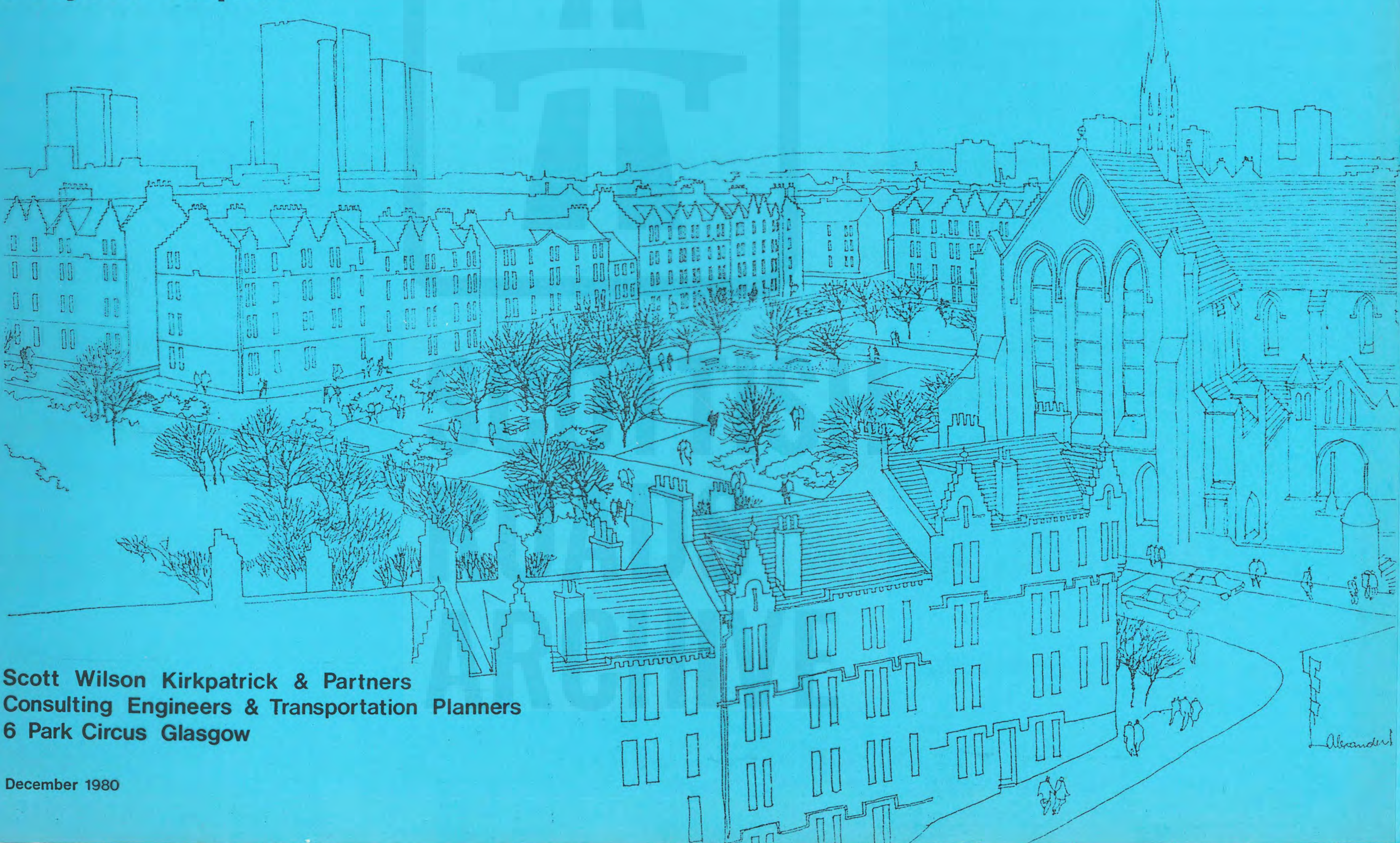
TOWNHEAD TO LONDON ROAD - LINK

Project Report



Scott Wilson Kirkpatrick & Partners
Consulting Engineers & Transportation Planners
6 Park Circus Glasgow

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1. INTRODUCTION

1.1 Terms of Reference

Scott Wilson Kirkpatrick & Partners were requested by the Director of Roads to prepare this project report on the Townhead to London Road Link in order that a justification statement could be presented to Strathclyde Regional Council. We were specifically requested to carry out an economic benefit assessment for this project independent of any other future road proposals.

1.2 History

Proposals to improve the congestion in the Townhead area were first examined by SWK in "A Highway Plan for Glasgow" published in 1965.

Growing public concern about the adverse environmental effects of the Ring Road scheme led to a detailed study of alternative proposals to downgrade the route.

The project proposals contained in this report minimise the environmental impact on the area, while achieving traffic relief to this congested area of the City.

2. TRAFFIC

2.1 Introduction

With the completion of the M8/M73/M74 route in mid-1980, a significant increase in traffic volumes was observed on the North Flank of the Inner Ring Road. This increased traffic load subsequently resulted in congestion and delays for motorway traffic, and a certain degree of shedding onto the surface street network occurred.

A 'critical screenline' for study was selected to the south and west of Townhead Interchange. This screenline cuts all the main distributor roads for the Monkland section of the M8, the North Flank of the Ring Road and Springburn Road. As no alternative surface street distributors are available across the screenline which might alleviate future congestion, this screenline best identified the need for the provision of a new route such as Townhead-London Road Link Road.

A further consideration is the difference in capacity and hence traffic volumes which will cross the screenline with the completion of Townhead Interchange. The so-called 'base network' to be studied has therefore included this final stage of construction. The 'design network' represents the inclusion of Townhead-London Road Link on the base network or TPP 83 base, as it is known.

2.2 Existing Traffic Conditions

As stated, the base network to which present day traffic should be assigned for calibration purposes includes the final stage of Townhead Interchange and until this scheme is completed and integrated into the network it will be necessary to make use of present day assignments to the base network as opposed to counts. The hourly variation in flow crossing the screenline has been assumed consistent from scheme to scheme and was derived from count data obtained 1977/78.

Fig 2.1A illustrates the hourly variation in flow across the critical screenline for 1980 traffic on the base network, and Fig 2.1B illustrates similar conditions on the base network prior to the opening of the M8 through to Baillieston. Referring to the Practical Capacity on the Townhead Screenline, it can be seen that traffic flows prior to the opening of the M8 only just reached capacity during the AM peak while after the M8 through route was opened traffic volumes exceeded screenline capacity for 3 hours of the day. The subsequent congestion and delays which would be expected on the motorway have indeed materialised and ADT counts obtained in the summer,1980 (104,000) suggest that spreading of the peak periods due to delays and shedding of motorway traffic onto surface streets has occurred.

2.3 Screenline Capacity

As the CHS traffic model excludes all scheduled bus services, surface street route capacities have been downgraded accordingly to reflect the component of flow exclusive of buses. Two categories of capacity have been defined:

a) Practical Capacity

This is the theoretical flow which a route may accommodate without excessive congestion and delays occurring. For the case of motorways, this figure is a function of free flow capacity, weaving and gradients, while surface street capacity is a function of traffic signal phasing and junction geometry.

b) Tolerable Capacity

This figure is determined by considering practical route capacity in the context of environmental and pedestrian demands. In many instances Tolerable Capacity is synonymous with present day flows.

The capacity of the critical screenline has been considered in total for the purposes of the traffic appraisal.

2.4 Future Traffic Flows

In keeping with the recommendations of SH7/80, the appraisal of design schemes has been based on both upper and lower bound forecasts for traffic growth. Furthermore, the critical screenline has been examined in the year 2000, this being 15 years after the earliest date of scheme completion, in order that an adequate level of service may be provided by the proposed route.

Using growth factors based on vehicle kilometres, a series of histograms illustrating the hourly variations in traffic flow across the Townhead Screenline were constructed. The hourly variation pattern is consistent with 1977/78 conditions, while the upper and lower bound factors are equivalent to those recommended in SH7/80 Table 1:

Upper Bound 1978 - 2000	59% increase for all vehicles
Lower Bound 1978 - 2000	25% increase for all vehicles

Three networks have been examined for 2000 traffic:

TPP 83 Base Network Unrestrained	Fig 2.2
TPP 83 Base Network Restrained	Fig 2.3
Design Network	Fig 2.4
(TPP 83 + Townhead-London Road Link)	

2.5 Traffic Appraisal

Traffic assignments to the unrestrained base network for the year 2000 indicate that flows would exceed Tolerable Capacity throughout the 10 hour period and Practical Capacity for the majority of that period, Fig 2.2. The resulting congestion and delays developing on the motorway will, in turn, lead to traffic build-up on the surface streets and thus considerable disbenefits to all road users, including commercial vehicles, during such periods. The net effect of these delays has been illustrated on Fig 2.3 which represents traffic loading in the year 2000 on the restrained base network. It will be seen that traffic crossing the critical screenline still exceeded the corresponding values of Practical Capacity for a minimum of 3 hours and Tolerable Capacity for a period not less than 4 hours.

As any reasonable restraints imposed in the base network appeared to be unable to produce a viable network crossing the critical Townhead Screenline, a solution was sought in the form of a traffic assignment to the design (Townhead-London Road Link) network. The resulting traffic volumes required a certain degree of restraint on the North Flank and the final assigned volumes are shown in relation to the improved screenline capacities on Fig 2.4. It is apparent that the design network should provide sufficient capacity to cater for traffic volumes up to the year 2000, with the exception of a 5% overload (some 1,200 vehicles) during the AM peak period. This 'overload' should be acceptable by normal traffic engineering standards and is likely to occur only if higher bound growth occurs up to 2000.

2.6 Public Transport

The design scheme will result in considerable improvements to bus travel times in the study area. In particular, the provision of 'Bus Only' routes from Ingram Street to Clydeside will result in a significant time savings to passengers and operators.

We estimate the total travel time savings between Clyde Street and Royston Road will be in the region of 3½ minutes northbound and 2½ minutes southbound.

An economic benefit has been attributed to these time savings and is presented in Section 4 of this report.

3. HIGHWAY PLANNING STUDIES

3.1 Road Capacity

While Section 2 of this report has related future traffic predictions in the year 1990, it must be assumed that the road link now proposed cannot be completed until 1985 at the earliest. On the basis of present Government practice (ref SDD Tech Memo SH7/80), a design year some 15 years after opening, namely the year 2000, must be considered.

Projecting the 1990 traffic flow on the Link of 48,000 vpd to the year 2000 results in a probable flow of 53,000 vpd, assuming a lower-bound traffic growth rate. This projected flow, along with the operational characteristics on the Link, indicates in our view that provision should be made for dual 3-lanes. The operational requirements in this section are:

a) The need to provide suitable lane balance with Townhead Interchange. A major 4-lane merge reducing to 3 lanes occurs on the southbound carriageway.

b) The northbound carriageway is on a sustained gradient of 5%.

c) Provision for traffic weaving on the northbound lanes.

In addition, due to the constraints in the Tunnel section, it would be extremely difficult to increase the capacity of the Link at a future date.

3.2 Proposed Road Alignment

The proposed Link Road alignment takes account of the various property constraints shown on Report Drawing No 1. In addition, the new route takes cognisance of the major district distributer routes and railway lines crossing the proposed Link. It is proposed that the new road passes in tunnel (constructed in cut and cover) under Cathedral Street and High Street before rising to cross existing and realigned Duke Street. It is not possible within the 80 kph (50 mph) design standards to maintain full vertical clearance at Duke Street, making it necessary to realign the road. A vertical clearance, however, of 3 m is provided at Duke Street to allow for maintenance of existing services. The new link crosses over the electrified railway east of High Street Station before passing under the existing railway bridge at Bell Street. It will be necessary to lower the existing road at this point by 0.33 m (1 ft) to attain the full 5.2 m clearance. A direct connection from the new link is provided to the Central Area via, initially, a one-way pair at Ingram Street and College Street. An ultimate two-way connection at Ingram Street (ref Report Drawing No 5) could in the long term be provided when the Fire Station is relocated, thereby dispensing with the College Street link.

The proposed road layout at College Interchange has been designed to take cognisance of the possible St John's Rail Link. Although the design profiles for this scheme do not cater for the Rail Link the vertical alignment could be altered at some later date to satisfy any future rail proposals.

3.3 Environmental Considerations

With the adoption of a tunnel solution from Townhead to just north of Duke Street, it is possible in our view to achieve the proposed road link with virtually no environmental dis-benefits to this historical part of the City. Furthermore, with the establishment of the new interchange within the precincts of College/High Street Goods Stations, it would be possible to introduce a complete frontage development along High Street, thereby creating a suitable screen between the existing buildings and the interchange.

With the construction of the new Link Road, it will be possible to close Glasgow Cross to through traffic (except buses and service vehicles) which in our view will add considerably to the environmental improvements already taking place in this area.

3.4 Geometric Standards

The new road proposals have been designed to meet the requirements laid down in "Roads in Urban Areas" amended by the latest Scottish Development Department Circulars and Memoranda. Table 1 shows the alignment standards.

It is not proposed to provide a hard shoulder on the main carriageway; however, the provision of a shoulder is proposed on all single lane slip ramps.

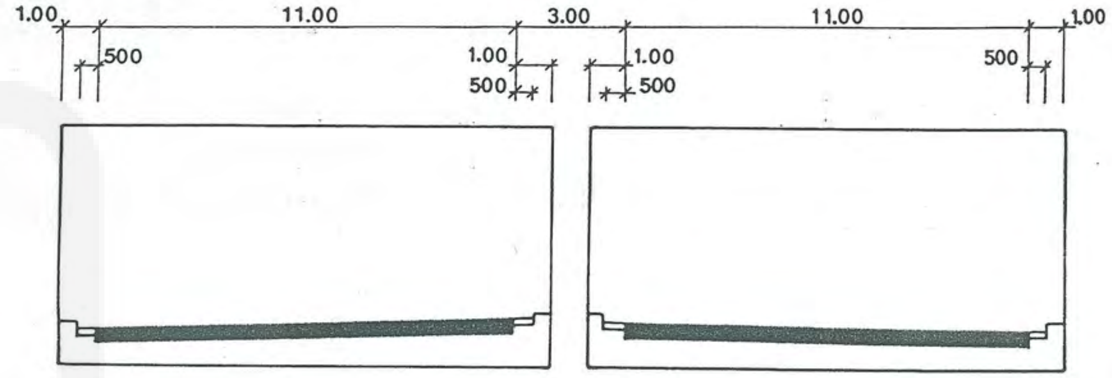
TABLE 1

		Link Road	Slip Roads*
Design Speed		80 km/hour	60 km/hour
Radius	Desirable	400 m	150 m
	Minimum	230 m	130 m
Maximum Gradient		5%	6%
Minimum Sight Distance		140 m	90 m
Minimum Vertical Curve (K Value)	Crest	25	10
	Sag	25	6
Maximum Superelevation		7%	7%

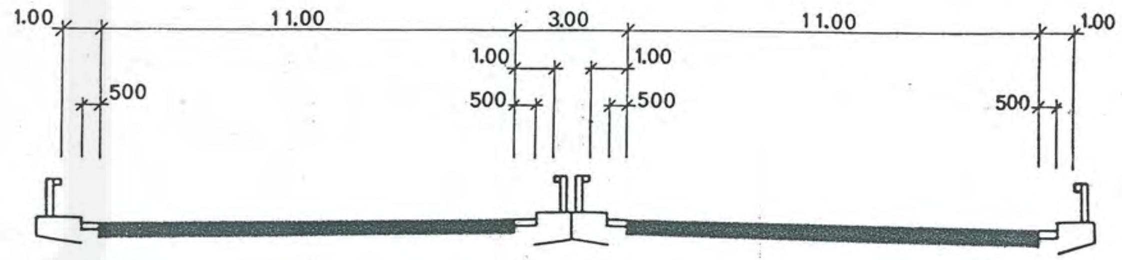
Note: 'K' is the length of curve required to effect a 1% change in gradient.

*Loop slip ramps have been designed to satisfy a speed of 30 km/hour with a minimum radius of 30 m.

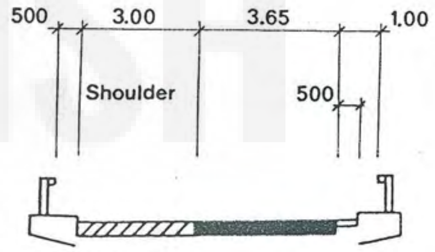
Typical Cross-sections



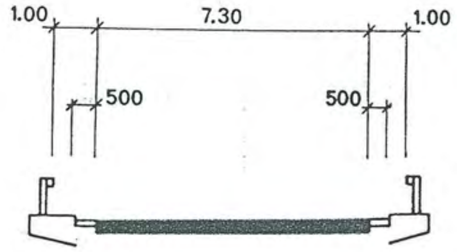
Cut & Cover Section



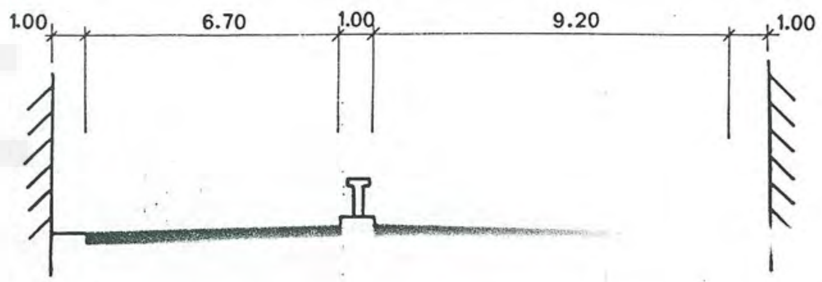
Dual 3



One Lane Slip Road



Two Lane Slip Road



Bell Street Bridge

3.5 Geology and Soils Appraisal

The River Clyde alluvial plain of silty sands continues up as far as College Goods Station, to be replaced by raised beach deposits of silts and silty clays. These overlie the Millstone Grit series of rocks. The area is cut by an east-west fault which downthrows to the north.

To the west of High Street Goods Station, an intrusion of teschenite occurs beneath the superficial deposits. The rock is closely similar in petrological character to that of the adjacent Necropolis hill.

Between Duke Street and Rottenrow, the area is cut by an east-west fault line, downthrown to the south. The teschenite intrusion is replaced by the Upper Limestone Group of rocks. This area also marks the boundary between the raised beach clays and the glacial boulder clays. These boulder clays continue northwards to the existing North Flank and overlie the Upper Limestone Group of rocks.

