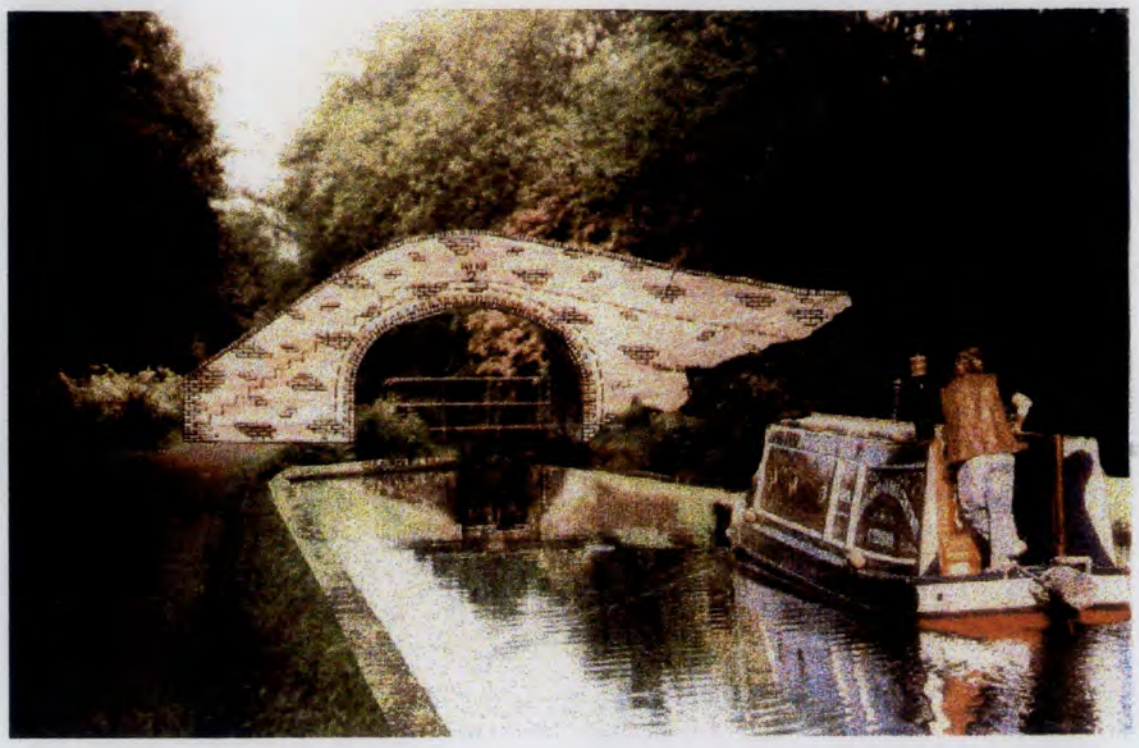

THE LAPAL CANAL

Restoration of the Dudley No 2 Canal

From Hawne Basin to Selly Oak

ENGINEERING FEASIBILITY STUDY

JULY 1999

Gerard Pakes Consultants
CHARTERED CIVIL ENGINEERS

LAPAL CANAL TRUST

Restoration of the Dudley No 2 Canal

From Hawne Basin to Selly Oak

ENGINEERING FEASIBILITY STUDY

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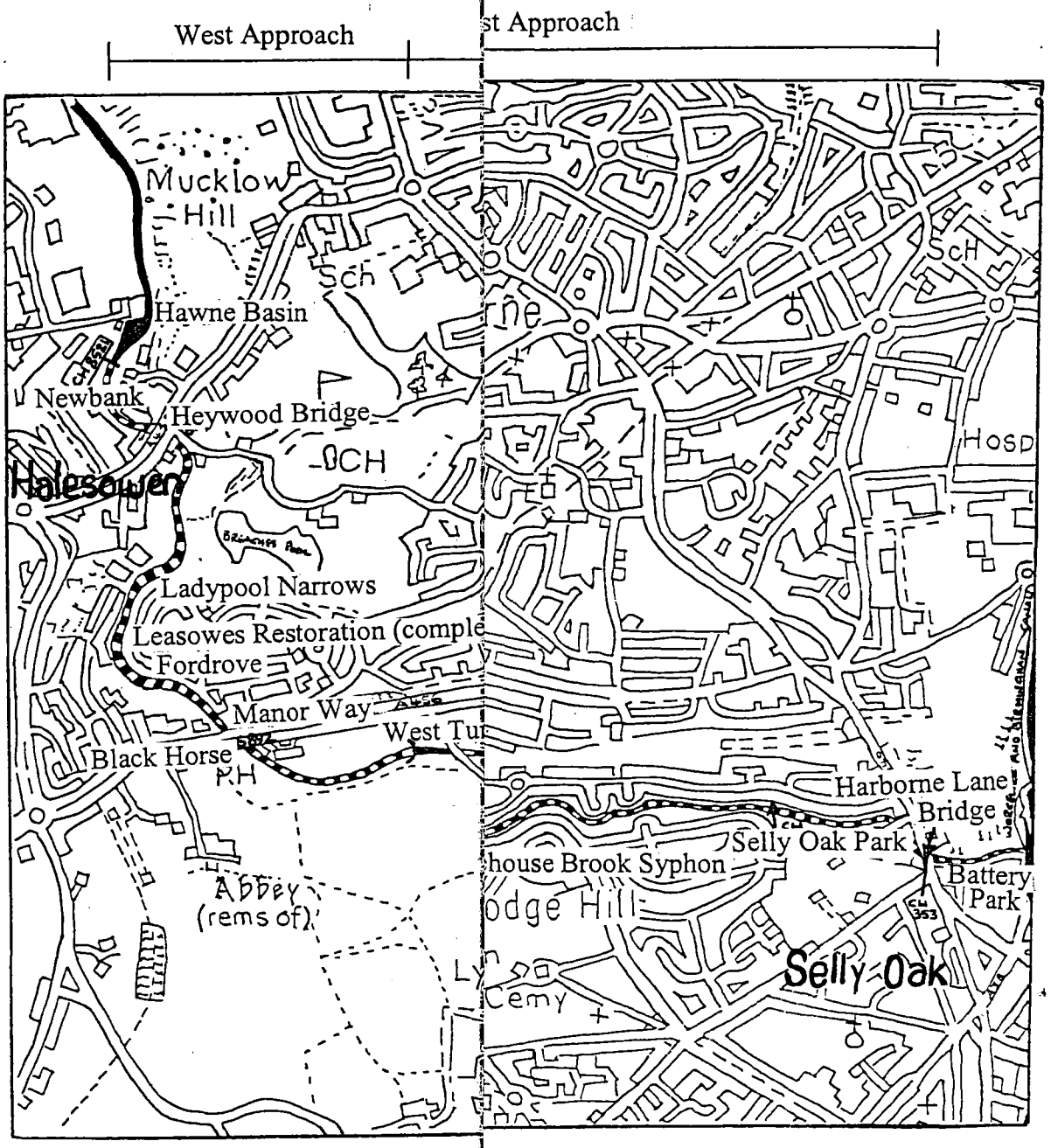

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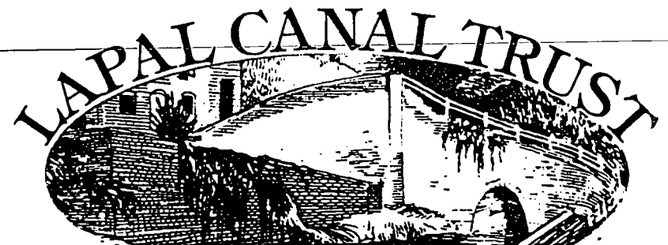
1. EXECUTIVE SUMMARY



THE LAPAL CANAL

ENGINEERING FEASIBILITY STUDY

1. Executive Summary

Gerard Pakes Consultants have been commissioned by the Lapal Canal Trust to complete an engineering feasibility study into the possible restoration and re-opening of the section of the Dudley No 2 Canal between Hawne Basin in Halesowen and Selly Oak Junction in Birmingham.

The canal was constructed in the late 1790's and opened for traffic just over 200 years ago. The Lapal Tunnel was closed in 1917, severing the canal into two halves. The eastern (Selly Oak) end was disused by the late 1940's, and the whole length abandoned in 1953.

Unusually for a canal which has been out of use for so long, there are few physical obstructions to restoration, even though those that do exist are significant problems. Only one permanent building, a basic factory unit adjacent to Mucklow Hill, has been constructed on the canal line, but most of the alignment has been retained as linear public open space in the ownership of Dudley Metropolitan Borough Council and Birmingham City Council.

The major engineering obstructions to restoration are as follows:

- A458 Crossing – Mucklow Hill
- A456 Crossing – Manor Way
- Lapal Tunnel
- Infilled area at the tunnel east portal

The A458 crossing is understood to use the original canal bridge, extended laterally by embankments. Many services cross the canal on each side of the road. While it would be possible to tunnel from each side and re-expose the original bridge, a completely new, full width bridge is the preferred solution.

The A456 crossing at Manor Way is at canal water level, and the road either has to be raised about 3m over an on-line culvert, with all the attendant accommodation works. An alternative is to divert the canal westwards to cross Manor Way on an aqueduct, assuming the land ownership problems inherent in this proposal could be solved. The construction costs of both solutions are about the same.

