable time to allow such works to take place.

In summary, the track gauge and small tunnel size have been the two key technical considerations when examining options to extend the Subway.

These key technical issues need to be considered within a wider economic and transport assessment (e.g. a STAG³-based approach) when looking at appropriate transport solutions for an area or corridor, particularly where existing heavy rail and bus-based solutions already exist.

³ Scottish Transport Appraisal Guidance (STAG), Transport Scotland's appraisal methodology.
www.transport.gov.scot/our-approach/industry-guidance/scottish-transport-analysis-guide-scot-tag/#42948



Summary of Studies into Extending Glasgow Subway

At various times throughout the Subway's 121 year history, consideration has been given to extending the network across the city. The illustration at Appendix 1 shows these plans.

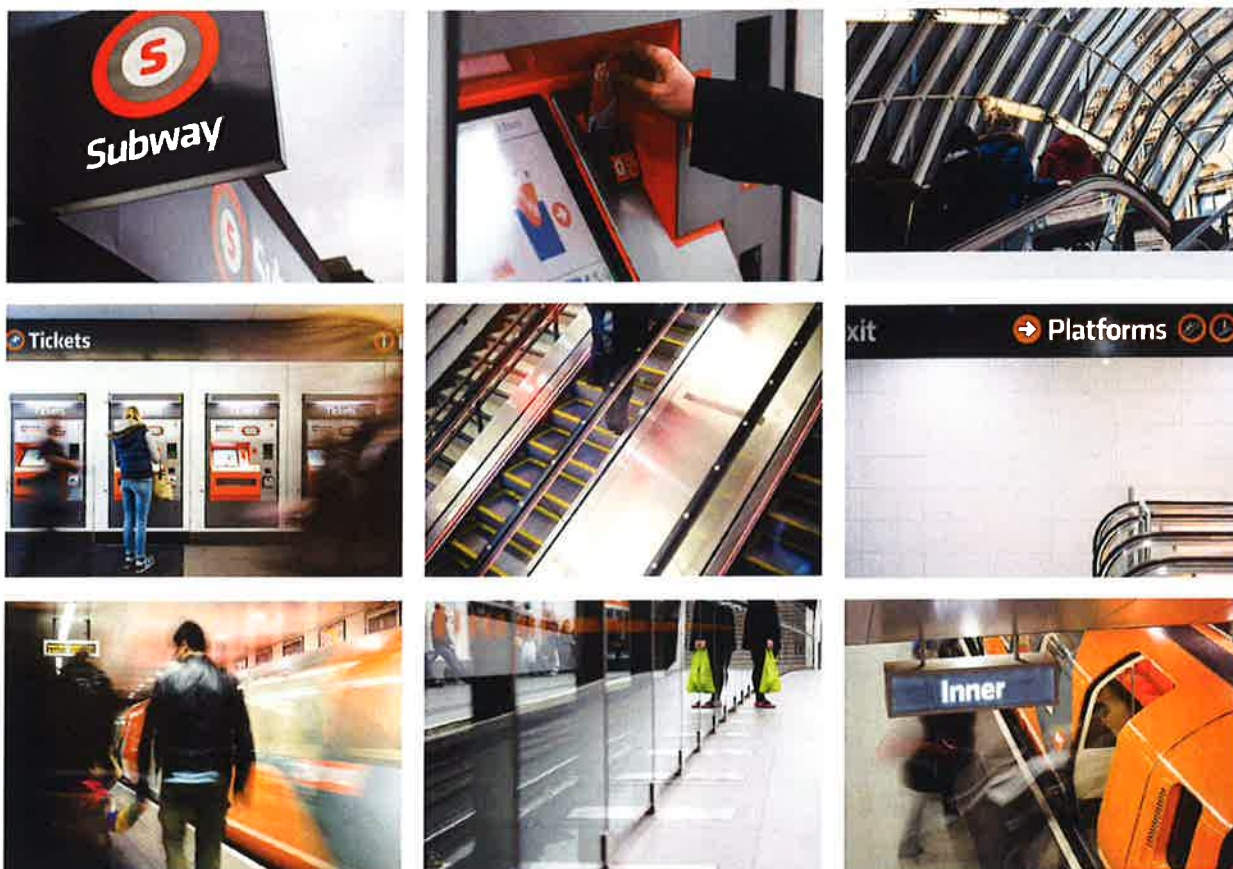
The first record of a proposal to extend the Subway dates back to 1937, some forty years after it opened and just two years after electrification in 1935. Glasgow Corporation, who in 1922 had taken over operation of the Subway from the privately run Glasgow District Subway Company, considered an option to extend the Subway north from Buchanan Street to Robroyston, and south from Bridge Street to King's Park. It is not clear why these proposals were not taken any further, but it has been suggested that the growing concerns of an imminent war and resultant economic viability were almost certainly key factors.