From historical borehole data south of Cathedral Street a preliminary appraisal has been made of the soil conditions along the route. Rock level would appear to follow closely the proposed road formation from Townhead to the south portal of the Tunnel. South of Duke Street no borehole data exists within High Street Goods Station but from data within College Goods Yard the rock level varies between -4.0 m OD at the east side to -28.0 m OD on the west side, the whole area being as previously stated overlain by silty sands.

3.6 Drainage and Services

It is not envisaged that these proposals will increase the existing surface water run-off in the area and it is presumed that the present system can be utilised.

From preliminary examination of the main service routes, it would appear that the only major service diversions that require to be carried out are at the High Street crossing. In addition, the existing 3 ft diameter sewer in High Street will require to be diverted north towards Rottenrow. Proposals to divert the 36 in water main that runs north along Glebe Street are under review within the present construction contract at Townhead.

3.7 Structural Considerations

A. Tunnel Section

(i) Extent of Cut and Cover Tunnel

The section in tunnel extends from just north of Duke Street for 300 m, passing under High Street and Cathedral Street.

(ii) Ground Conditions

Historical borehole records indicate the presence of firm sandstone at a level approximately 2 m below that of the carriageway profile for the northern half of the tunnel, with the rockhead encroaching above the profile to a maximum of about 2 m for the southern half. Stiff boulder clay overlies the sandstone, with sandy gravel and fill material near ground level. The records show that groundwater is not present within the depth of the tunnel section. (Fig 3.1)

(iii) Method of Construction

The preferred method, in our view, ensures that the effects of construction noise and vibration on adjacent property are kept to a minimum. Diaphragm walling and sheet-pile alternatives were considered unsuitable due to the nature of the ground conditions.

The outer and inner walls of the tunnel would be 1 m diameter contiguous bored piles socketed into rock, thereby preventing lateral movement at the base, and the roof a reinforced concrete slab cast integrally with the tops of the piles.

During the first stage of construction, original ground would be excavated to a level corresponding to the underside of the roof. The piles comprising the walls would be bored and concreted into rock to the correct level. (Fig 3.2)

The roof slab would be constructed in the second stage and then material beneath the slab would be excavated to formation level. Towards the southern end of the tunnel about 5,000 m^3 of rock would require to be excavated. (Fig 3.3)

Elevating the roof over part of the tunnel, bringing it closer to original ground level, would reduce the imposed loading and lead to an economical solution. In addition, it would provide a vertical face for the location of overhead gantry signs on both carriageways and form a level area of ground opposite the Barony Church. Finished ground level would generally be lowered over the length of the tunnel, necessitating the closure of Rottenrow and McLeod Street.

After backfilling to the proposed ground level, the finishes would be applied to the interior of the tunnel. (Fig 3.4)

(iv) Construction beneath High Street

Two problems arise in connection with this section of the works; firstly, the requirement to divert the services which at present run the length of High Street, and secondly, the need to maintain traffic flow whilst construction is in progress.

The services of greatest concern are a 2 ft water main on the south side of High Street and a 3 ft sewer which runs along the centre of the road. Other services to be diverted would include gas, electricity and telephone ducts. The sequence of construction in this area would be as follows:

The bored piles forming the tunnel walls are constructed as close as possible to High Street. Services under the south footpath are then diverted southwards over the tunnel roof and those under the north footpath, together with the 3 ft sewer, diverted northwards. (Fig 3.5) The SSEB sub-station, at present sitting above the line of the tunnel, would be resited along the new line of ducts.

The remainder of the tunnel may now be constructed in two halves, with High Street traffic diverted as shown in Fig 3.6.

(v) Ventilation and Fire

Natural ventilation has been used by some countries in tunnels of up to 1,000 m in length which have free-flow traffic conditions. Tunnels not having free-flow conditions normally require artificial ventilation upwards of 400 m long. Due to the anticipated traffic flow through the tunnel, and because the carriageways are unidirectional, it would be sufficiently well ventilated without the need for booster fans.

Owing to the relatively short length of the tunnel, it is expected that even in the event of a large petrol fire tunnel users would be able to leave in safety by either portal. Tests have shown that in fires of short duration the effects on the structure are negligible. It is anticipated that the Police Department monitoring by means of closed circuit television would be effective in controlling an event of this nature, as witnessed recently on the North Flank of the Ring Road.

(vi) Development on Tunnel Roof

The basic cost of the tunnel allows for nominal dead and live loadings on the roof. Two additional schemes have been examined, both of which involve building development over the line of the tunnel.

A scheme which allows for the construction of 4-storey property adjacent to the portals at High Street and Cathedral Street would be expected to add an additional 2.5% to the basic cost. Further, a scheme which allows for similar development over the entire length of the tunnel would add an additional 5% to the basic cost.

As the bored piles carrying the tunnel roof and building loading are fixed into the rockhead, and as the carriageways are independent of the structure itself, the effects of vibration on these buildings are expected to be minimal.

Consideration should be given to promoting the development of 4-storey property adjacent to the portals. The small additional structural on cost of 2.5% will give, in our view, substantial environmental benefits by way of creating an effective visual screen and noise baffle.

B. College Interchange

Five bridges would be required in the area of High Street Station and College Goods Yard, carrying the main line over realigned Duke Street, carrying Ramp C over the main line, and carrying Ramps A, B and J over the railway.

The requirements of British Rail are such that precast beams would provide the simplest solution to the railway crossings. The bridges carrying Ramps B and J would be single spans of about 25 m, with Ramp A a double span, each of about 17 m.

The road geometry and site conditions are such that a similar section would be most suitable for the remaining two bridges. Both would be twin-span structures, each of 15 m for Ramp C Bridge and 25 m for Duke Street Bridge.

The choice of substructure depends on information from the available borehole information, and the proximity to British Rail tracks. It would appear that spread footings are the most economical and desirable, obviating the need for piled foundations, the construction of which is likely to be restricted.

3.8 Road Signing

With the downgrading of the route, any road signing proposals are on the whole straightforward. As the structural design of the tunnel section requires excess height clearance, it is possible to accommodate advance direction overhead signs within the tunnel. This is particularly important on the southbound carriageway approaching College Interchange. It is presumed that the present SRC-CITRAC system would be incorporated in any signing proposals.

3.9 Cost Estimate (at November 1980 Prices)

(i)	Roadworks			£ 2,131,800
(ii)	Earthworks			618,800
		Total Fill	81,800 m^3	
		Total Cut	118,700 m^3	
(iii)	Services			500,000
(iv)	Structures			
		Bridges	£1,293,600	
		Tunnel	3,165,200	4,458,800
				£ 7,709,400
	Add 15% Preliminaries & Dayworks			1,156,400
				£ 8,865,800
	Add 10% Fees & Supervision Costs			886,600
				£ 9,752,400
	Acquisition Cost			3,450,000
		TOTAL		£13,202,400

4. JUSTIFICATION AND BENEFIT ASSESSMENT

4.1 Introduction

Having decided upon the Design Scheme to be investigated, a series of assignments of 1990 traffic onto both the Design and Base (do nothing) networks was made, Runs Nos 3-74 and 3-72 respectively. These unrestrained assignments represented the desired trip pattern on networks with capacities as calculated in 1977.

However, examination of certain routes indicated that during peak periods of the day such trip patterns would result in a grossly overloaded network in various middle and central areas, in particular on Castle Street (Townhead Stage 3 form) on the base network.

Accordingly, restraints were applied to reduce the attractiveness of these overloaded routes until a flow close to the 'Practical Capacity' of each of the links was achieved.

As the Design Network with Townhead to London Road Link Road offered a relatively low impedance alternative to the congested Castle Street route on the Base network, a correspondingly increased series of benefits accrued from the peak periods of the day.

The 'Critical Capacity Screenline' around Townhead Interchange was considered as best demonstrating the reduction in congestion on surface streets resulting from the construction of the Link to London Road.

The reduction in surface street traffic has the immediate benefit of improving the environmental standard of the adjacent housing and hospital areas while accessibility to a motorway route will obviously improve the industrial valuation of nearby areas awaiting development.

Finally, reduction in congestion will also effectively reduce bus journey times and an evaluation has been made of these savings.

4.2 Data Collected

(i) 12 Hour Classified Counts

12 hour classified counts were implemented on both Castle Street north of Stirling Road and George Street west of Albion Street.

The hourly variation of traffic at both these locations can be studied on Figs 4.1 and 4.2. Although directional peaking on Castle Street is evident, it will be observed that when the flows are aggregated the level is reasonably constant throughout the entire study period with only a PM peak pronounced. This was in fact consistent with observations which indicated that at present Castle Street is operating at or above capacity during most of the day.

Using daily expansion factors (Traffic Flow Characteristics, Strath-Clyde Regional Council, Department of Roads), the ADT flows were determined for both these routes.

(ii) Journey Time Surveys

A number of timed runs were carried out during both peak and off peak periods with the primary routes of interest being:

Route 1 Clydeside to Royston Road along High Street,
Route 2 Cathedral Street to Royston Road,
Route 3 Cathedral Street to Alexandra Parade, and
Route 4 Duke Street through to George Square.

The surveyed link speeds were used as a guide (remembering that the model assignments were for the year 1990) when determining link impedances to be applied for the unrestrained (off peak) and restrained (peak) periods of the day.

(iii) Bus Journey Time Surveys

These surveys were implemented on the routes described above with the journey time comprising junction delays and actual moving time, the periods during which buses were picking up and depositing passengers being excluded.

A series of off-peak journey times was recorded between 1900 and 2000 hours on these routes. A benefit for the journey time savings has been calculated in Annex 2, assuming the evening off-peak condition to be representative of surface street conditions after the opening of the new route.

4.3 Economic Analysis

(i) Introduction

In keeping with previous similar exercises, a series of unrestrained and restrained benefits were calculated, with the proportion of ADT flow receiving the respective benefits determined by examination of the predicted flows in the design (and subsequent) year(s) with regard to the practical capacities of the primary routes affected by the scheme.

At this stage, the question of which hourly variation pattern to apply to the future Castle Street ADT flow arose. If the pattern from the survey results obtained for the purposes of this study was applied along with factors from Traffic Flow Characteristics, then Fig 4.3 resulted for the critical routes. However, if the hourly variation in flow obtained from the entire Townhead Screenline was applied along with the appropriate peak factors, then Fig 4.4 resulted.

The Practical Capacity of the routes in question, Cathedral Street and High Street, was considered to be some 36,000 ADT when combined and is shown accordingly in both Figures.

When Fig 4.4 was examined, the number of hours which were subject to congestion was considered to be between 5 and 6, allowing for some shedding of the peak overloads to different time periods rather than different routes. This resulted in the proportion of ADT flow receiving restrained benefits lying between 38% and 44%, the final proportion being taken as 40%.

However, on examination, Fig 4.3 indicated that for 8 hours of the day traffic would exceed practical capacity and therefore derive restrained benefits. The resulting proportion of ADT flow deriving these benefits was 64% and a final figure of 60% was used for the calculation of restrained benefits in 1990.

(ii) Method of Economic Analysis

The traditional evaluation method has been applied in Annex 1, utilising a lower bound growth in traffic of 18% from 1977 to 1990 in keeping with SDD Technical Memo No SH7/80. A further reduced rate of growth of 9% between 1990 and 2000 in general traffic levels has been applied and no growth is assumed beyond 2000.

The Design Scheme year of opening has been assumed to be 1990 with a subsequent evaluation period of 20 years over which benefits were discounted at 7% per annum.

(iii) Economic Benefits

The benefits accruing from the construction of the new Road Link have been calculated as follows (excluding public transport benefits):

A 1st year estimated rate of return	= 11.5%
A COBA type ratio (discounting year 1990)	= 0.7

When public transport benefits are taken into account (Annex 2), the benefits returned are:

1st year estimated rate of return	= 12.9%
COBA ratio	= 0.9

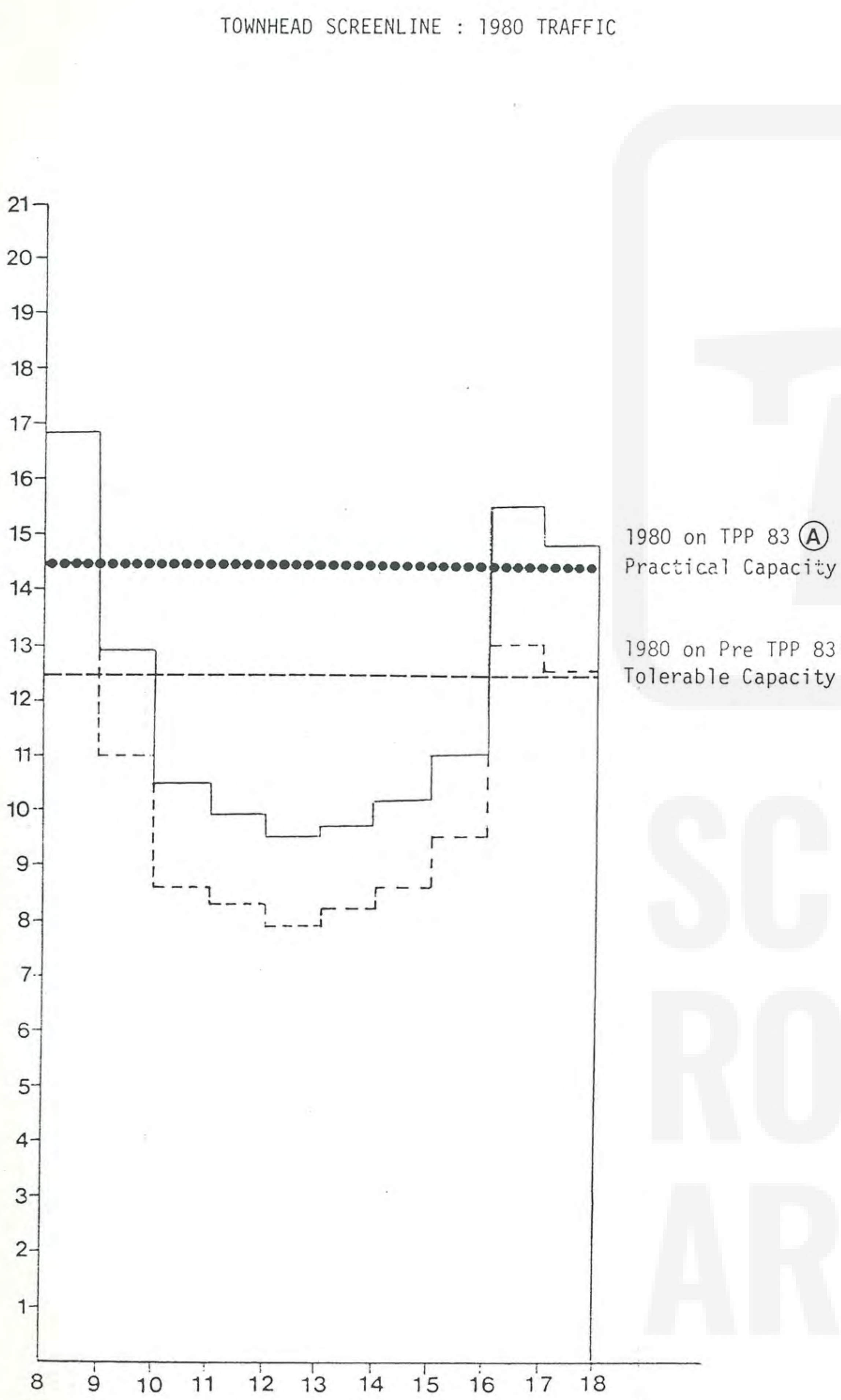

TOWNHEAD SCREENLINE : 1980 TRAFFIC
1980 on TPP 83 (A)
Practical Capacity
1980 on Pre TPP 83 (B)
Tolerable Capacity
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Fig 2·1

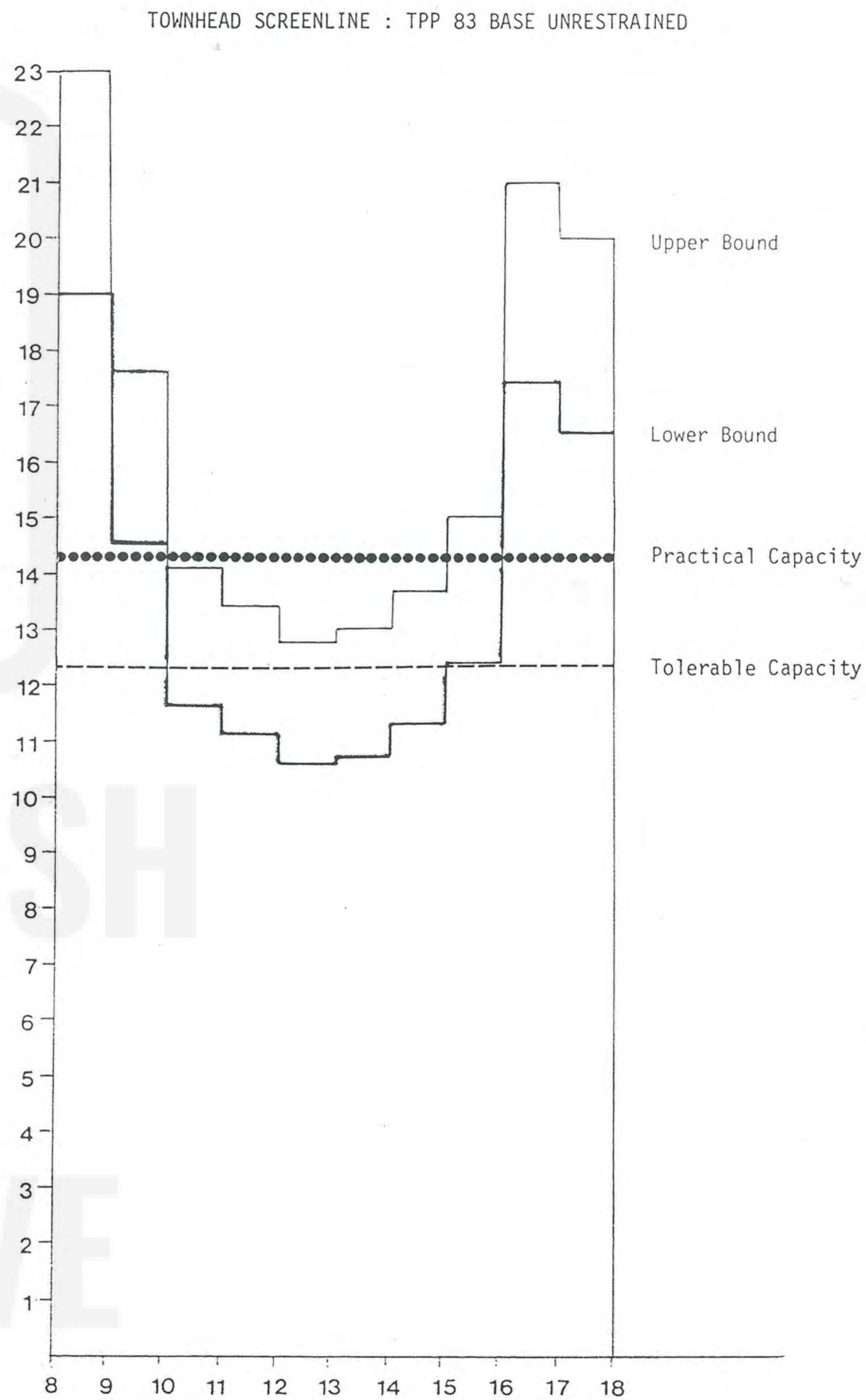
TOWNHEAD SCREENLINE : TPP 83 BASE UNRESTRAINED
Upper Bound
Lower Bound
Practical Capacity
Tolerable Capacity
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Fig 2·2