The Lapal tunnel suffered throughout its life from poor design and poor quality construction, and while piecemeal rebuilding of the collapsed and dangerous sections only is a possible option, this would leave a maintenance legacy, and create operational difficulties. An on-line reconstruction, using modern techniques and materials is therefore seen as the preferred option, possibly recreating the original portal structures only with the traditional appearance. This type of tunnel reconstruction was used at Blisworth and, if funds permitted, the Lapal tunnel could be made sufficiently wide for two-way working, while incorporating an emergency walkway and space for services, Longitudinal ventilation is envisaged to avoid re-opening ventilation shafts.

The infilled eastern portal cutting was used in the 1960's as a rubbish tip, and is now generating considerable quantities of methane. Removal of all offending material is the best environmental solution, but a cut and cover tunnel, 200 metres long, constructed within sheet piles, is the most cost-effective option. After construction of the tunnel, the present open space between Stonehouse Lane and Stonebrook Way could be reinstated.

There are also many smaller obstructions and service diversions, none of which constitute a major engineering problem. The main remaining task is then excavation and disposal of, in total, about 65,000m^3 of fill material which has been deposited in the canal channel since 1953, and the reinstatement of the canal infrastructure, such as accommodation bridges. All this work is seen to be tasks for contractors, with volunteer groups providing the additional resources necessary to complete the waterway restoration.

Basic construction costings have been done on all the operations described and result in the following.

1.	Hawne Basin to Lapal Tunnel west	£ 5.90m
2.	Selly Oak Junction to Lapal Tunnel east	£ 4.90m
3.	Lapal Tunnel	£17.50m
	TOTAL	£28.30m

The costs for the west side include for either an aqueduct over Manor Way or a culvert on the original line. Land costs are not included. The Lapal Tunnel cost includes for complete reconstruction as a 2-way tunnel to modern standards as described. A saving of about £2.5m could be made by constructing a single way tunnel, and while a piecemeal "repair and renovate" approach could save a further £2m-£3m in capital costs, it would be at the expense of a lower, (possibly unacceptable), standard and increased maintenance.

The study concludes that there are no insurmountable engineering obstacles to restoration of the Lapal Canal to navigable standards. Each end of the canal is a viable restoration project in itself, and the section to Manor Way in the west, and to Weoley Castle in the east, in total about 4000 metres, could be restored easily, with few engineering problems, at a moderate cost. The large capital expenditure (75%) is involved in crossing Manor Way, restoring the tunnel and crossing the area of the eastern tunnel portal.

2. INTRODUCTION AND HISTORY

2.1. Background

The Dudley No 2 Canal is part of the Birmingham Canal Navigations, and was opened in 1798. It runs in an L-shape, north to south along the western edge of the Black Country escarpment, from the original Dudley Canal at Blowers Green, then west to east through the watershed at Lapal and the Bournebrook Valley to the Worcester and Birmingham Canal at Selly Oak in Birmingham. The total length is approximately 10½ miles (16 kilometres).

Since abandonment of the southern section in 1953, the canal has fallen into three distinct parts.

1. From Blowers Green to Coombeswood. Owned and maintained by British Waterways as a cruiseway as far as Windmill End and thereafter as a remainder waterway. Length 6500m (4.3 miles)
2. From Coombeswood to Hawne Basin. This section, having been abandoned, was restored to a navigable state by the Coombeswood Canal Trust in 1990. Length 1000m (0.7 miles)
3. The southern section, locally known as the Lapal Canal or the Selly Oak Extension Canal, running from Hawne Basin to the Worcester and Birmingham Canal at Selly Oak. Length 8500m (5.6 miles)

The Lapal Canal Trust was formed in 1990 with the object of protecting from further depredations those parts of the southern section of the Dudley No 2 Canal which were still in existence, and eventually restoring the whole length of the canal to navigable condition.

Gerard Pakes Consultants has been commissioned by the Lapal Canal Trust to carry out an engineering feasibility study for the Lapal Canal from Hawne Basin to Selly Oak. The study is primarily to determine whether full restoration to navigable condition is physically possible and, if so, the likely effects and costs.

This engineering feasibility study will be combined with studies into the following aspects, to be carried out by the Trust.

1. an environmental impact study
2. investigations into the viability of the partly restored and fully restored canal length,

The three studies together will form a complete restoration feasibility study.