Options for extension were again examined in 1944, this time by way of an 'eastern circle' serving Blochairn, Camtyne and Dalmarnock, then linking back to Bridge Street, St Enoch and Buchanan Street.

However, at this time, the city was beginning to adopt a more pragmatic approach to planning, and had adopted the City Engineer's 1945 "First Planning Report" (known as 'the Bruce Report') in which it acknowledged the important role that transport had for the city.

Building on the Bruce Report, in 1948, a Report on the Future Development of Passenger Transport in Glasgow ('the Fitzpayne Report') was published (above left). This report included several proposals such as electrification of existing rail routes, and new electrified rail routes. The proposal was for these newly electrified rail routes to operate underground in some parts of the city and at surface level in others. The report also went on to set out examples of how buses (or trolley buses) could integrate with the rail network.

Importantly, Fitzpayne also identified the technical constraints of the Subway by virtue of its unique track gauge, narrow tunnel diameters, sharp radii of curves and steep tunnel gradients. Fitzpayne concluded that "it is impracticable for the Subway to be adapted or extended, but that it must be retained as a separate entity offering the possibility of interchanges with the emerging electric rail network".



In 1954, six years after Fitzpayne published his report, further proposals emerged, this time in a report by Sir William Halcrow and Partners ('the Halcrow Report'). Many of the proposals within the Halcrow Report bore similarities to the earlier Fitzpayne Report, however, consideration was given to new proposals to extend the Subway south to Castlemilk, and to the north, by way of an extension from Glasgow Cross through Anderston to an interchange at Partick Cross, then to Kelvindale, Blairdardie and Drumchapel. These routes were to have utilised existing unused rail tunnel infrastructure, and at sections, operate at surface level. While again the exact reasons are unclear, it is thought that funding issues played a key part in these proposals not being taken any further.

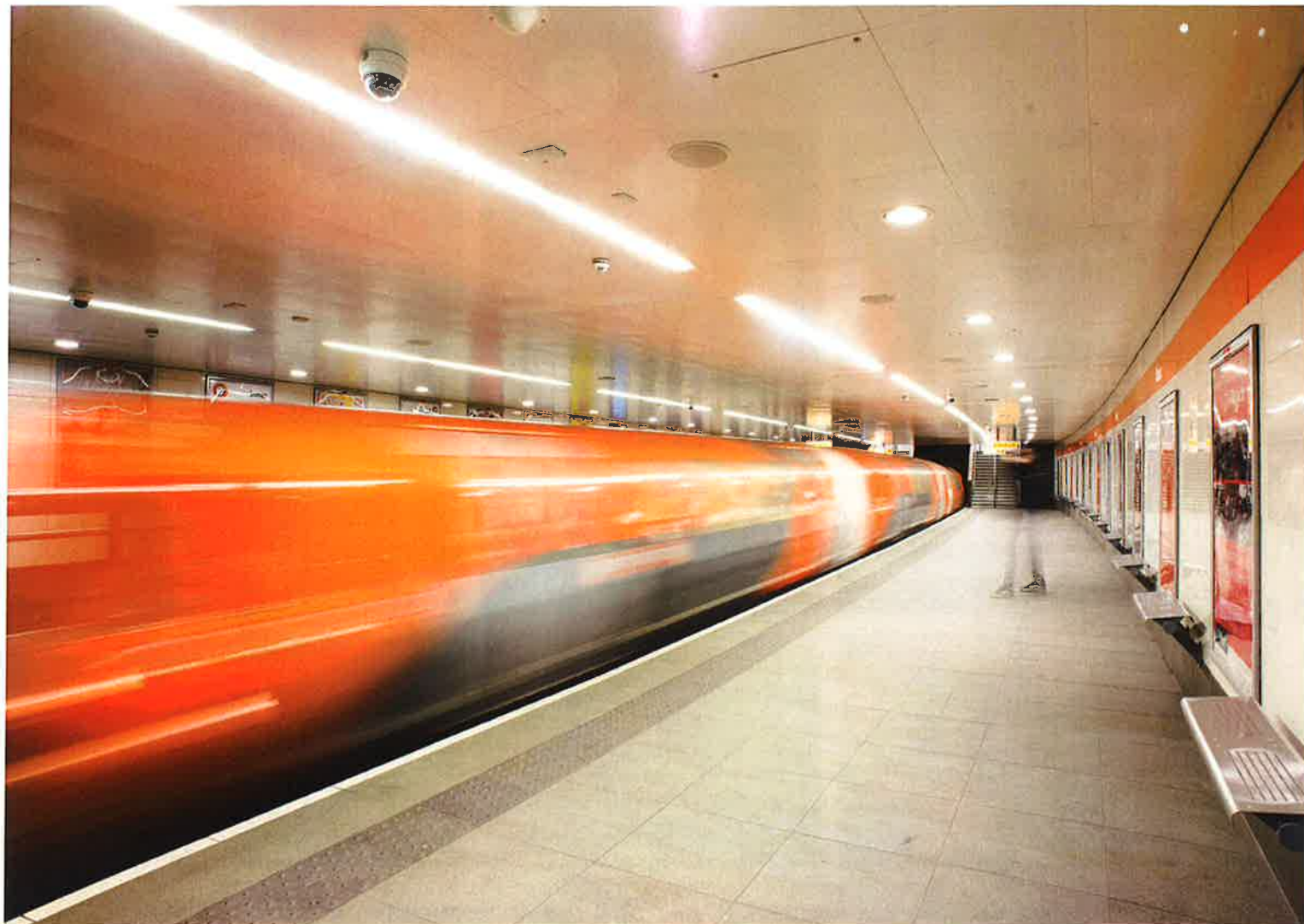
In 1969, Fitzpayne commissioned another study, examining costs to widen the Subway track to standard rail gauge but this was not progressed further. It has been suggested that Glasgow Corporation Transport was suffering financial losses at the time and is therefore likely that costs were the decisive factor in this instance.