TOWNHEAD SCREENLINE : TPP 83 BASE RESTRAINED

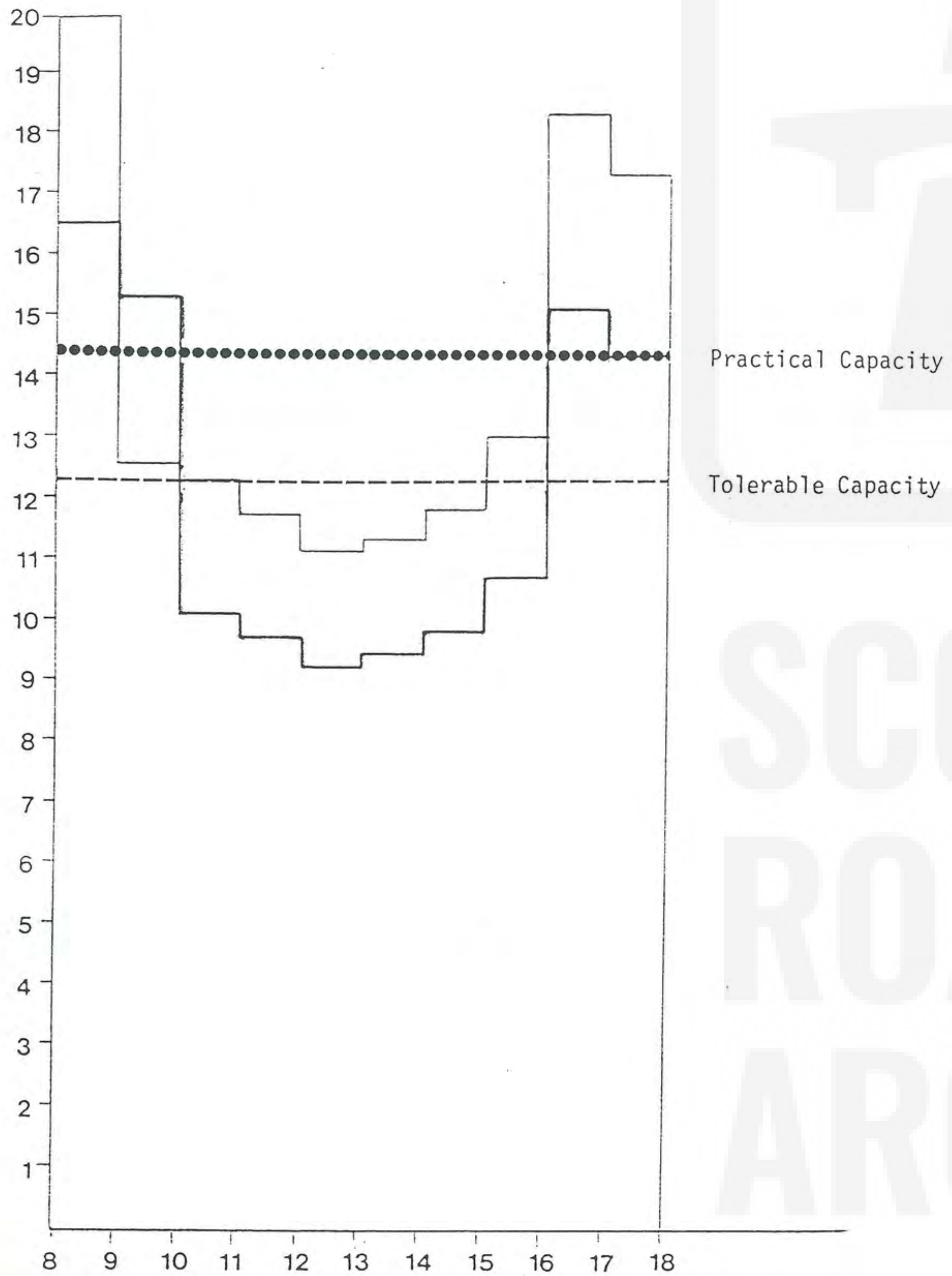


Fig 2·3

TOWNHEAD SCREENLINE : DESIGN RESTRAINED

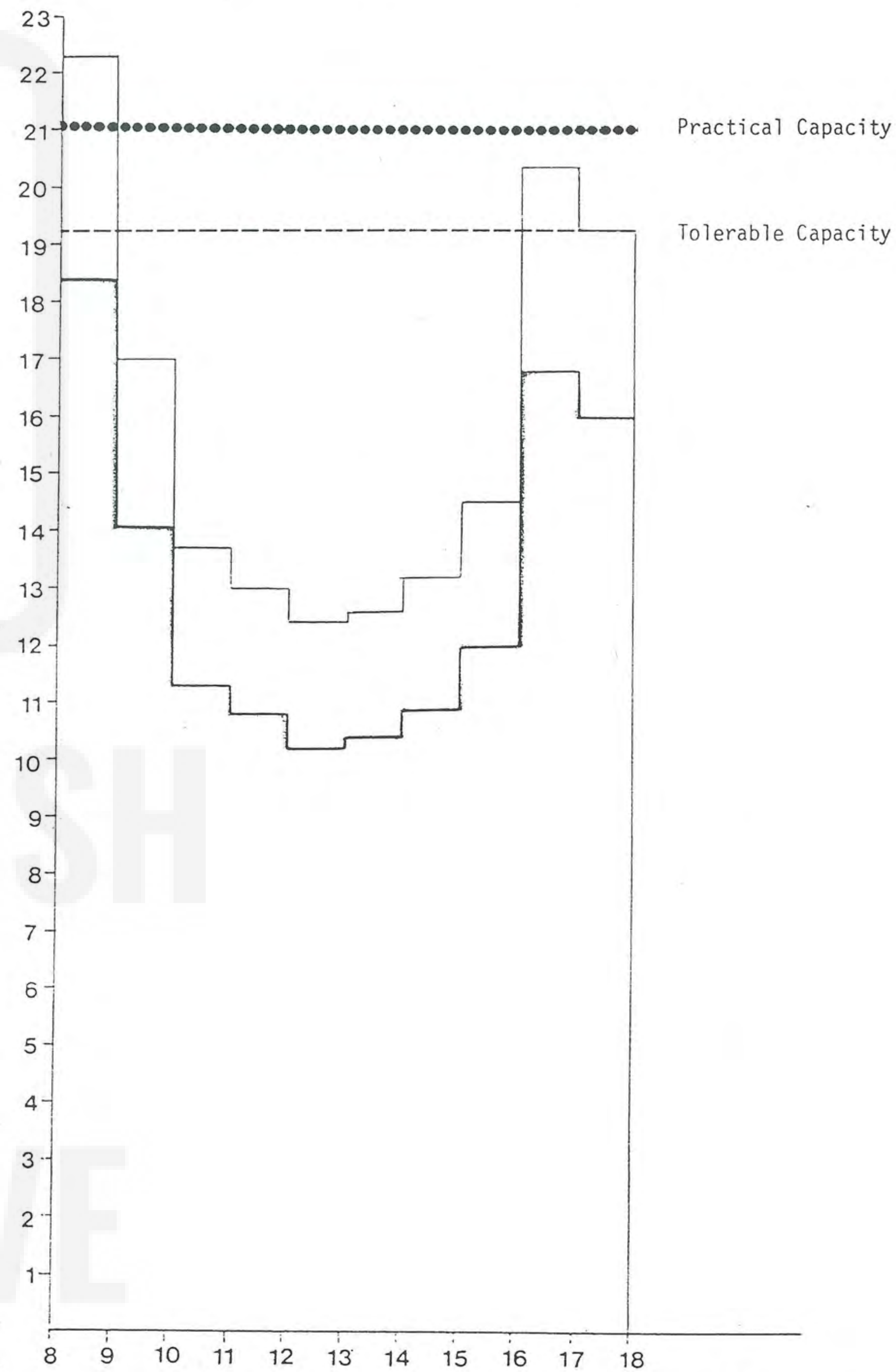
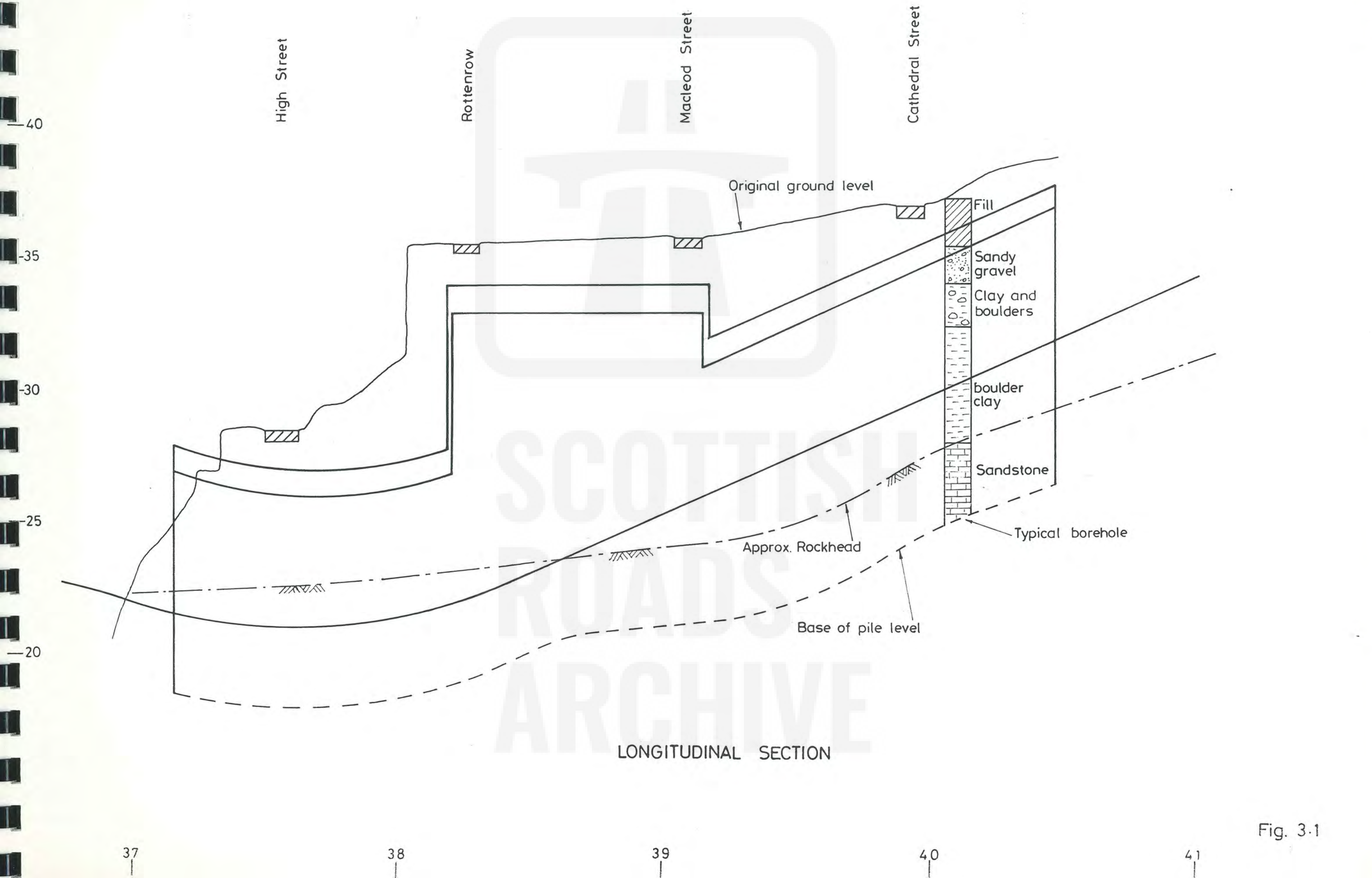
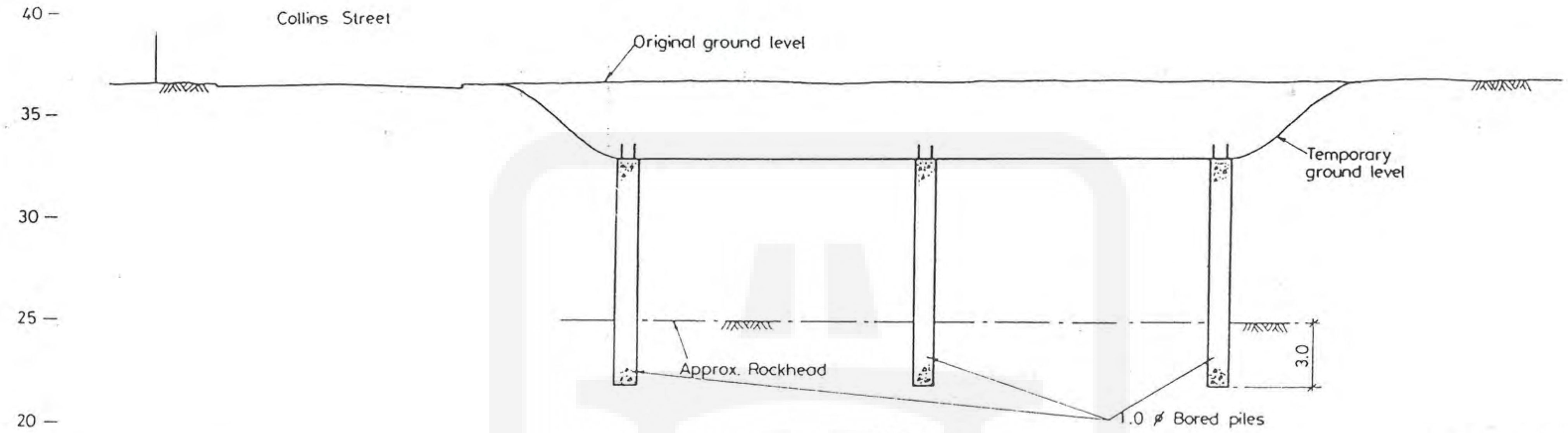