2.2 Restoration Objectives

Restoration proposals for the Lapal Canal are being put forward with the following objectives:

1. By producing a continuous water link, create and maintain a linear park area through the south western parts of the Birmingham Conurbation.
2. Create further boat cruising "rings" in the North Worcestershire, South Staffordshire area.
3. Re-create the original intention of the Dudley No 2 Canal and provide a canal by-pass to the Birmingham Canal and the centre of Birmingham.
4. By initiating waterside development, help to regenerate the areas on the canal line in need of redevelopment.
5. Generally create opportunities within the boating industries and associated services for development in the area.
6. Protect and reinforce the existing green belt areas of the alignment.

2.3 History

The Dudley No 2 Canal was first suggested at a public meeting in Birmingham on 31 August 1792, chaired by Isaac Spooner, to promote a canal from near Birmingham to the collieries at Netherton. The meeting agreed to negotiate with Lord Dudley and the Dudley Canal Committee who met the following day and agreed that an extension of the Dudley Canal to the proposed Worcester canal would be "highly advantageous" to the interests of the Dudley Company.

After an approach to the Worcester and Birmingham Canal Company, it was agreed that the Dudley Company would build the extension, and would subscribe £28,500 to it, the remaining £90,000 being raised by the Birmingham promoters. The Act of Parliament was obtained in 1793, with the support of the Worcester and Birmingham and the embryonic Stratford Canal Companies, and despite intense opposition from the Birmingham Canal and the Staffordshire and Worcester Canal, with whom the extension would compete. It was reported in a local newspaper that 13,000 of the principal inhabitants and manufacturers of Birmingham petitioned the House in favour of the Bill, mainly due to dissatisfaction with the monopoly position of the Birmingham Canal Company. This figure is almost certainly an exaggeration, but there was obviously strong support for the canal in the area.

The line as surveyed was 10.9 miles long, on the "Birmingham Level" of 453 ft AOD, with three tunnels, Gosty Hill (557 yards), Halesowen (29 yds) and Lapal (3795 yds). Josiah Clowes was appointed Engineer, at 3 guineas per day, with William Underhill (a particularly apt name for the construction of the fourth longest canal tunnel in England!) as Resident Engineer at £150 per year and a house. Thomas Green was the works superintendent. The surveyors setting out the line were told to avoid deep cuttings and substantial embankments, but nevertheless proposed the Leasowes embankment south of Halesowen at some 60 feet high and 550 yards long - by any measure a substantial earth structure in 1793. On the death of Josiah Clowes in 1796, the

work was continued by Underhill, subsequently assisted by Robert Whitworth and Benjamin Timmins. The canal was opened to Halesowen in 1797.

Great difficulty was experienced with construction of the Lapal Tunnel, which was driven from 30 shafts and two portals, with three steam engines used for pumping. The Committee were obviously concerned with the haemorrhage of money into the tunnel, and at one point appear to have lost confidence in their Engineer, for Thomas Brettel, the Company Clerk, wrote in June 1796 that, short of turning miners themselves, there was little the "hard working Committee" could do than to supervise the Engineer much more closely!

The canal was reported as "completely open" in May 1798, but traffic was light until the Stratford and the Warwick and Birmingham Canals were opened in 1802, providing a through route towards London, and until the Worcester and Birmingham Canal opened to Worcester and the Severn in 1815. Serious maintenance problems with the Lapal Tunnel, attributed to "subsidence" but probably due to construction defects, had caused prolonged closures of the canal in 1801 and again in 1805. The tunnel was to suffer recurrences of these problems throughout its life. The narrow bore of the tunnel also meant that it caused a traffic bottleneck as the boats took over 4 hours to be "legged" through, and for a time the Dudley Canal Company paid boatmen special allowances to assist in hiring additional leggers. In 1841, a unique system was installed which created a current through the tunnel with the help of a large steam pumping engine close to the Halesowen Portal, the current assisting the boats by flowing first one way for a period and then reversing. This system operated until 1914.

During most of the 19th century and up to 1914, the canal saw steady traffic, despite the regular closures for maintenance of the tunnel and other structures. By the end of this period, however the heavy traffic was concentrated mainly at each end, and a serious roof fall in the tunnel in 1917 caused an extended closure. Reopened briefly in 1922, a further roof fall then brought about the permanent closure of the tunnel. Trading continued to the brickworks, factories and mines, especially at the Halesowen end where intense trading to steelworks

continued, but by the late 1940s, the eastern end was largely disused past the junction basin at Selly Oak, and the western end past Hawne Basin. The length of canal between these points, including the Lapal Tunnel, was officially abandoned in 1953.

3. EXISTING CONDITIONS

3. EXISTING CONDITIONS

3.1 Alignment

Unusually, for a canal which has been severed into two halves for 80 years and officially abandoned for 46 years, the alignment of the canal is still clearly discernible over 90% of the length and, because of various factors, much of the linear corridor has been protected. Development, except for one short length, is currently absent, and much of the land is still in public ownership

The state of the alignment at present is given, in general terms, in Table 3.1.