Between 1969 and 1971, several studies, including the Greater Glasgow Transportation Study, looked further at options for the Subway. These studies considered various ideas ranging from a minor 'facelift' to a fully modernised Subway network. Consideration was even given to closing the system completely. None of these options included proposals to extend the Subway. The resulting conclusions recommended modernisation of the existing system.

With the recommendations from these reports put before Greater Glasgow Passenger Transport Executive (GGPTE), who by now had taken over transport functions from Glasgow Corporation Transport, proposals were developed to fully modernise the Subway. Following GGPTE's successful application in 1974 to the Scottish Office for funding support, the modernisation project got underway in 1977 and saw the Subway close for the next 3 years. The system reopened on 16 April 1980 and with its new iconic rolling stock, became fondly referred to as Glasgow's 'Clockwork Orange'.

By 1988, GGPTE had been replaced by Strathclyde Passenger Transport Executive (SPTPE) who subsequently commissioned the Strathclyde Transport Development Study. The outputs of this study were intended to form the basis of public transport investment decisions into the 1990s. As part of this work, the study again looked at potential options for expansion of the Subway, including potential routes to Summerston via Maryhill, to Glasgow Airport, and a loop serving the eastern part of the City Centre. However, the study concluded that for operational and economic reasons, further investigation of extending the Subway was unwarranted.

⁴ A Report on the Future Development of Passenger Transport in Glasgow, E.R.L Fitzpayne 1948 [Page 13].



Most recently, between 2007 and 2010, and with the Subway having reached 30 years since its last full modernisation, many elements of the system were becoming 'life-expired' and would need to be replaced or refurbished. With this in mind, SPT commissioned a scoping study of potential options for the future of the Subway, the 'Long Term Strategy for the Subway'. As with many previous studies, this commission was again tasked with considering possible extension options.

The potential options for expansion identified were:

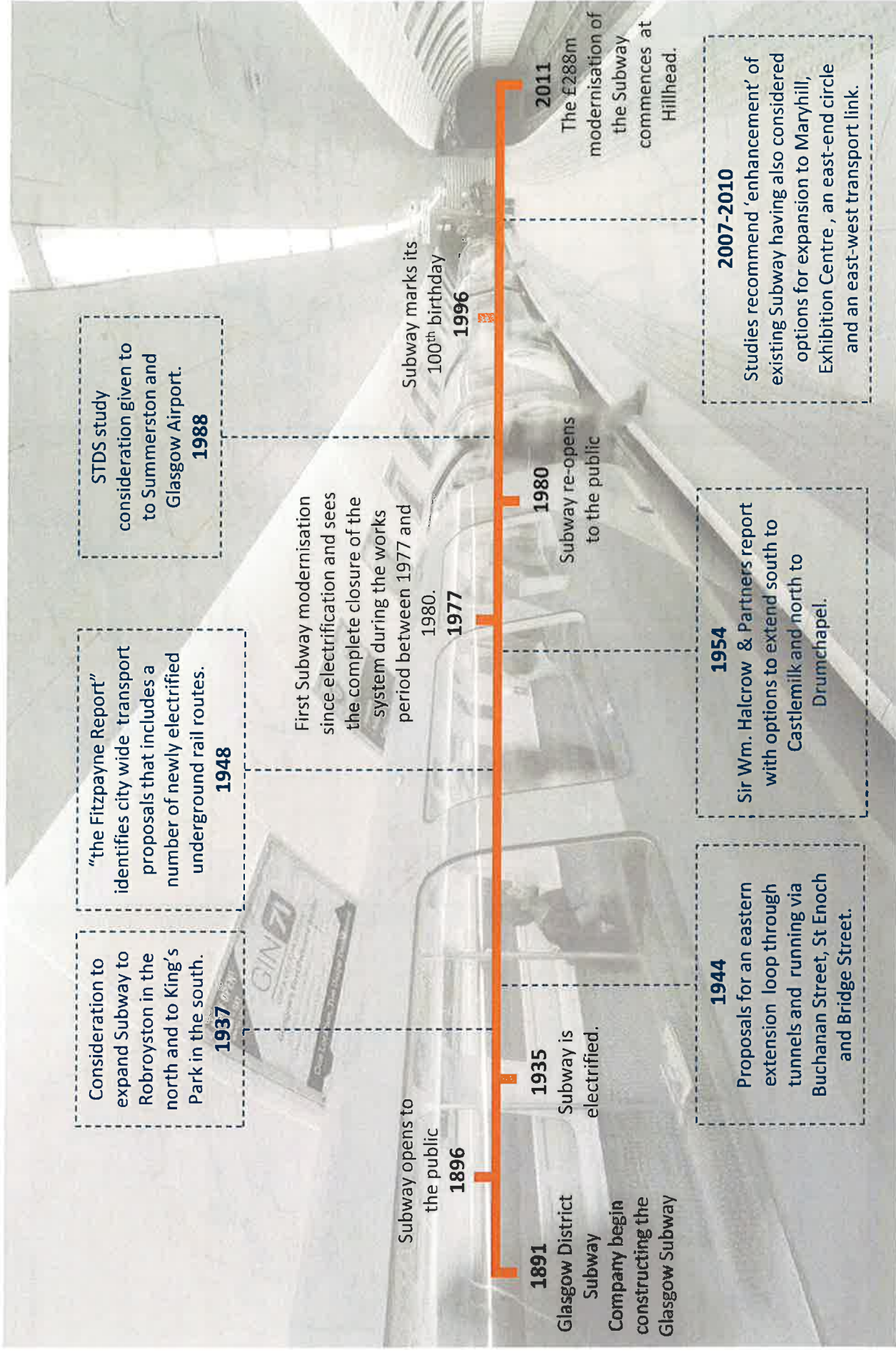
- A route from Exhibition Centre to Maryhill using existing tunnel infrastructure;
- A route to Cathcart using part of the existing suburban rail network; and,
- A loop through the east end of Glasgow interchanging with the existing Subway at Bridge Street, St Enoch and Buchanan Street and then running through 'St. Mungo's', 'Onslow', 'Duke Street' (interchange with the Springburn rail line), 'Celtic Park', 'Dalmarnock' (interchange with the Argyle rail line), 'Newhall', 'Gorbals' and back to Bridge Street.

However, these options would, depending on scale and combination of options, involve capital costs as high as £5.5billion for a single route extension and up to £10billion⁵ for an entire network including rebuilding the existing system to standard gauge and tunnel size. These preliminary engineering cost estimates assumed that the Subway be enhanced with full size tunnels and standard track gauge. Further work concluded that alternative transport options including, for example bus rapid transit, represented a more appropriate and affordable transport solution at that time.