Fig 2·4



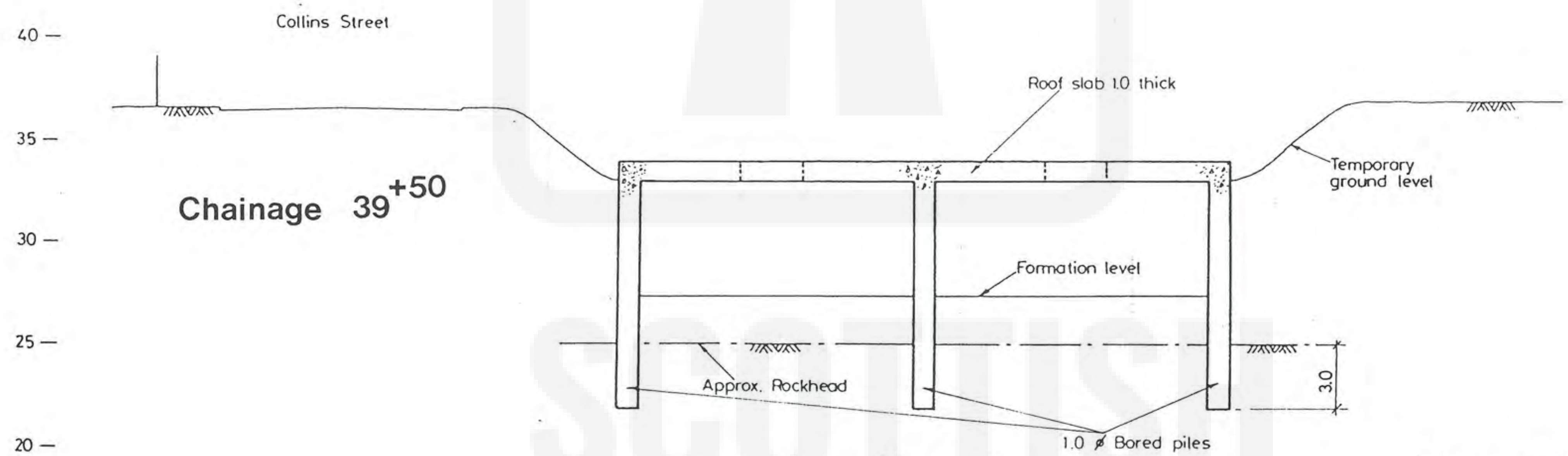
LONGITUDINAL SECTION

Fig. 3·1



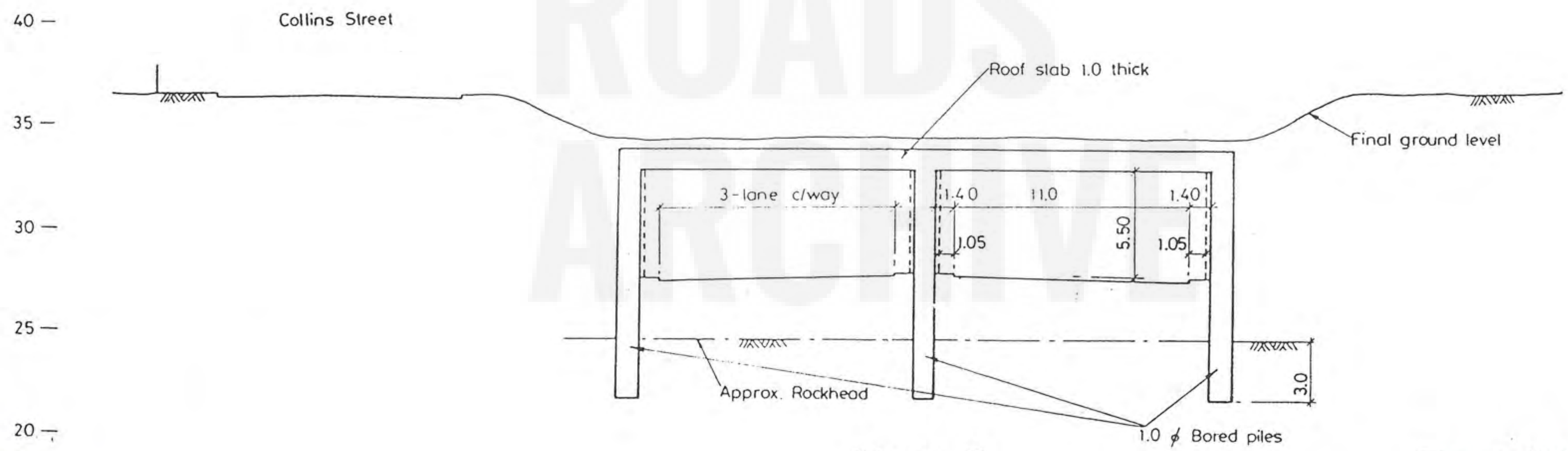
Stage 1

Figure 3.2



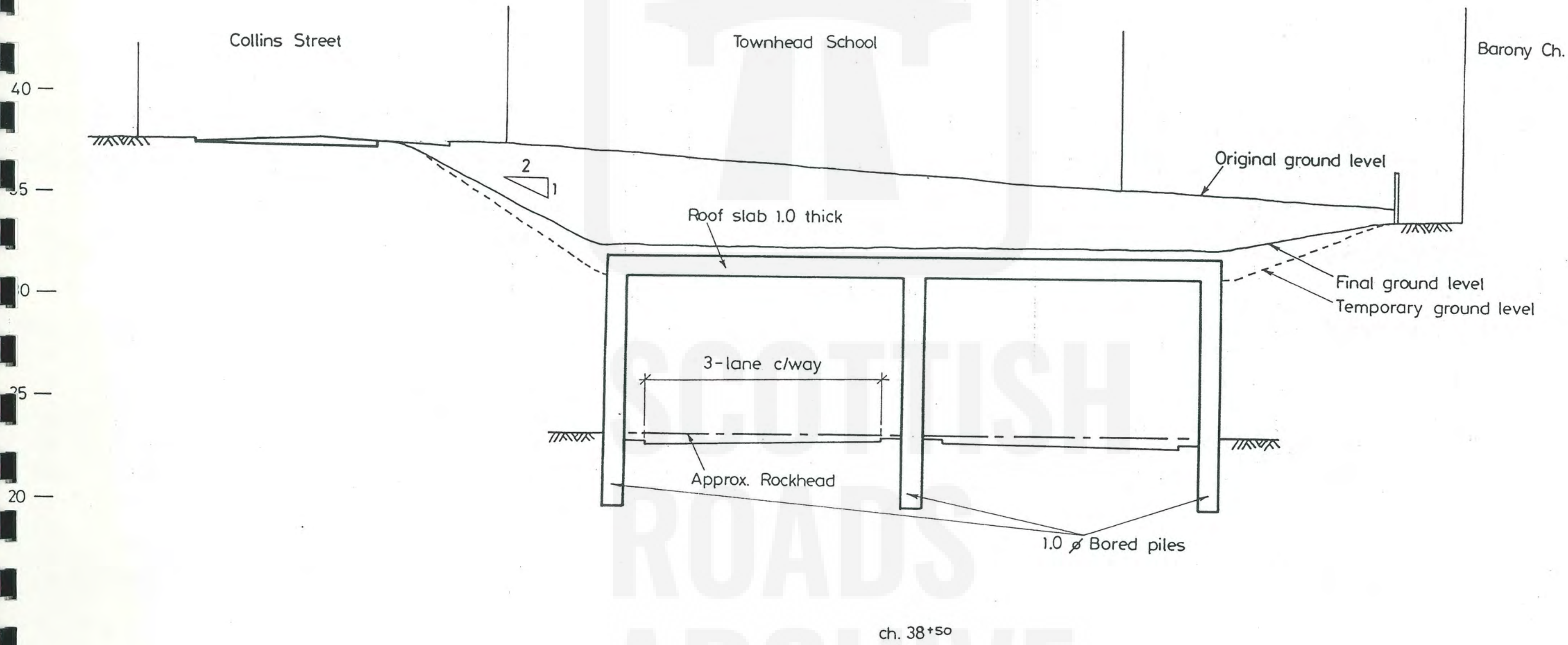
Stage 2

Figure 3.3



Stage 3

Figure 3.4



SECTION WITH ELEVATED ROOF

Fig. 3·5

HOURLY VARIATION IN TRAFFIC VOLUMES ON CASTLE STREET
(NORTH OF STIRLING ROAD)

DECEMBER 1980

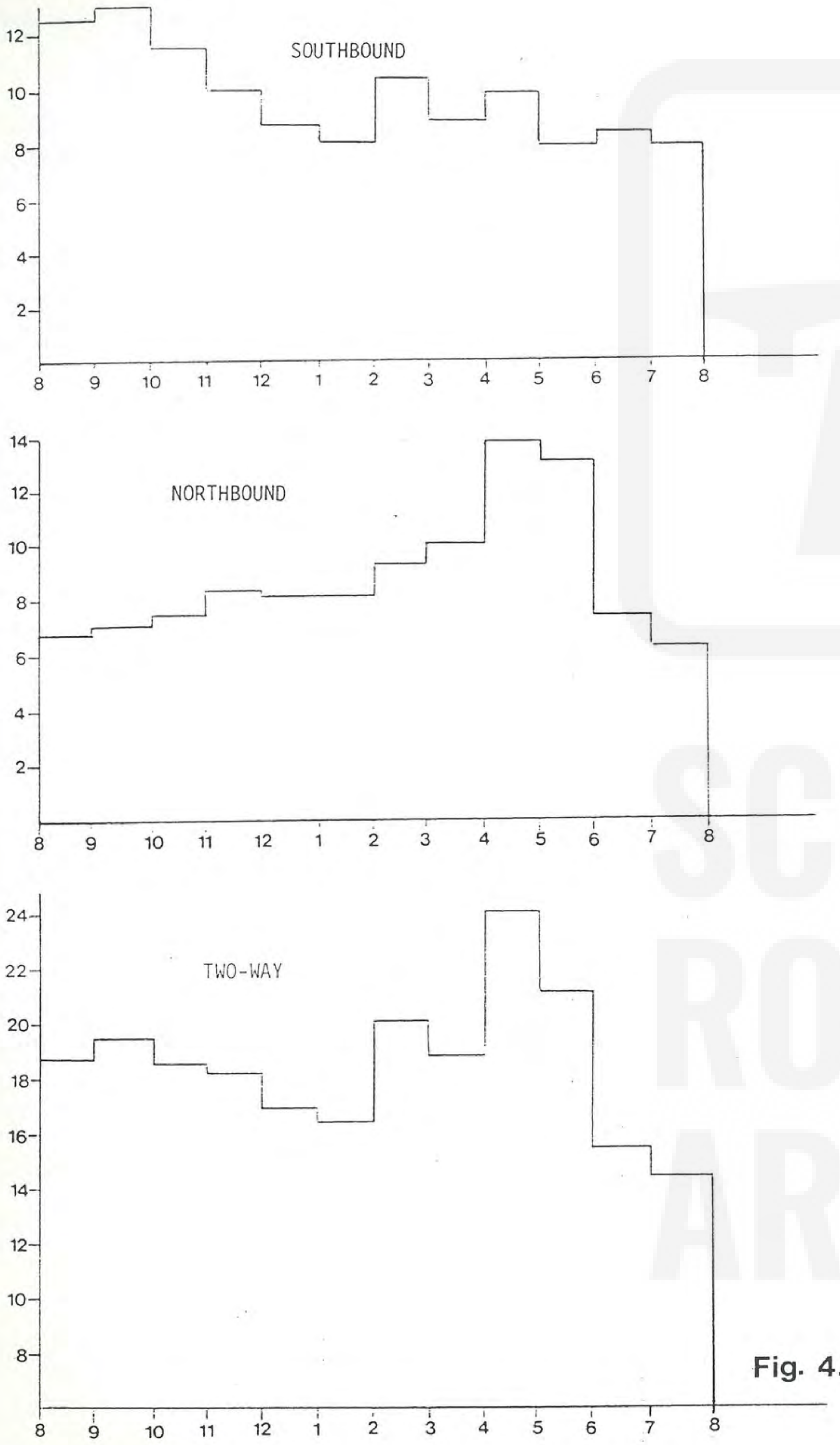


Fig. 4.1

HOURLY VARIATION IN TRAFFIC VOLUMES ON WEST GEORGE STREET (WEST OF ALBION STREET)

SEPTEMBER 1980

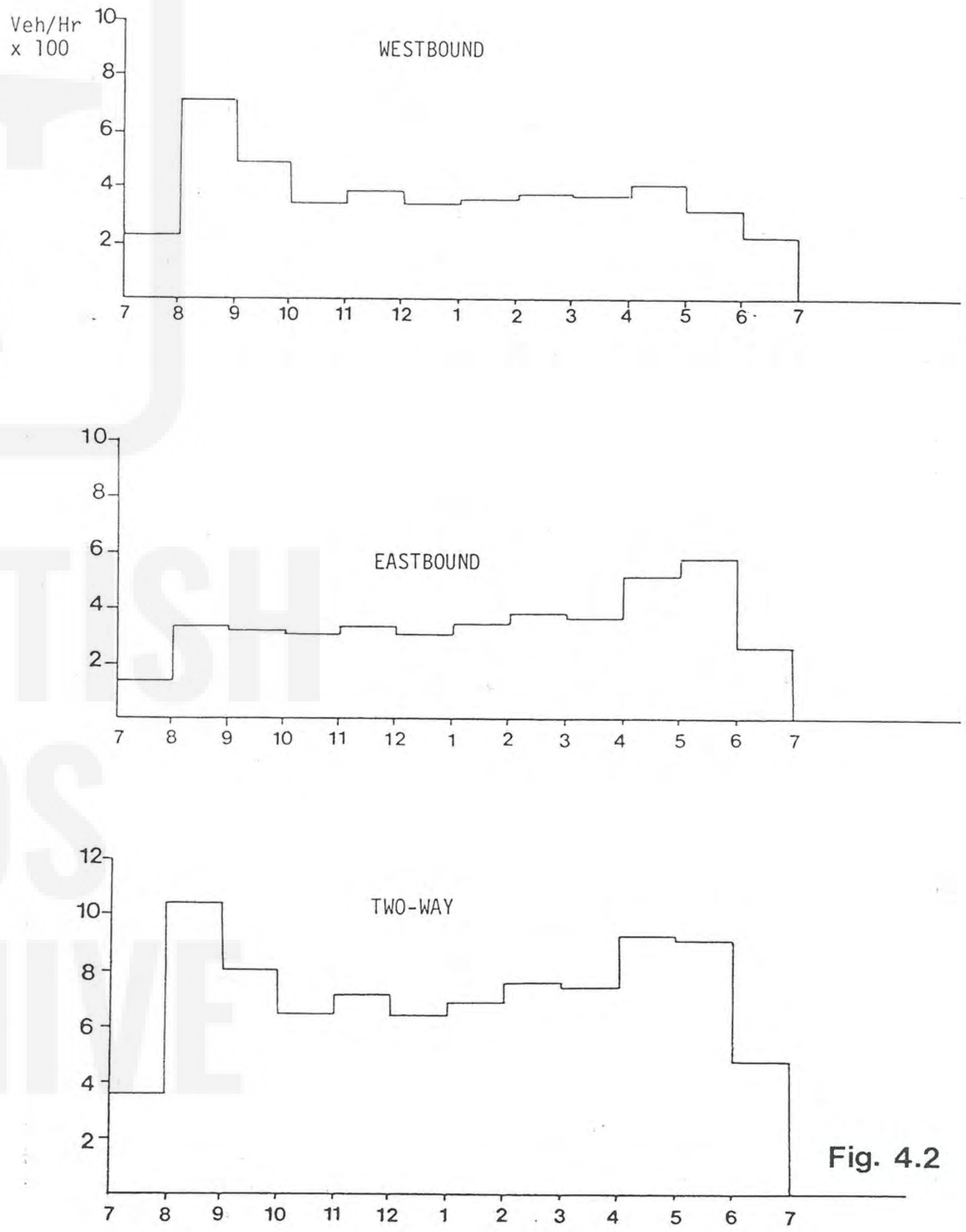


Fig. 4.2

HOURLY VARIATION IN TRAFFIC VOLUMES ON CASTLE STREET (NORTH OF STIRLING ROAD)
(NB: This pattern was recorded by survey December 1980)

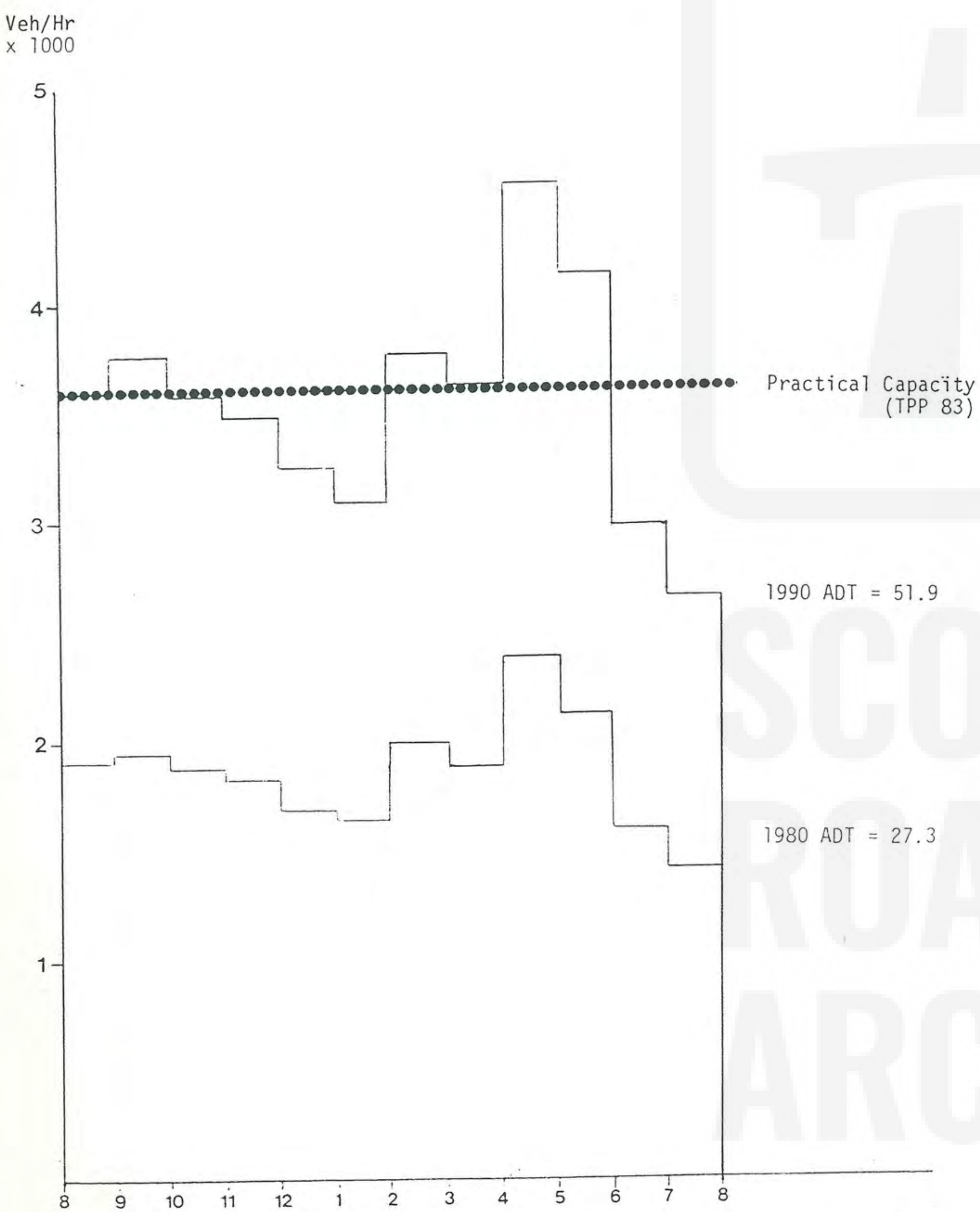


Fig. 4.3

HOURLY VARIATION IN TRAFFIC VOLUMES ON CASTLE STREET (NORTH OF STIRLING ROAD)
(NB: This pattern was established from complete Townhead Screenline counts 1977.)