	Hawne Basin To Selly Oak Length in Total 8557m	
1.	Length of original canal in water	180m
2.	Length of restored canal in water	466m
3.	Length of channel in existence but dry	600m
4.	Length of channel infilled (industrial)	400m
5.	Length of channel infilled (green areas)	3289m
6.	Length of channel built over (buildings)	75m
7.	Length of channel under obstructions	80m
	Total	5089m
8.	Length in Tunnel	3468m
	Total	8557m

Table 3.1

3.1.1 Original Canal in Water

The Section of the original channel which is still in water is at the extreme western end of the Lapal Canal, adjoining that section of the Dudley No 2 Canal restored by the Coombeswood Canal Trust in 1990. It is connected to the Coombeswood section by an end-on junction.

3.1.2 Restored Canal in Water

This is the newly restored Leasowes Embankment, where a length of some 466m through the Leasowes Park has recently (1998) been renovated.

3.1.3 Channel in Existence But Dry

There are two lengths where the canal channel is still in existence, but where it is not in water at present:

1. From the end of the restored section in Leasowes where the channel extends for a further 300m southwards, almost to the site of the original Fordrove Bridge.
2. In Selly Oak Park at the Birmingham end, where a defined channel exists, albeit with some obstructions, which is currently used as a storm drainage balancing pond.

3.1.4 Infilled Industrial Section

The channel has been infilled for lengths at both the Birmingham and Halesowen ends.

1. From Harborne Lane Bridge eastwards to the Worcester and Birmingham Canal, the line of the Lapal Canal ran through what used to be the factory site of the Birmingham Battery Limited and, since the works closure, the whole area has been cleared. It is understood from the Selly Oak Development Study that there is contaminated fill in this area. The fill level is approximately at towpath level and the original canal alignment is still discernible through the area of derelict industrial land.

2. Adjacent to the Newbank site at the Halesowen end, a steel stockyard and factory has been located on the canal line. A new retaining wall holds the service road running to the east of this factory. The factory and stockyard is currently (1999) under-used and the remaining period of the lease is for sale.

3.1.5 Infilled Green Areas

1. A short length at the eastern end of Selly Oak Park, adjacent to Harborne Lane Bridge, has been infilled to just below towpath level, and the line of the canal, including an original accommodation bridge, reportedly one of the oldest original bridges on the Birmingham Canal Navigations, has been retained as a feature.
2. From Selly Oak Park westwards, the channel has been infilled to towpath level and the whole alignment converted to a linear walkway through the Lodge Hill and Weoley Castle Estates. The walkway is broken at Bottletourt Road, where a short length has been used for a builders yard, but it is understood that this area is scheduled to become part of the same linear walkway.
3. The area around the eastern portal of the Lapal tunnel has been infilled completely and totally re-landscaped, and all traces of the canal have disappeared. The area is, however, public open space and is also the site of an extensive methane drainage operation recently installed due to the fact that the original canal tunnel approach cutting was filled with domestic refuse before being capped (see section **4.1.4**).
4. From Manor Way to the western portal of the Lapal tunnel, the channel has been infilled and the land returned to agriculture. The towpath hedge can, however, clearly be discerned, but the cutting leading to the Lapal tunnel western portal has been filled back to the original ground level.
5. From the site of Fordrove Bridge as far as Manor Way, a distance of 250m, the original canal alignment forms a public

walkway. The channel has been filled to towpath level and some minor landscaping works have been carried out.

3.1.6 Length Built Over

One factory building (see **3.1.4.2**, erected adjacent to Mucklow Hill at Heywood Bridge, is the only building erected on the actual line. The end bay of the factory occupies what used to be the canal alignment, and a retaining wall has replaced the original cutting.

3.1.7 Obstructions

Two major roads break the canal line alignment at the Halesowen end.

1. The A458 (Mucklow Hill) Bridge has been infilled and extended by embankments, although the original crossing point is still clearly discernible.
2. The A456 (Manor Way) crosses the alignment at canal level and this major dual carriageway forms a serious obstruction. On the south side of the road the canal continues through the extended car park of the Black Horse Public House.

3.1.8 Tunnel

The remainder of the total length of 8557 metres consists of the Lapal Tunnel and this is described fully in Section **4.1.3** below. Since the closure of the tunnel, the M5 motorway has been constructed and new, private housing has been erected at the Lapal end. Further east the 1960's Woodgate Housing Estate was built over the tunnel for a length of about 1000m. The remainder of the tunnel alignment consists of open space, either the Woodgate Valley Country Park or the playing fields attached to Woodgate School. Although no shaft superstructures are currently visible on the surface, the spoil heaps resulting from 24 of the 30 shafts can clearly be found by following the tunnel alignment.