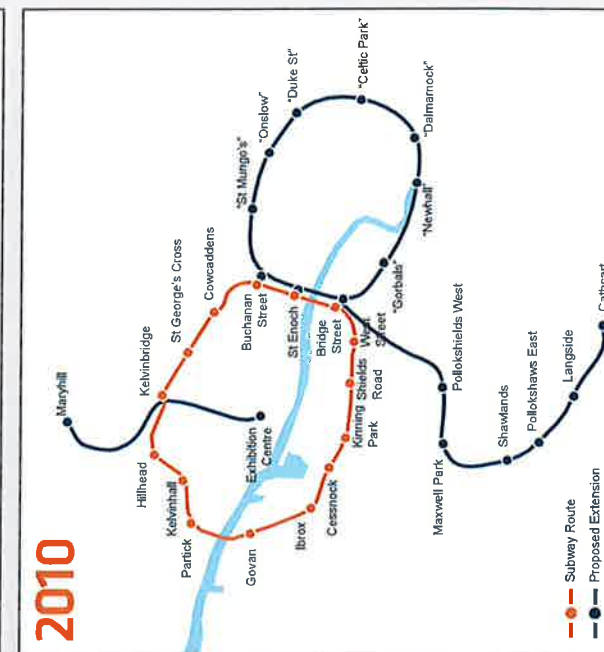
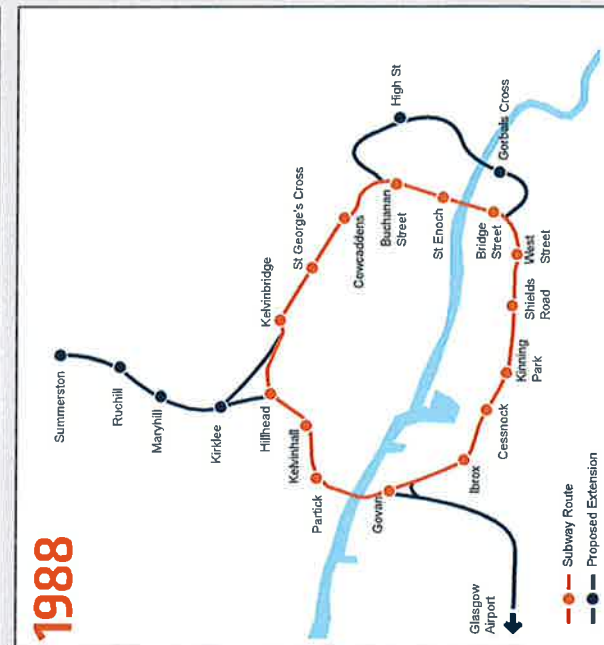
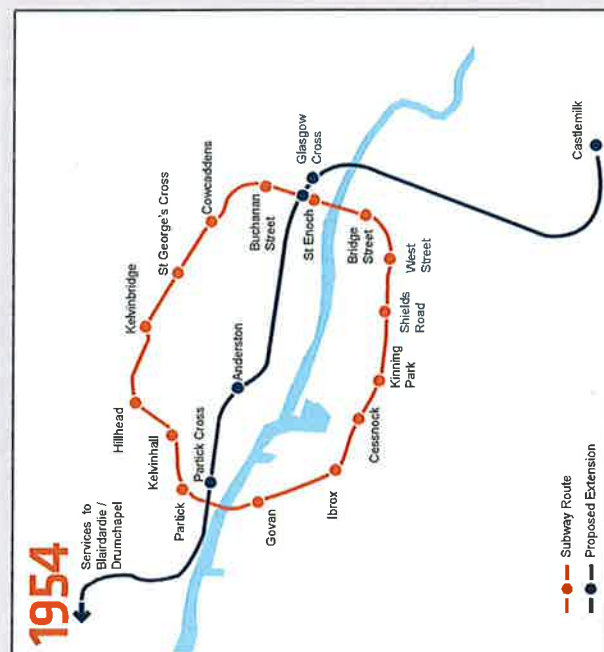
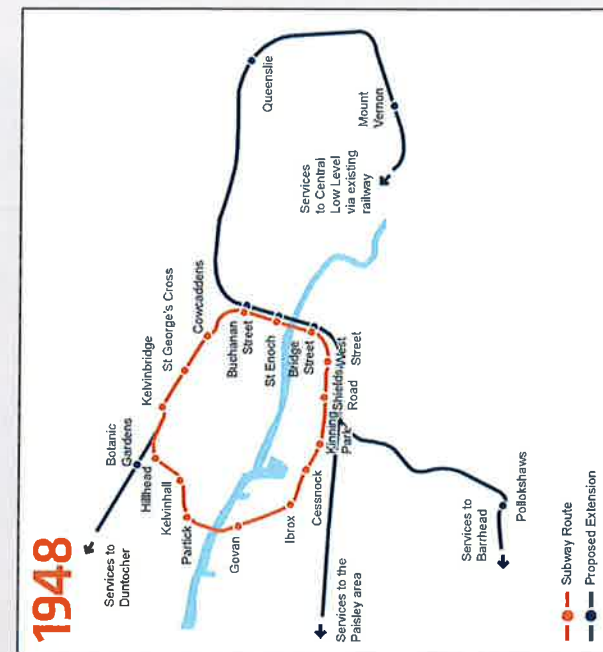
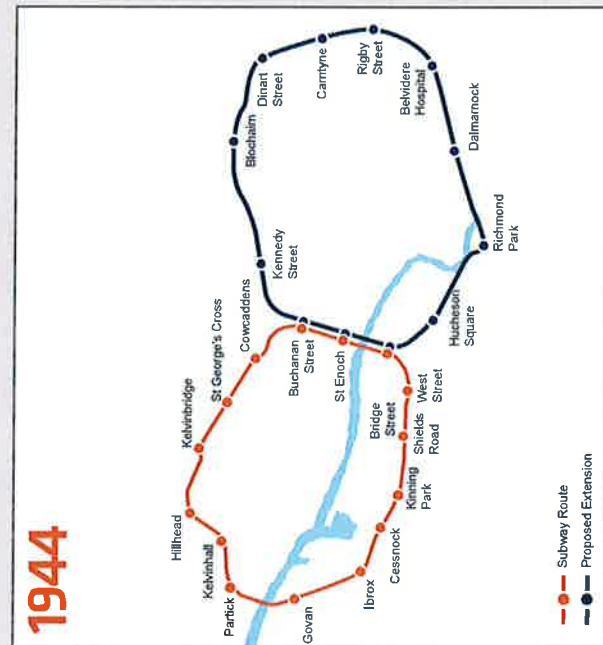
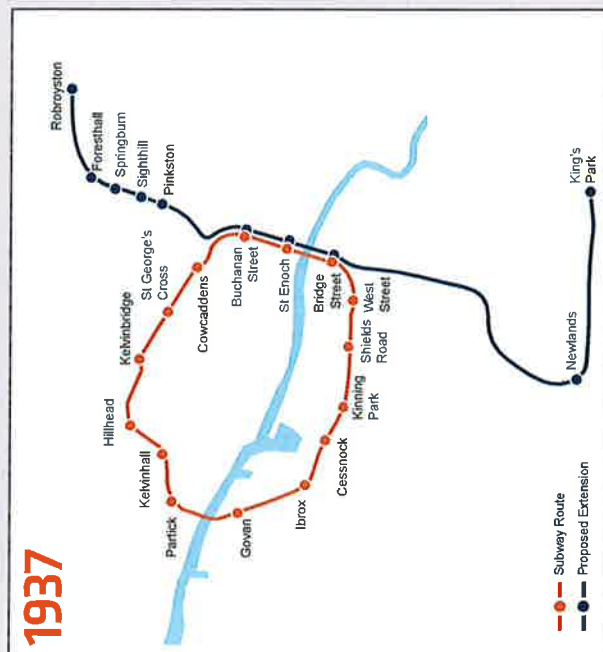
In 2011, SPT's Subway Modernisation Business Case received funding support from the Scottish Government and by the end of that year, Subway modernisation works got underway beginning at Hillhead station. The £288m modernisation programme, still currently in progress, includes smart ticketing, station refurbishments, infrastructure asset renewal (including tunnel refurbishment), a fleet of new driverless trains with a new control centre and fully automated signalling system.

⁵ Atkins (Feb 2007), 'Long Term Strategy for the Subway'; Chapter 8 – Technical Options for Appraisals (figures include prices adjusted for inflation and optimism bias).

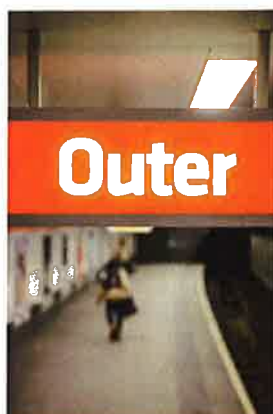
Appendix 1 – Timeline of Previously Considered Subway Extension Proposals.



Appendix 1 - Previously Considered Subway Extension Proposals



Note: In cases where route plans were unavailable, route and station diagrams have been drawn based on available historical descriptions and may differ from original plans. (Plans not to scale).



For further information on the current **Subway Modernisation programme**, please visit spt.co.uk/subwaymod

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