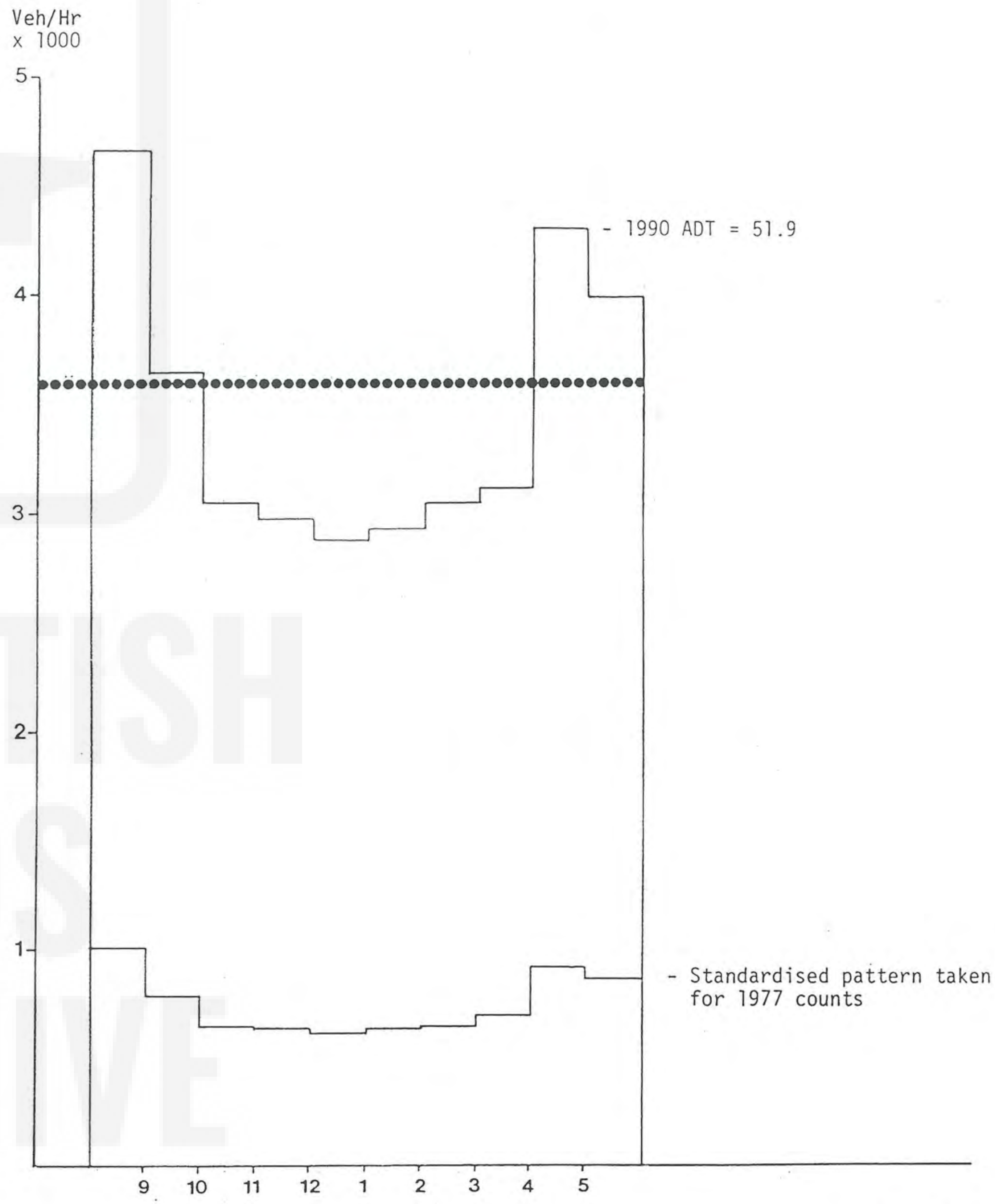
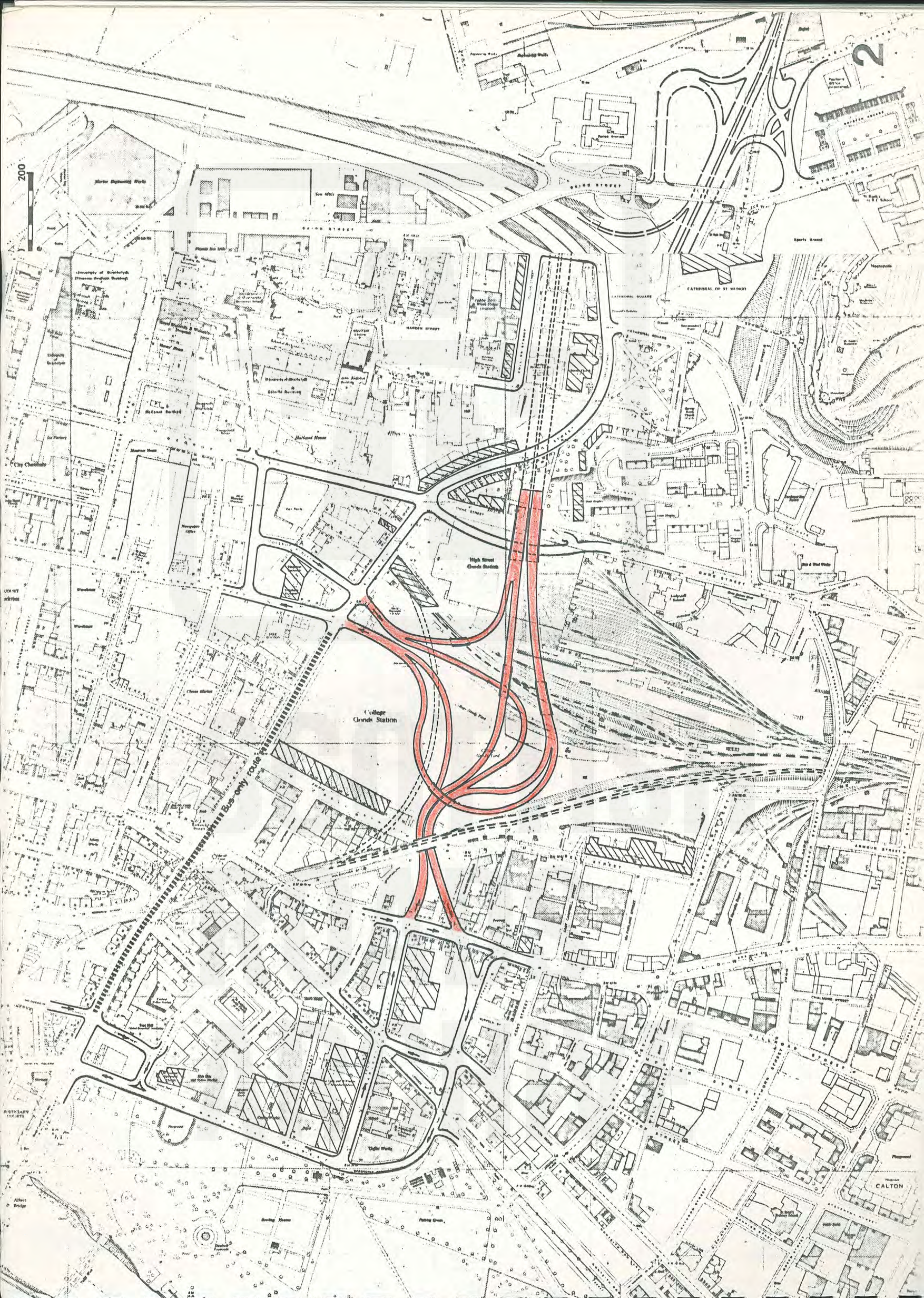
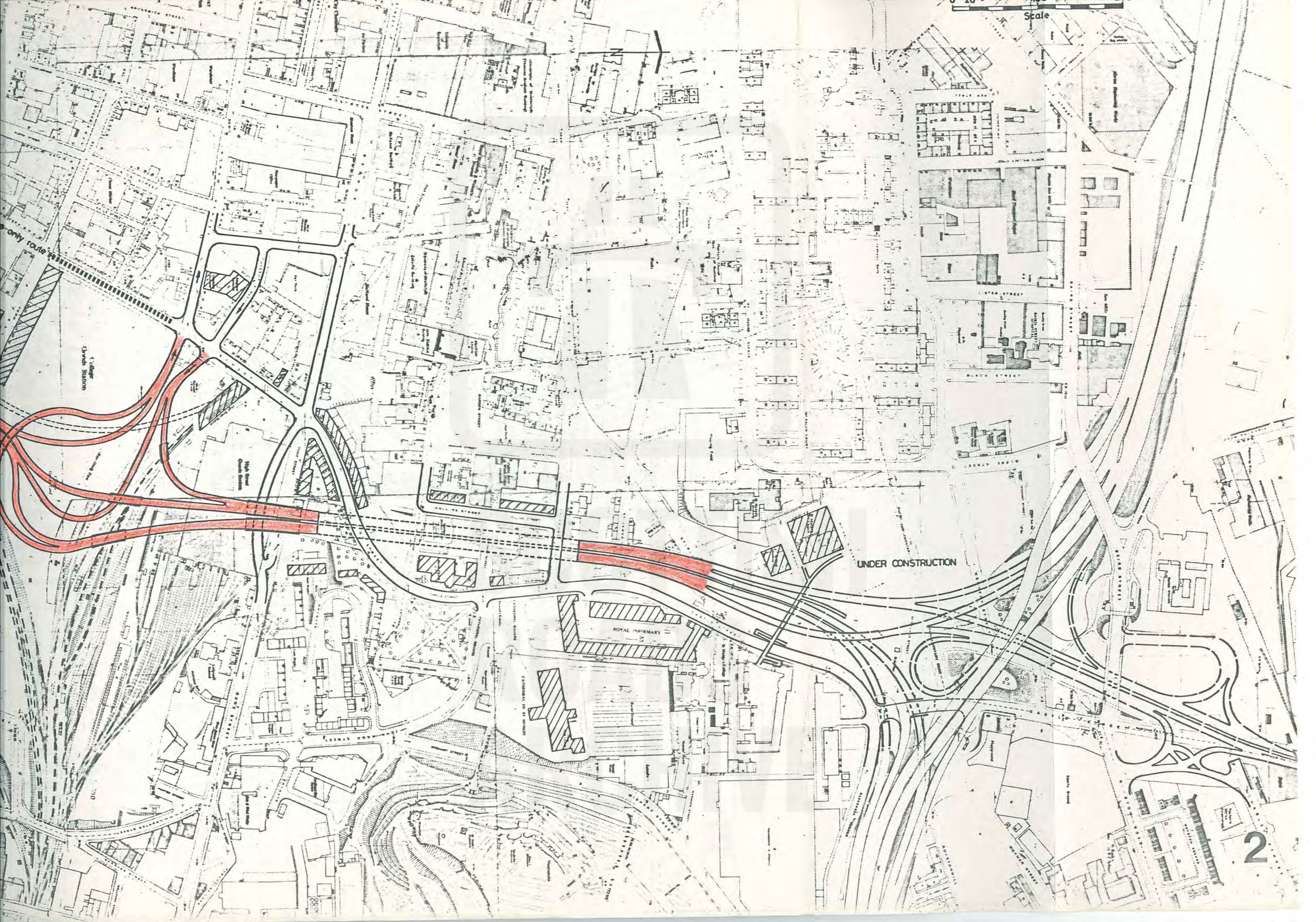


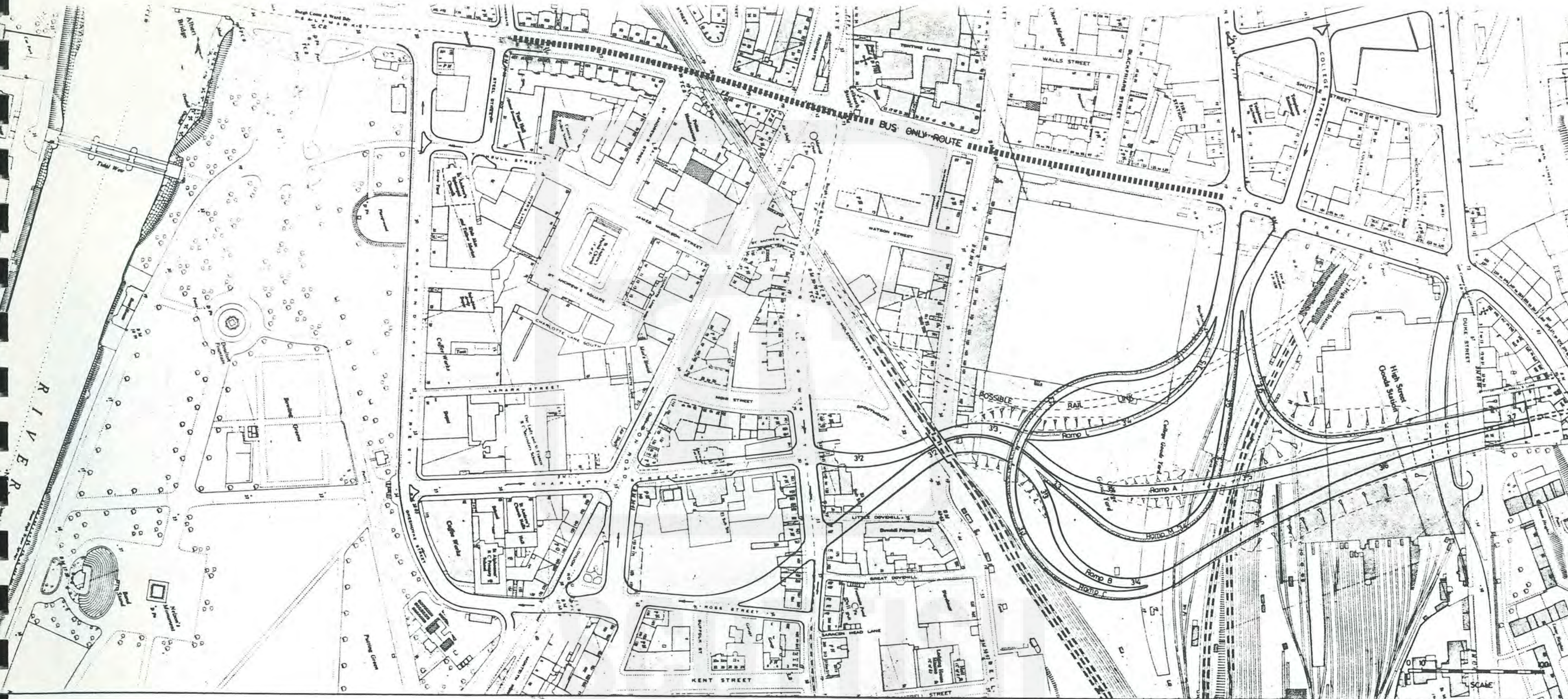
Fig. 4.4

CITY OF GLASGOW
Cowcaddens
Garnethill
Anderston
Kingston
Tradeston
Laurieston
Hutchesontown
Calton
GLASGOW GREEN
River Clyde
Central Station
Kingston Bridge
George the Fifth Bridge
Glasgow Bridge
Suspension Bridge
Albert Bridge
King's Bridge
General Terminus
Bus Station
Goods Station
ROYAL INFMY
CATH
City Hall
HPO
Univ
Dismantled Railway
1

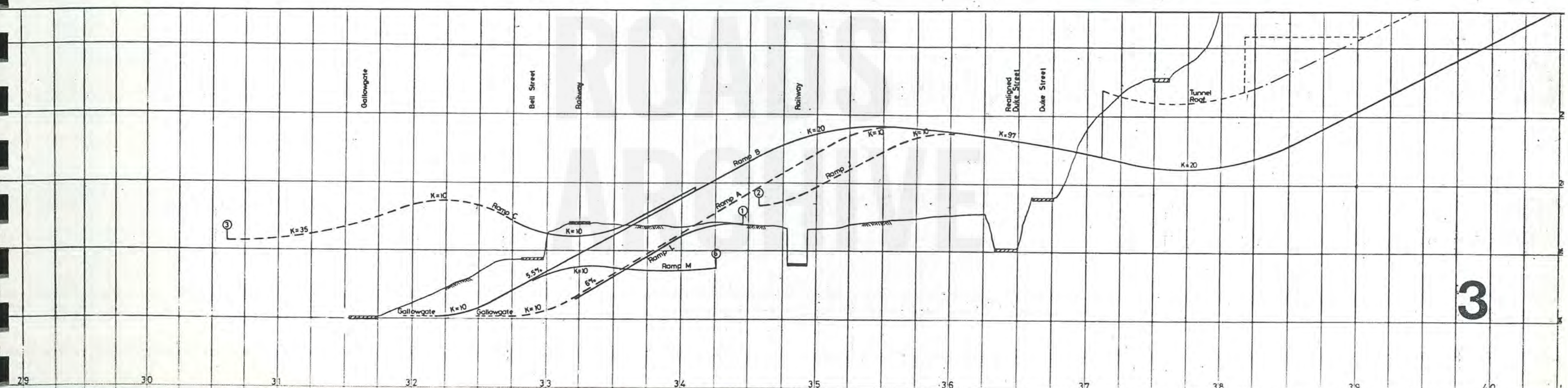

2
200
CATHEDRAL OF ST MUNGO
High Street Goods Station
College Goods Station
Bus-only route
CALTON



Scale
UNDER CONSTRUCTION
ROYAL INFIRMARY
2

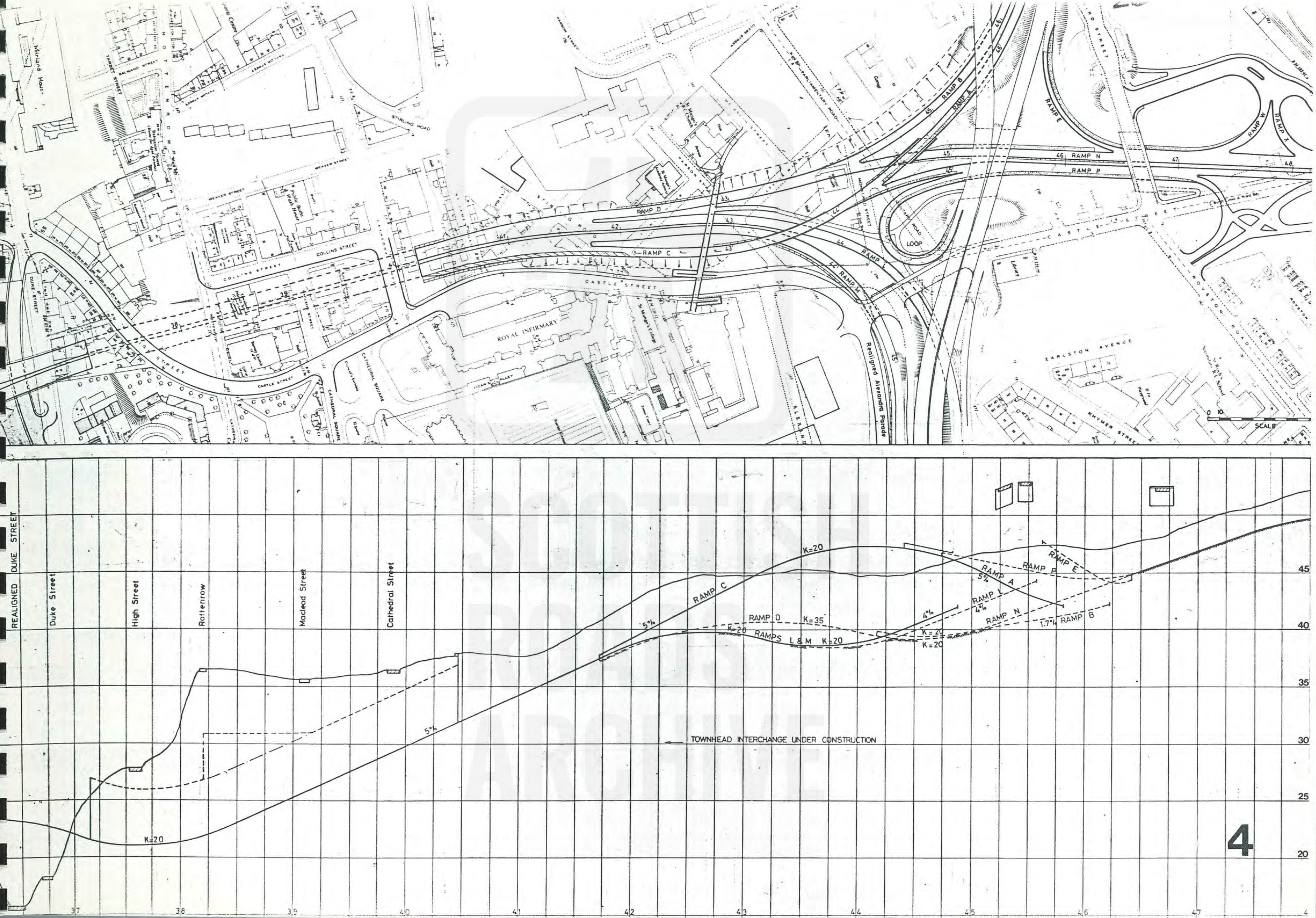


BUS ONLY ROUTE
RIVER
Albert Bridge
Tidal Weir
WALLS STREET
BLACKFRIARS STREET
COLLEGE STREET
SHUTTLE STREET
BELL STREET
JAMES MORRISON STREET
ST ANDREW'S SQUARE
CHARLOTTE LANE SOUTH
LANARK STREET
MOIR STREET
WATSON STREET
TONTINE LANE
POSSIBLE RAIL LINK
Ramp
Ramp A
Ramp B
Ramp C
Ramp M
College Goods Yard
High Street Goods Station
DUKE STREET
LITTLE DOVEHILL
GREAT DOVEHILL
Dovehill Primary School
ST MUNGO STREET
SUFFOLK ST
KENT STREET
Bowling Green
Putting Green
Nelson's Monument
Coffee Works
SCALE