3.2 Physical Obstructions

The physical obstructions which have occurred or been constructed since the canal was closed are as follows.

1. Stonehouse Brook Crossing
2. The east portal of the Lapal tunnel infilled with domestic refuse and buried.
3. Collapsed sections of the Lapal tunnel.
4. The buried west portal of the Lapal tunnel
5. A pylon and buried high tension cables to the south of Manor Way
6. Manor Way
7. Mucklow Hill Bridge
8. The stockyard and factory of the Newbank Forge.

Of these, the Manor Way crossing, the East Tunnel Portal area and the Lapal Tunnel present the major restoration problems.

Various service utilities also cross the canal line and many footpaths have developed or been constructed during the period when the canal has been out of use. Both services and footpaths are present in the Fordrove Bridge/Manor Way area and footpaths in the Lodge Hill Green Corridor between Selly Oak Park and California. At the eastern end, the towpath bridge for the Worcester and Birmingham Canal has been removed, and in Selly Oak Park a storm water overflow chamber has been built in the centre of the existing channel. It is also understood that on the Selly Oak side, drainage pipelines have been laid down the full length of the original canal line, at the base of the channel, following floods shortly after the official abandonment of the line, and before infilling. A reappraisal of the drainage structures in this area will be necessary.

3.3 Planning Questions

More than 90% of the length of the Lapal Canal is either in green belt land or in areas designated as green areas. Although the length to the north of Mucklow Hill to Hawne Basin is zoned as industrial, it is understood that in the strategic plan this area could become part of the Coombeswood Green Wedge, extending southwards through Halesowen and connecting with the Leasowes Park. The Leasowes section is in a Grade I listed park and the walkway from Fordrove to Manor Way is a protected green area. To the south of Manor Way, the canal is adjacent to the ruins of Halesowen Abbey and efforts are being made on the planning front to improve access and parking to the Abbey by opening up this area, and at the same time protecting the line of the canal.

On the Birmingham side the section from the eastern portal as far as Harborne Lane, is designated green area, either as the Lodge Hill linear walkway or Selly Oak Park. From Harborne Lane Bridge to the Worcester and Birmingham Canal is currently designated as an industrial zone, but development plans for this area include proposals for a change of use, and possibly for canal restoration. The area is currently (1999) part of the Selly Oak Development Study.

3.4 Land ownership

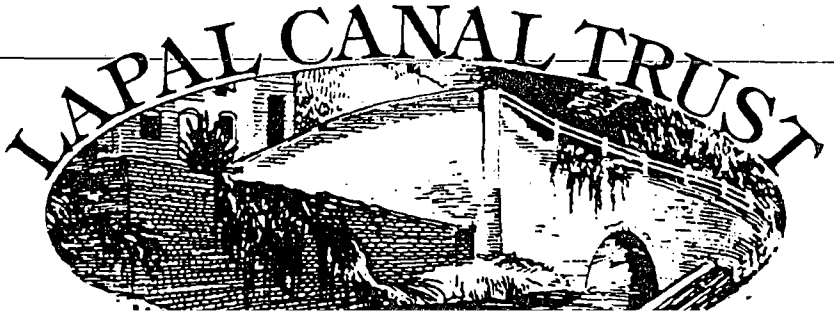
A brief schedule of landowners and lessees appears in Table 3.2 below.

Length	Owner	Lessee	% of Length
Harborne Lane Bridge to the Worcester and Birmingham Canal	J Sainsbury Ltd	None	4
Lapal Tunnel eastern portal to Harborne Land Bridge	Birmingham City Council	None	29
Lapal Tunnel	British Waterways	None	41
Black Horse to the Lapal Tunnel west portal	Mr C Tudor	?	6
Car Park of the Black Horse Public House	Dudley Met Borough Council	Allied Domecq	1
Mucklow Hill to Manor Way, Leasowes Section	Dudley MBC Dudley MBC	None LCT	15
Hawne Basin to Mucklow Hill	British Waterways	Newbank Forge	4

Table 3.2

Of the whole length therefore 90% is in public ownership and only 2 short lengths, comprising 10%, is in private ownership. One length owned by British Waterways, comprising 4%, is leased on a 99 year lease to a private lessee. This lease is currently (1999) for sale

4. ENGINEERING WORKS



4. ENGINEERING WORKS FOR RESTORATION.

4.1 Major Works

Major engineering works required for restoration of the Lapal Canal are:

1. Crossing of Mucklow Hill, the A458.
2. Crossing of Manor Way, the A456.
3. Restoration of the Lapal Tunnel
4. Excavation of the domestic refuse tip forming the eastern cutting to the Lapal Tunnel

4.1.1 Mucklow Hill (Heywood Bridge)

The dualling of Mucklow Hill in the early 1970's involved the construction of an embankment on either side of the existing canal bridge in order to provide sufficient width for a dual carriageway road. It is understood that the original canal bridge remains in place under the centre section of the road and, according to the owners Dudley Metropolitan Borough Council, may still carrying load even though the bridge arch has been infilled. There are extensive service utilities laid in both extended verges of the Mucklow Hill dual carriageway.