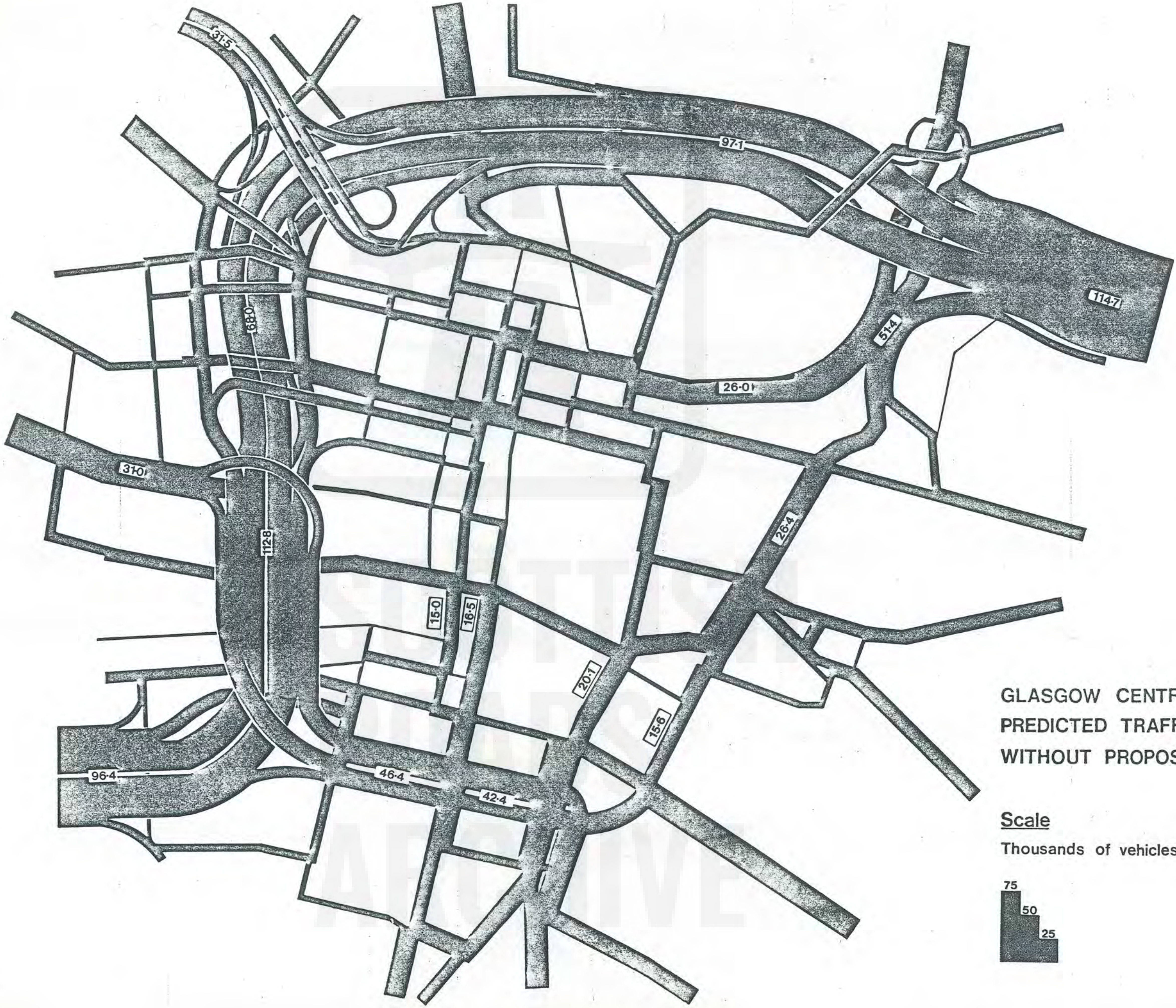


Gallowgate
Bell Street
Railway
Railway
Realigned Duke Street
Duke Street
Tunnel Roof
Ramp A
Ramp B
Ramp C
Ramp L
Ramp M
Gallowgate
K=10
K=20
K=35
K=97
5.5%
6%
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0

3



ROYAL INFIRMARY
CASTLE STREET
COLLINS STREET
WEAVER STREET
STIRLING ROAD
PARLIAMENTARY ROAD
CATHEDRAL SQUARE
Realigned Alexandra Parade
EARLSTON AVENUE
RHYMER STREET
ROYSTON ROAD
RAMP A
RAMP B
RAMP C
RAMP D
RAMP E
RAMP L
RAMP M
RAMP N
RAMP P
RAMP W
RAMP X
LOOP
SCALE
REALIGNED DUKE STREET
Duke Street
High Street
Rottenrow
Macleod Street
Cathedral Street
K=20
K=35
RAMPS L & M
5%
4%
1.7%
TOWNHEAD INTERCHANGE UNDER CONSTRUCTION
4

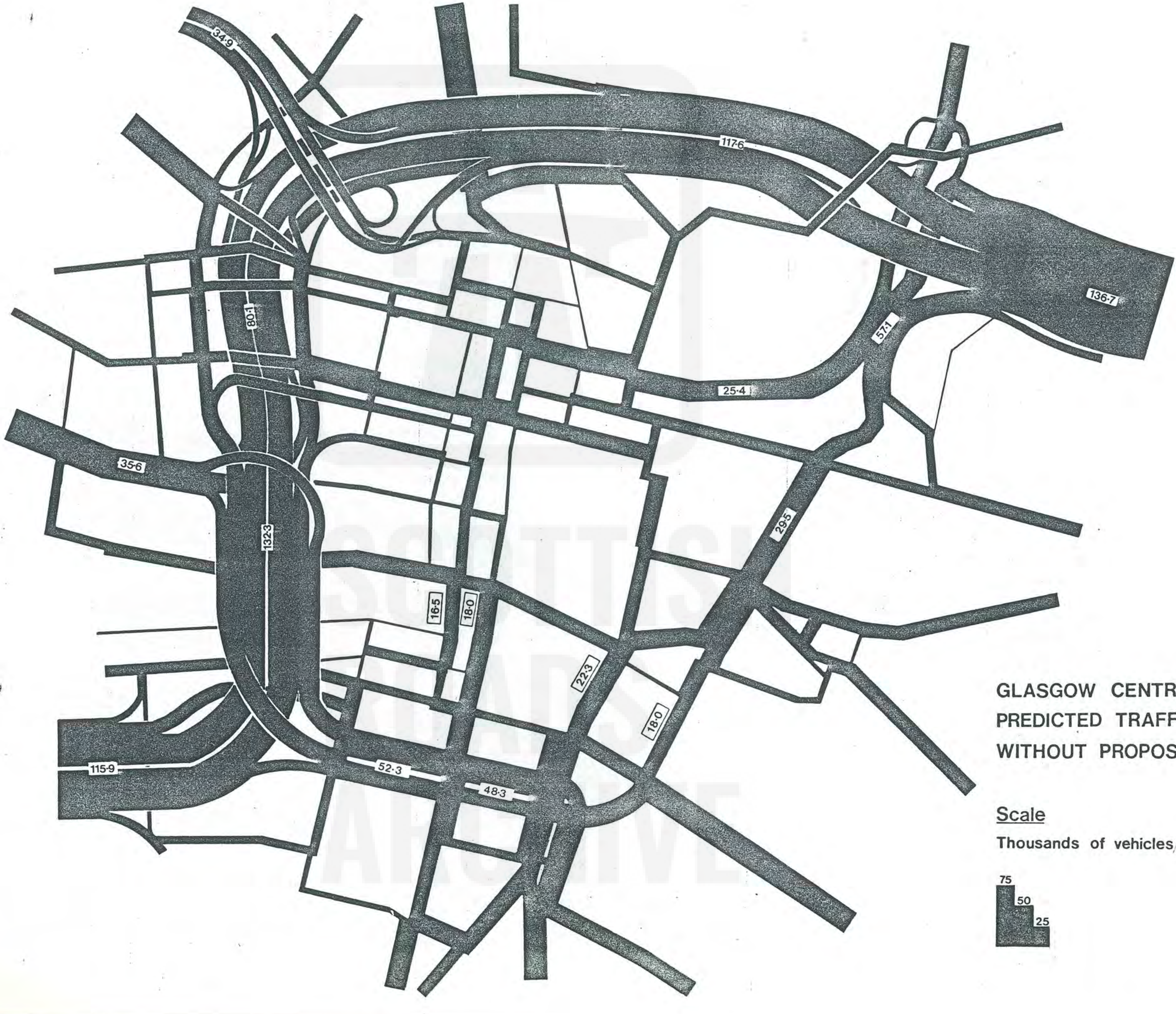


GLASGOW CENTRAL AREA
PREDICTED TRAFFIC IN 1980
WITHOUT PROPOSED LINK

Scale

Thousands of vehicles/day

75
50
25

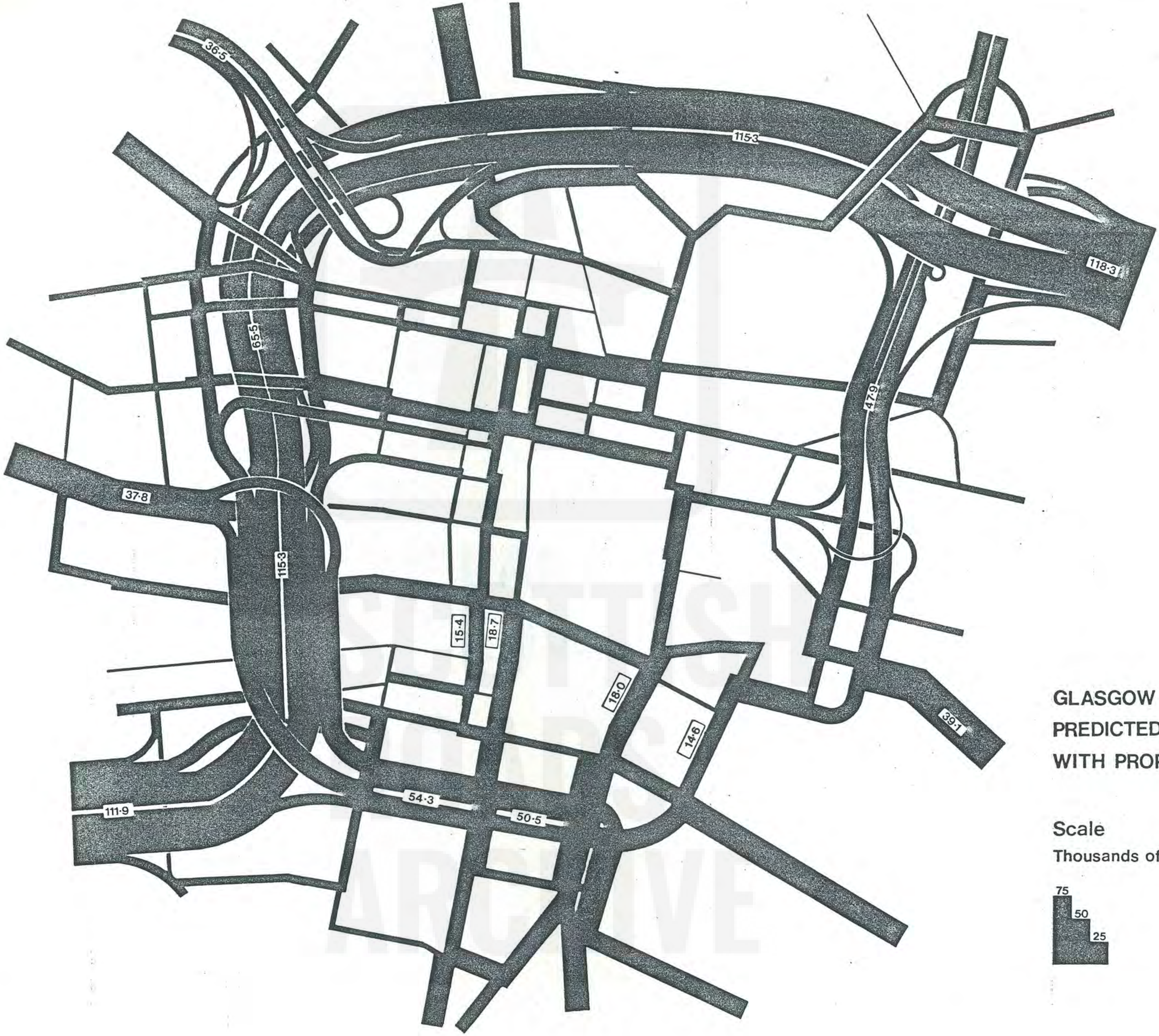


GLASGOW CENTRAL AREA
PREDICTED TRAFFIC IN 1990
WITHOUT PROPOSED LINK

Scale

Thousands of vehicles/day

75
50
25



GLASGOW CENTRAL AREA
PREDICTED TRAFFIC IN 1990
WITH PROPOSED LINK

Scale
Thousands of vehicles/day

75
50
25

ANNEX ONE

LANDSCAPE and ENVIRONMENTAL STUDIES

HOLFORD ASSOCIATES
4 PARK CIRCUS
GLASGOW G3 6AX

INTRODUCTION

The Townhead to London Road Link Road follows a line from Stirling Road in the North to London Road in the South. (See drawing no 1). The line is depressed in cut and cover construction from St James Road to a point just south of High Street where it emerges into an area of ground at present known as High Street/ College Goods Station.

It is considered that the line of this route has taken the maximum advantage of the opportunities available in utilising existing ground contours and land uses. The result is a successful integration of an urban link road with the eastern section of the Merchant City. Opportunities will exist to develop both the historic fabric and commercial land uses of High Street and Cathedral Street. The completion of the West Flank of the ring road and the re-utilisation of the west end of Sauchiehall Street has proved that these opportunities can be realised.

1 CATHEDRAL PRECINCT (See drawings no 2, 3 & 4)

The depressed section of the road link preserves the environs of the Cathedral Precinct and the other historic buildings in this vicinity. Cathedral Street and High Street should be allowed to revert to their former roles within the Glasgow street pattern and hopefully will provide a springboard for the future development of the Cathedral Square.

The landscape plans accompanying this draft Report indicate the hard and soft landscape that would be carried out by the SRC Roads Department/....

Department on completion of the proposed cut and cover works. Although the proposal indicates no building development over the structural box, the opportunity should be taken to make allowance at this stage to design the structure thus permitting future building development. The cost, at this stage, for this provision would appear small in terms of possible benefit to the area and, in certain circumstances, it is desirable in engineering terms to allow for a building load rather than ground surcharge. It is considered that provision in the structure to take building loads over would complete the "Roads Team's obligations" to the future development of this area of the City. The town scape of both High Street and Cathedral Street would, effectively, be enhanced by the development of town housing along their frontages which in essence would be over the end portals of the cut and cover deck. It is acknowledged that the decision required to proceed these proposals is not a current consideration, however, we believe that the brief, in this instance, requires to provide a base which would allow the Planning Department a flexibility for the future design of the area. Meetings have been held with the Director of Planning in conjunction with the SRC Roads Department and the areas of possible development tabled at these meetings appeared to be acceptable to those concerned. It is understood that the Planning Department are at present consulting with Housing Management over the future planning of the area.

2 COLLEGE INTERCHANGE (See drawing no 5)

The depressed road link emerges from the cut and cover box on structure spanning re-aligned Duke Street then onto structural embankments which would form the College Interchange. The environmental proposals for this section would be to provide a landscaped area of trees, shrubs and grass in an attempt to soften the inevitable hard lines of the roads comprising the Interchange. The comments on the Interchange in this report have been restricted to the scheme as shown.

The major impact of the Interchange would be screened from the High Street by landscape and by maintaining and developing residential and commercial frontages to High Street and Duke Street. It is maintained that the roadlink proposals should retain the existing street pattern thereby reducing any adverse effects on the existing fabric of the City. However, it is noted that the traffic management "square-about" proposals for the areas of Gallowgate and London Road have re-emerged in the light of these proposals. The traffic justification of the proposal is understood but concern is felt at the inevitable alteration to existing street patterns and even more importantly in this area, the possible continuity of commercial development along these roads between Glasgow Cross, The Barrows and the new proposed housing areas of Carlton.

It is recommended that, in the event of a further stage of this road being realised, consideration could be given to providing a traffic management scheme which would allow future development of this commercial link from Carlton to Glasgow Cross and hence the Argyle Street and Buchanan Street Shopping Complex.

PROJECTED 1990 WITHOUT COMPLETION
OF INNER RING ROAD

Parallel to this report, consideration is also being given to the environmental impact should the East and South Flanks not be built. The various issues arising from this complimentary study are listed below under individual headings.

URBAN FORM

Glasgow Cross and the Cathedral Precinct are two important highlights of Glasgow's urban form (townscape).

The historical Tolbooth at the Cross serves not only as a guide to Glasgow's past but stands at the intersection of two important corridors of movement and commerce, namely High Street and Argyle Street.

The area in and around the Cathedral Precinct is dominated by four main civic institutions (the Cathedral, Royal Infirmary, Provand's Lordship and the University of Strathclyde Campus) and two main arterial routes, namely High Street and Cathedral Street.

Whilst High Street remains essentially commercial, a significant amount of development is residential, particularly between Castle Street and Duke Street. There are approximately 192 houses (excluding residences in the Fire Station) overlooking High Street between Castle Street and Osborne Street at Saltmarket.

Travelling northward along High Street, the following 'events' are perceived. The five/six storey development of shops and offices at Glasgow Cross which give High Street a dense and 'urban' feel opening out at Ingram Street due to gap sites on the left and High Street Goods Station which is opposite. This zone is underdeveloped and is unsympathetic to the route. Crossing Duke Street, a winding procession, flanked by four storey tenements, lends a sense of intimacy before High Street opens out into the visual climax of Cathedral Square.

Pedestrians and vehicles compete for advantage along the length of High Street which in 1978 carried between 11 and 18.5 thousand vehicles per day at various locations.

Should the East Flank not be constructed, it is estimated that the volume of traffic in 1990 using High Street will approximately treble the 1978 figures. The effect upon the micro-environment of such a volume of traffic will be severe as well as wideranging in the complexity of the problems and secondary effects, linkages, etc.

TRAFFIC NOISE

The congestion caused by such a high volume of traffic being channelled along High Street combined with the expected traffic mix (private, commercial, HGV) slow average speed and stacatto pattern of traffic flow will increase the undesirable effect of traffic noise in the vicinity, particularly on the steeper gradient north of Duke Street. Even with improved road surfacing which may dampen sound, the increased noise from engines, particularly in heavy vehicles, will become more apparent as traffic moves at slower speeds due to congestion.

The physical and psychological effects of noise and noise annoyance are expected to be significant north of Duke Street where houses face onto High Street in an enclosed corridor. As traffic using the route will have many diverse assignments, noise annoyance is likely to be a problem during most of the 24 hour cycle.

Traffic noise in the vicinity of the Royal Infirmary and Cathedral will be undesirably high and the secondary effect on related activities such as tourism will also be significant.

In the subsequent report, a quantitative analysis of projected levels, related to the line of the east and south flanks, will be included to indicate the spatial effect of noise and where it is likely to be most extreme.

VISUAL INTRUSION

Large volumes of traffic, particularly long vehicles on surface streets, have a negative psychological effect on the observer. Should there be no East Flank in 1990, not only would the scale of High Street be disturbed but the profound impression gained would be one of oppression. Tourist attractions such as Provand's Lordship and the Cathedral would be hampered by the intrusion of slow moving traffic and excessive parking as the amenity value of the buildings would be reduced. The focus of the observer would be distracted from the Cathedral etc. by the equally strong image of lines of slow moving heavy vehicles. Whilst movement is an essential experience, the balance in the relationship between people and the built form would be disturbed by a third, stronger element.

Areas of visual confusion and/or deterioration, gaps in backcloth, colour and texture starvation will be highlighted and discussed in the following report alongside design criteria and objectives.

SEVERANCE

An approximate trebling of the existing volume of traffic using High Street would be likely to lead to an undesirable level of physical and psychological severance. Severance, along with noise annoyance atmospheric pollution and the threat of injury can induce a psychological state in residents whereby certain trips e g to particular shops, are avoided. This is usually referred to as 'trip suppression'. The heavy flow of traffic (and size of HGV's) would physically sever one side of High Street from the other forming a barrier to movement. Whilst the number of light controlled crossing points might be increased, the observer would still perceive a barrier to exist, therefore it can be anticipated that due to psychological severance the number of trips would be reduced or, substituted by a search for alternative facilities on the same side of the street. A secondary effect would therefore be 'community severance' and an associated impact on local shops.

Whilst severance is difficult to measure, it is hoped to measure the utility loss/changes of trips both for pedestrians and drivers and relate the findings to the expected advantages if the East and South Flanks are built i e the net utility.

VIBRATION

It can be assumed that the amount of vibration from vehicles in 1990 will correspond to the projected traffic flow. Airborne vibration, resulting from fluctuations in pressure around engines affects movable objects such as windows and doors. Therefore, it can be assumed that traffic congestion in High Street will affect residents living north of Duke Street and offices located near Glasgow Cross.

The deterioration of road surfaces as a result of heavy usage would in turn be likely to increase ground-borne vibration and therefore increase the likelihood of structural damage to buildings.

Whilst people generally adapt to living near to major sources of annoyance such as railways, the annoyance caused by airborne vibration would most likely contribute to social dissatisfaction in the area.

Further studies will be carried out to locate the areas most likely to be affected by vibration and secondary effects.

ATMOSPHERIC POLLUTION

An extensive increase over the present volume of traffic using High Street would at the same time increase the level of atmospheric pollution in the area affecting not only people but buildings. The interrupted flow of traffic combined with a significant proportion of goods vehicles would increase the amount of smoke and fumes given off, particularly at light controlled crossings where pedestrians, being stationary, would be at greatest risk. (The wearing of face masks has become compulsory in certain Japanese cities where large volumes of traffic have to use the existing surface street system.)

At a later stage, it is hoped to predict 1990 levels of pollution according to sector.

PEDESTRIAN HAZARD AND DELAY

Without substantial alterations to the street system, and at the same time by attempting to keep traffic moving, pedestrian movement by 1990 would be inhibited. This would not only manifest itself in social and economic disbenefits but would most likely cause route deviation and risk taking with the resultant danger to pedestrians and motorists.

It is possible that the benefits accrued from the building of the North and West Flanks would be lost due to an increase in the number of accidents as a result of a major increase in surface traffic.

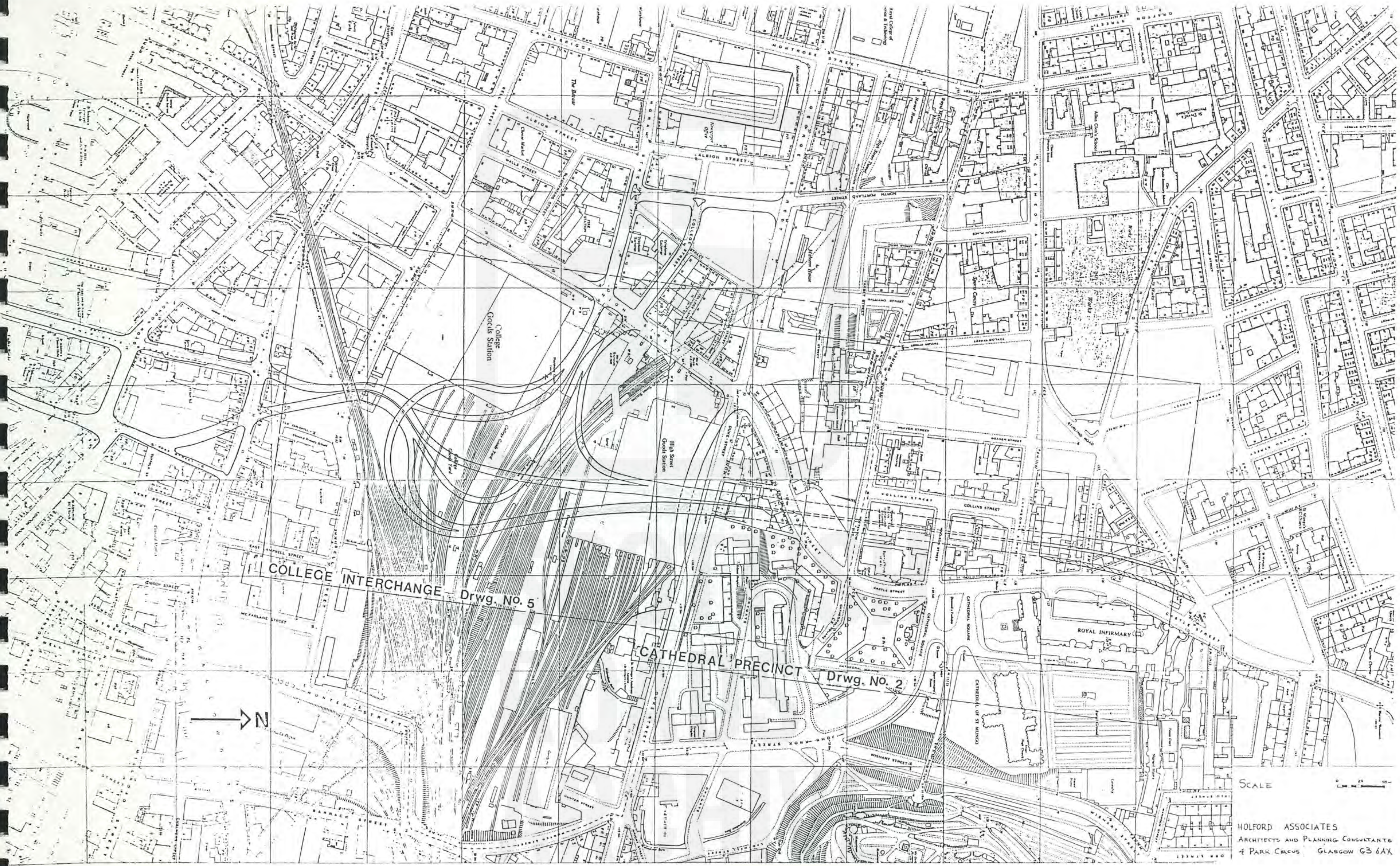
At a later stage, accident 'black spots' and likely areas of route deviation/pedestrian vehicular conflict will be defined.

PLANNING CONSIDERATIONS

A trebling of traffic using High Street would be likely to continue to suppress property values and new development fronting the corridor, which in turn would continue to prevent the Cathedral Precinct and Glasgow Cross from being developed to their full potential, therefore hindering the expansion of Strathclyde University, commerce and the re-organisation of Cathedral Square. A backwash effect would be likely to spread to Cathedral Street, Ingram Street, Duke Street and Argyle Street, frustrating the campus and commercial development currently taking place.

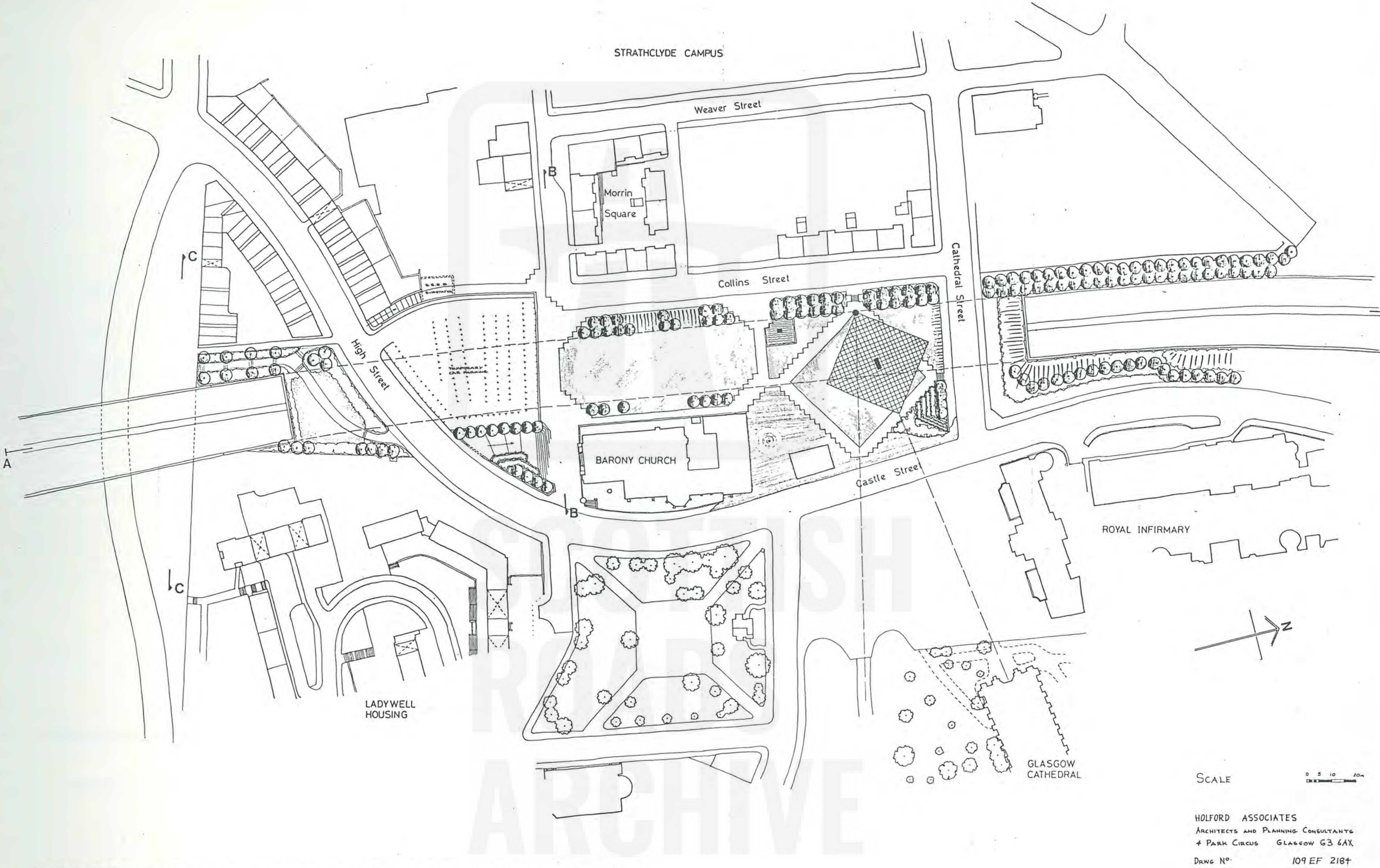
The scope for development would also be limited by the high volume of traffic in the area, therefore precluding several avenues for change.

In the following report, greater attention will be paid to the 'backwash' effect of the increase in vehicle numbers and mix.



TOWNHEAD TO LONDON ROAD LINK ROAD
LOCATION PLAN

1



TOWNHEAD TO LONDON ROAD LINK ROAD
CATHEDRAL PRECINCT LANDSCAPE SKETCH PROSALS

2

SECTION AA WEST

SECTION AA EAST

SCALE 0 5 10 20m

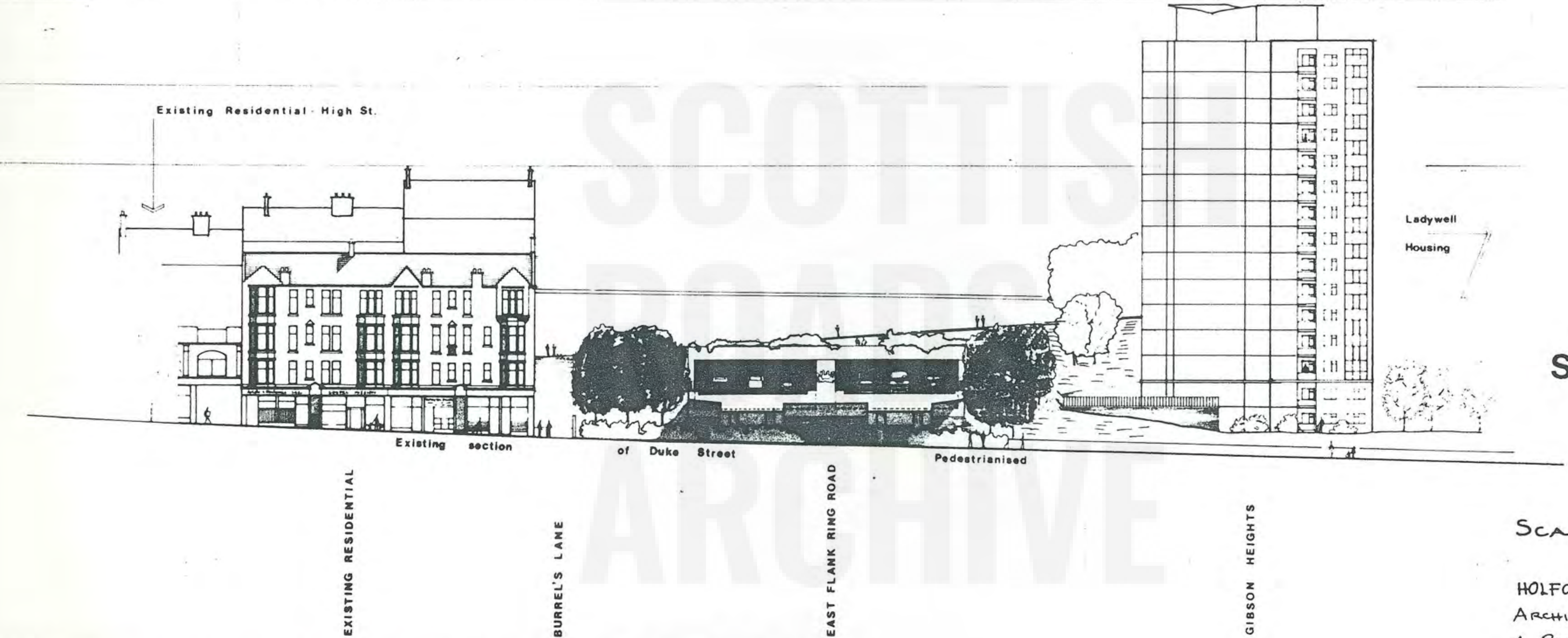
HOLFORD ASSOCIATES
ARCHITECTS AND PLANNING CONSULTANTS
4 PARK CIRCUS GLASGOW G3 6AX

DRWG. No 109 EF 2186

TOWNHEAD TO LONDON ROAD LINK ROAD
CATHEDRAL PRECINCT LONG SECTIONS SKETCH PROPOSALS

3

SECTION BB

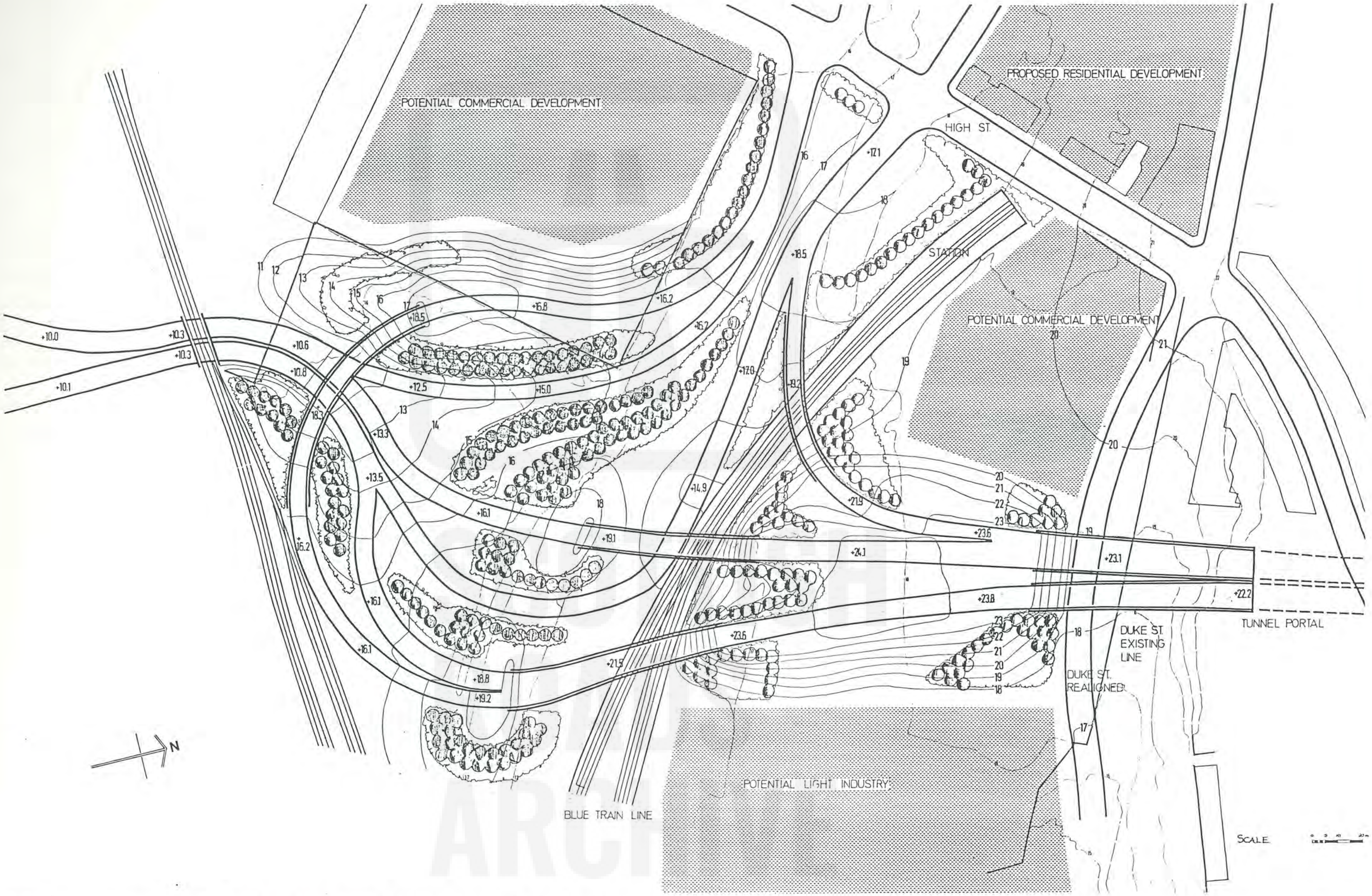


SECTION CC

SCALE 0 5 10 20m.