As the road level afford sufficient air clearance to canal water level, there are two restoration options:

1. To construct a new bridge for the full width of the dual carriageway, replacing the existing composite structure.

2. By box jacking, or other tunnelling methods, restore the canal through the embankments on each side of the original bridge, expose the original bridge arch and refurbish, including strengthening as necessary.

Both options are technically feasible but, in view of the currently increasing vehicle loads on road bridges, it would appear that a new bridge would probably be the better option if the funding question could be solved. Details are given in Appendix 3.4.

4.1.2 Manor Way

This is a major engineering problem to full restoration, as the existing, very busy, A456 dual carriageway crosses the canal at water level. The vertical alignment of the road is already on a steep gradient of 1 in 22 and raising the road to give clearance over the canal would require extensive accommodation works and further increase the gradient on the western side. Five crossing options have been considered:

1. A culvert crossing on the original line by raising the road level.
2. An aqueduct crossing to the west of the existing alignment.
3. A deep culvert crossing to the east of the existing alignment.
4. "Out of level" canal crossing options
5. Boat transporter systems

4.1.2.1 Crossing by means of a culvert on the original alignment presents considerable difficulty. Extensive accommodation works will be required to raise the road level to allow clearance underneath a bridge or culvert, involving filling on both sides of the canal line by about 2.5m. This increase would then have to be run out over the western side of the A456 over a length of at least 263m, increasing the gradient to 1 in 18. Adequate sight lines for the speed of the road will be difficult to establish, and the appearance of a slight "hump backed" bridge would be created.

It is understood that Allied Domencq wish to redevelop the site of the Black Horse Public House, possibly involving the demolition of the existing building. This would remove some objection to the raised road level, but the proximity to houses in

Cloister Drive remains a problem. On the other hand, a raised road level would simplify access possibilities to the area west of the public house, which is being considered for development as parking and a Visitor Centre for the historic Hales Owen Abbey. A culvert crossing at this point, incorporating a towpath, would also provide a much needed safe pedestrian route across Manor Way.

Full details are given in Appendix 3.3.

A further complication of construction south of Manor Way on the original route are the 275 Kv cables which, from the pylon immediately to the south of the Black Horse Public House, are taken underground and run close to the side of Manor Way. The induction loops for these cables lie across the original canal alignment. Alterations would have to be made to these cables to lower or divert them. (See 4.3 below and Appendix 3.3)

4.1.2.2 Aqueduct Crossing

If the crossing point at Manor Way is moved approximately 120m west of the original line, the A456 could be crossed by means of an aqueduct with only minor alterations to the road level, and still maintaining the minimum Highways Agency clearance of 5.25m.

The canal approach on the north side of Manor Way to an aqueduct would have to run through land owned by Sandvik, whose premises lie to the west of the present canal line, fronting onto the A456. The aqueduct would landfall on the west side of the area being considered for development in connection with car parking for Halesowen Abbey, and a diversion canal would be necessary to rejoin the original line approximately 75m south of Manor Way.

Two types of aqueduct have been considered, either a short span aqueduct crossing the road itself, approached on each side by retained embankments, and constructed of either concrete or steel or, alternatively, a double long span steel aqueduct, probably cable stayed, spanning both the road and the Sandvik site.

The northern canal approach to a short aqueduct would make significant inroads on the Sandvik site. It would run across an area currently occupied by a derelict factory presumably intended for redevelopment by the owners. An advantage of this proposal is that the land at the east end of the Sandvik site, which would be divided off from the remainder of the site by the canal on its approach embankment, could be filled to the canal level and possibly be developed for housing or other use. The aqueduct itself would be comparatively short giving a choice of construction methods.

The alternative proposal of a long span aqueduct would span both the road and the Sandvik site and, except for a height restriction, the only footprint would be the size of the central pillar needed for carrying the cables. This would allow relatively free use for the landowner of the whole of the site. An aqueduct of this type would form a striking feature in the Illey Brook Valley when being approached from either direction on the A456.

In both cases the towpath could provide pedestrian access across the busy A456 and it would complete the walkway from Leasowes Park to Hales Owen Abbey. Further details of the aqueduct proposals are given in Appendix 3.2.