HOLFORD ASSOCIATES
ARCHITECTS AND PLANNING CONSULTANTS.
4, PARK CIRCUS GLASGOW G3 6AX

TOWNHEAD TO LONDON ROAD LINK ROAD
CATHEDRAL PRECINCT CROSS SECTIONS SKETCH PROPOSALS



TOWNHEAD TO LONDON ROAD LINK ROAD
COLLEGE INTERCHANGE LANDSCAPE SKETCH PROPOSALS

ANNEX 2

ECONOMIC ASSESSMENT OF ROAD USER BENEFITS
(excluding Public Transport Benefits)

Summary of Traditional Methodology

The parameters used in this assessment originate from the "Report of the Advisory Committee on Trunk Road Assessment" headed by Sir George Leitch, 1977. The economic values quoted have been adjusted to 1980 prices by use of the Retail Price and Earning Indices for that period. As stated previously, no relative increase in the cost of fuel has been acknowledged while the relative value of occupants' time has been assumed to increase at 2.4% per annum.

When evaluating Vehicle Operating Costs, only fuel and vehicle time savings have been included in the assessment.

Basic Unit Rates

Time

1.	Date at which benefits have been calculated	1990
2.	Composite value of vehicle occupants' time - 1980	£3.32/veh hour
3.	Annual increase in the relative value of working time	2.4% per annum
4.	Composite value of vehicle occupants' time - 1990	£4.21/veh hour
5.	Vehicle time cost	£0.45/veh hour

Fuel Consumption

6.	Fuel consumption of average car on surface streets	9.2 km/litre
7.	Fuel consumption of average car on motorway	13.5 km/litre
8.	Additional allowance to include all vehicle types	20%
9.	Cost of fuel (net of tax)	14.1 p/litre

Accidents

10.	Average accident rate on surface streets	1.847 IA/m V km
11.	-do- motorways	0.058 IA/m V km
12.	Cost per injury accident on surface streets	£6,758
13.	-do- motorways	£11,440

General

14.	Scheme cost including property acquisition	£14,500
15.	Number of equivalent days in a year	330

Work Tables

Peak Hour Benefits Category	Off Peak Benefits Category
Restrained 1990 Base Network and Restrained 1990 Design Network (EFStI)	Unrestrained 1990 Base Network and Unrestrained 1990 Design Network (EFStI)
Reduction in Vehicle Hours	
1,253 veh hours per day or 0.413 m veh hours per annum	353 veh hours per day or 0.182 m veh hours per annum
Change in Vehicle Miles	
Surface Streets:	
-41,235 veh km per day or -13.608 m veh km per annum	-17,129 veh km per day or -5.653 m veh km per annum
Motorways:	
+48,017 veh km per day or +15.846 m veh km per annum	+37,165 veh km per day or +12.264 m veh km per annum

CALCULATION OF ANNUAL ROAD USER BENEFITS IN 1990

	Peak Hour Benefits			Off Peak Benefits		
	Quantity	Rate	Value	Quantity	Rate	Value
Occupants' Time	0.413 m vhr	£4.21	£1.739	0.182 m vhr	£4.21	£0.766
Fuel	0.366 m l	£0.14	0.051	-0.352 m l	£0.14	-0.049
Accidents (SS)	25.134	£6,758	0.170	-10.441	£6,758	0.071
Accidents (MW)	-0.919	£11,440	-0.011	-0.711	£11,440	-0.008
Veh Time	0.413	£0.45	0.189	0.182	£0.45	0.082
			£2.138 m			£0.862 m
Proportion of ADT flow deriving Benefits			x 0.60			x 0.40
			£1.283 m			£0.345 m
						1.283 m
Total Benefit to Road Users attributable to Design Scheme						£1.628 m

$$\text{Hence, 1st year ERR} = \frac{1.628 \times 100}{14.126} = 11.5\%$$

Notes

(1) Peak Hour Fuel Savings:

Reduction in surface street fuel consumption = 13.608/92	1.479 m l
Increase in motorway fuel consumption = 15.846/13.5	1.174 m l
Net Saving	0.305 m l
+ 20%	0.366 m l

(2) Off Peak Fuel Savings:

Reduction in surface street fuel consumption = 5.653/9.2	0.615 m l
Increase in motorway fuel consumption = 12.264/13.5	0.908 m l
Net Saving	-0.293 m l
+ 20%	-0.352 m l

(3) Peak Reduction in Accident Frequency:

Reduction in surface streets accidents = 13.608 x 1.847	25.134
Increase in motorway accidents = 15.846 x 0.058	0.919
Net Reduction	24.215

(4) Off Peak Reduction in Accident Frequency:

Reduction in surface streets accidents = 5.653 x 1.847	10.441
Increase in motorway accidents = 12.264 x 0.058	0.711
Net Reduction	9.730

NET PRESENT VALUE ESTIMATES

As previously stated, all values have been quoted in 1980 pounds sterling with costs and benefits discounted to the opening year of the Scheme in 1990.

Assuming traffic growth will be in the order of 9% between 1990 and 2000, it is envisaged that the proportion of ADT flow during Peak Hour benefits will increase from 60% to 80%.

The real value of occupants' time has been assumed to compound at 2.4% from the year 1990 on, while in the case of fuel costs no annual increase has been included:

Gross benefits to road users in	1990	£1.626 m
" " " " " "	2000	£2.504 m
" " " " " "	2010	£3.073 m

The variation in benefits between these years has been assumed to be linear and Fig A-1 illustrates the various areas under the Benefit v Time Curve.

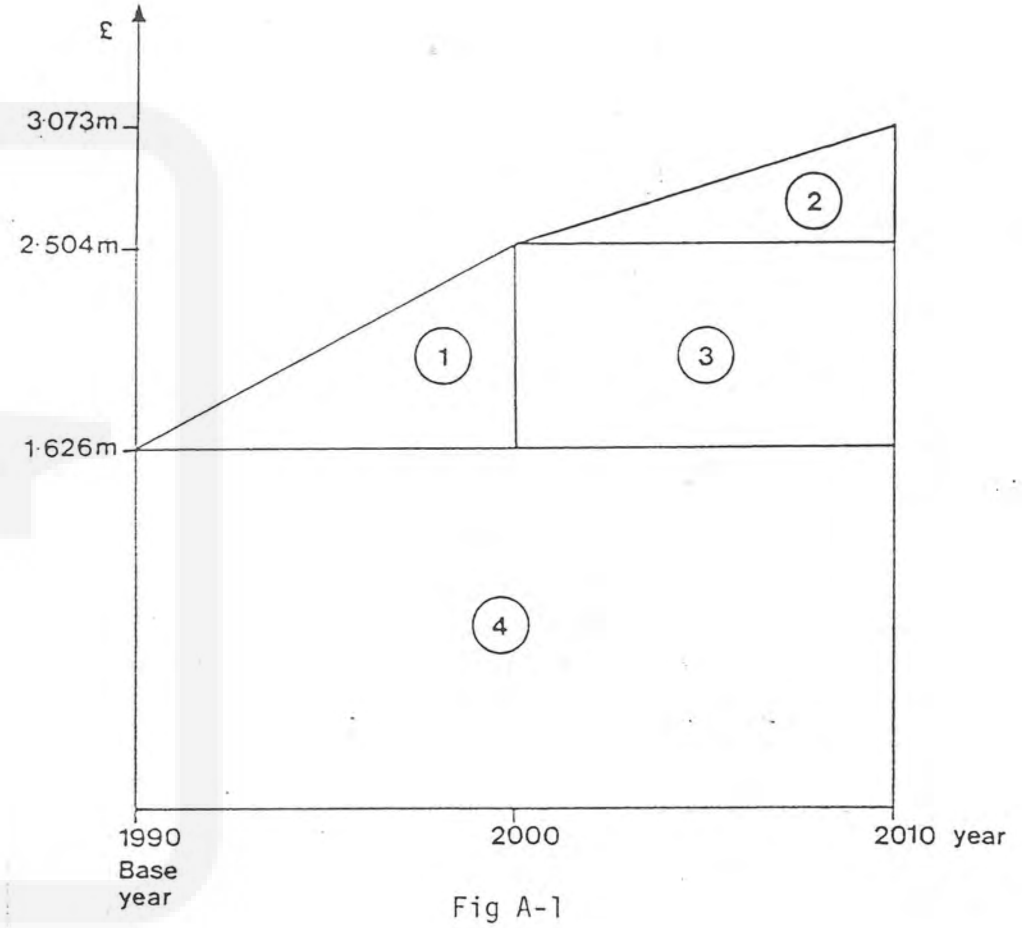


Fig A-1

CAPITAL COST OF CONSTRUCTION

Assume the components of cost to be made up as follows:

Construction Cost	£9.752 m
Property Acquisition	3.450 m
TOTAL	£13.202 m

Discounted to represent a mean construction year of 1989

∴ £13.202 x 1.07 = £14.126 m

Area 1	Present Value (PV) discounted to 1990		£ 3.050 m
Area 2	PV discounted to 2000 and subsequently to 1990	£1.977	1.005 m
Area 3	PV discounted to 2000 and subsequently to 1990	£6.167	3.135 m
Area 4	PV discounted to 1990		17.226 m
	Total Present Value of Benefits discounted to 1990		£24.416 m

Thus: Net Present Value = £24.416 - 14.126 = £10.290 m

Yielding a COBA type ratio of $\frac{9.916}{14.126}$ = 0.728

SUPPLEMENTARY ECONOMIC ASSESSMENT FOR PUBLIC TRANSPORT (BUSES)

The benefits due to time savings for passengers on routes alleviated by the Townhead-London Road Link Road and the provision of bus only lanes between Ingram Street and Bridgegate have been evaluated using a 1980 value of bus passengers' (non-working) time of 66 pence/hour.

Utilising bus frequencies and passenger levels obtained from the Greater Glasgow Passenger Transport Executive and the Scottish Bus Group, the benefits accruing from reduced surface street congestion have been calculated as:

Routes 1, 2, 4	PTE	£ 83,404
	SBG	32,692
		£116,096
Route 3	PTE	30,269
Elimination of Junction Delays	PTE	47,628
TOTAL BENEFITS		£194,000

These benefits increase the values obtained in Annex 1 to give:

1st Year Rate of Return	12.9%
COBA Ratio	0.9

JOURNEY TIME SAVINGS

ROUTE 1	HIGH STREET/CASTLE STREET (Duke Street to Royston Road)			
	Northbound	(310 - 170)	=	140s
	Southbound	(250 - 220)	=	30s
ROUTE 2	CATHEDRAL STREET/CASTLE STREET (North Hanover Street towards Royston Road)			
	Northbound	(280 - 210)	=	70s
	Southbound	(350 - 270)	=	80s
ROUTE 3	CATHEDRAL STREET/ALEXANDRA PARADE (Wishart Street to North Hanover Street)			
	Northbound	(260 - 230)	=	30s
	Southbound	(310 - 270)	=	40s
ROUTE 4	GEORGE STREET/DUKE STREET (John Knox Street towards North Hanover Street)			
	Northbound	(270 - 170)	=	100s
	Southbound	(200 - 150)	=	50s

DELAYS ALLEVIATED BY BUS ONLY LANES

Northbound (Clyde Street-Duke Street)		Southbound (Duke Street-Clyde Street)	
AM Peak	75s	AM Peak	88s
AMBP	84s	AMBP	121s
PMBP	60s	PMBP	198s
PM Peak	80s	PM Peak	69s

GGPTE PASSENGER LEVELS

	Northbound			Southbound		
	Total Passengers	No of Trips	Average Passenger Level	Total Passengers	No of Trips	Average Passenger Level
AM Peak	1,334	77	17.4	3,160	73	43.3
* AMBP	1,464	72	20.3	1,006	46	21.7
PMBP	2,121	87	24.4	954	45	21.2
PM Peak	5,253	115	45.7	1,582	84	18.8

SCOTTISH BUS GROUP PASSENGER LEVELS

	Northbound			Southbound		
	Total Passengers	No of Trips	Average Passenger Level	Total Passengers	No of Trips	Average Passenger Level
AM Peak	138	25	5.5	1,571	43	36.5
* AMBP	805	89	9.0	1,827	89	20.5
PMBP	2,598	99	26.2	931	93	16.0
PM Peak	1,681	44	38.2	103	43	2.4

* AMBP (0900-1300) PMBP (1300-1700)

TOWNHEAD SCREENLINE

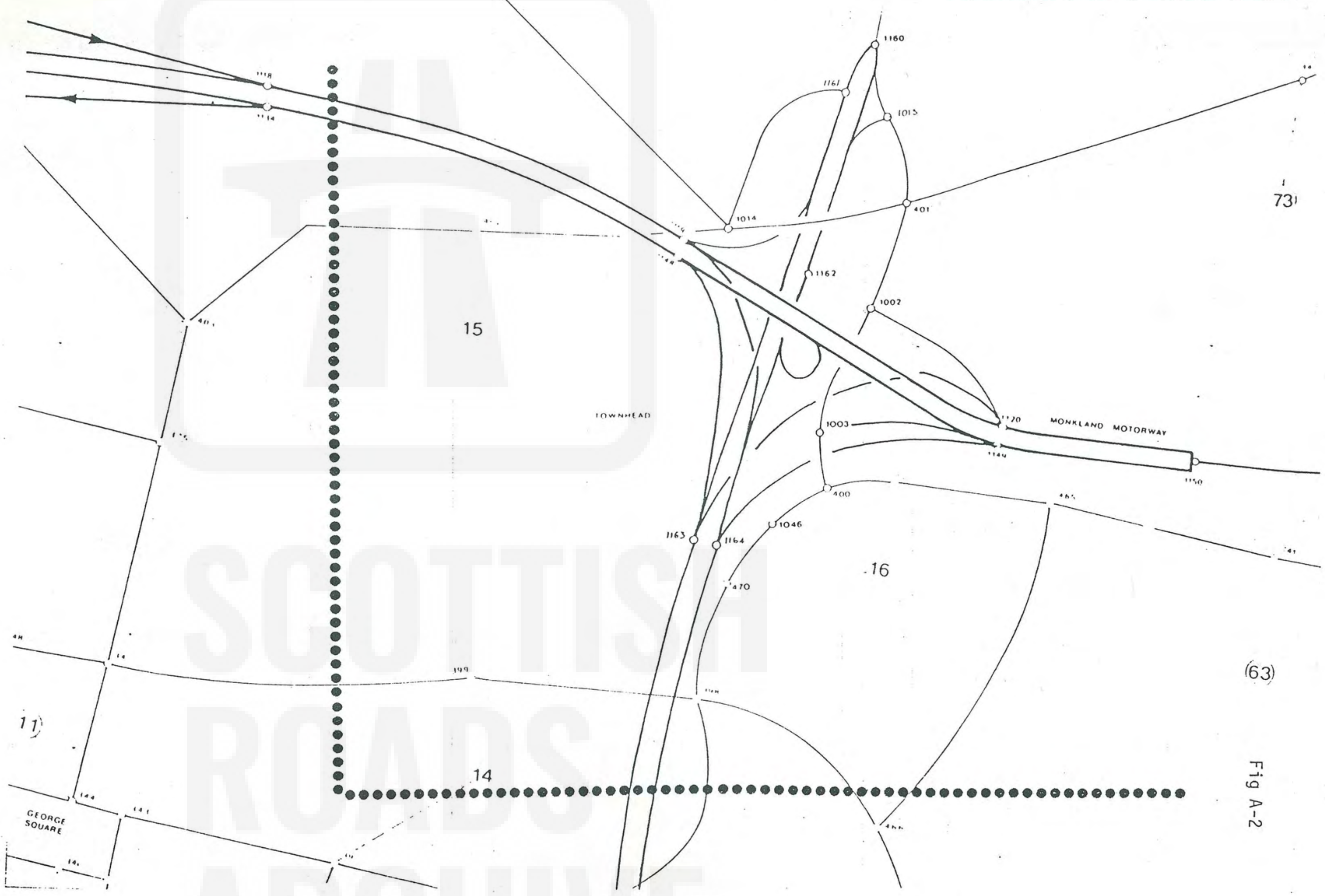


Fig A-2