4.1.2.3 Culvert Crossing East of the Existing Alignment

As Manor Way is on a steep gradient at the point of the canal crossing, a small diversion eastwards would provide sufficient cover for the road to cross the canal with adequate navigation headroom. It would appear possible to use the existing area of land between the BP Filling Station and the Black Horse Public House as a corridor for the culvert on the south side of Manor Way. On the north side of the dual carriageway however, the diversion necessary to connect a slightly curved culvert would probably require most of the garden of 1 Cloister Drive, and could involve purchase and demolition of the house itself. This diversion would also make serious inroads into the green area between Nos 2 to 6 of Cloister Drive and the dual carriageway, replacing the existing road junction. A new access, including a bridge to Cloister Drive would be required.

This solution would, however, provide a canal and pedestrian crossing of Manor Way without altering the road levels and, because it does not run through the car park of the existing Black Horse Public House, would also avoid the 275 kv cable induction loops. Because of the inroads into private domestic property, however, this option has not been further pursued.

4.1.2.4 "Out of Level" Canal Crossing Options

Two options have been briefly considered for crossing Manor Way at the original crossing point but on a level different to that of the rest of the canal.

Very large structures would be involved if an overhead crossing was to be considered, as the boat lifts necessary at each end of a short aqueduct would require a considerable site area. A structure of this nature, whilst interesting from the mechanical

point of view, would also have a considerable, probably unacceptable, visible impact on the area.

A crossing under the road where the canal is lowered through locks at each end is possible. Arrangements would have to be made for storage and back pumping of the water used in the locks at both ends, and because of the safety implications of much of the lower section of the canal being in culvert, adequate emergency drainage provisions would have to be made. These would probably have a larger impact on the landscape in the area than the canal crossing itself. This arrangement is however technically feasible, and probably the lowest capital cost option. Operating costs would be high.

4.1.2.5 Boat Transporter Systems

A system of transporting boats between canals on either side of Manor Way has been briefly considered, possibly as a temporary measure, should the rest of the navigation be open for through traffic before a solution to the Manor Way problem was found. While feasible, this solution is not considered practical or desirable.

4.1.3 Restoration of the Lapal Tunnel

The condition of the Lapal Tunnel at present is largely unknown as the last entry before the portals were backfilled was made in 1961. At that time, the eastern third of the tunnel, approximately 1000m was still in reasonable condition and passable by canoe. An investigation of the records by British Waterways has shown that the problems with the tunnel subsidence and roof collapses were mainly concentrated at the eastern third point. Geologically the Birmingham Fault intersects the Lapal Tunnel at about the western one third point. The western end is located in the Halesowen Beds of the Upper Carboniferous Series while the eastern end is in the Keuper Marl, or Mercia Mudstone, of Triassic age. It is expected that most of the problems would be in the eastern

third of the tunnel, where the stratification places much greater loads on the tunnel structure.

Local memories report that a section of the tunnel was grouted solid during construction of the M5 motorway in 1964. The Highways Agency however have no record of any such operation, although unconfirmed reports do mention a subsidence trough appearing overnight during construction, at the point where the Lapal Tunnel crosses. This was backfilled and levelled during the construction process for the M5. If it occurred, this trough could have been the result of a further fall inside the tunnel occasioned by the construction activities above, or possibly a shaft backfill collapse.

The Lapal Tunnel was always a very restricted cross section area and the rock convergence effect of the tall, narrow cross section exacerbated this problem. Restoration of the tunnel to the original cross section, therefore, would be (a) difficult to achieve, (b) produce a tunnel which would be difficult to maintain, (c) result in a tunnel which would be very difficult to ventilate when used by modern diesel craft.

In order to overcome the rock mechanics problems of the original tall, narrow profile, a circular section is proposed to remove those parts of the tunnel affected by convergence and roof falls. A 4m diameter tunnel would remove most of the original construction and some of the assumed failed ground, but a 5.5m diameter tunnel should remove all the original and the ground affected by subsequent subsidence. A concrete segmental lining could be installed behind a tunnelling shield, driven on-line to remove the damaged and subsided areas. This technique has been used on parts of the Blisworth Tunnel in Northamptonshire. A 4m diameter tunnel would allow single way traffic, an emergency walkway along one side and space for services and ventilation. A 5.5m diameter tunnel would allow two-way working with adequate room for emergency walkways, services and ventilation.

In the British Waterways investigation study, the last engineering survey reported sporadic areas throughout the whole length of the tunnel to be in need of attention. These are probably the sites of working shafts, of which 30 were required for construction of the tunnel, and these are traditionally weak points in brick lined canal tunnels. Collapses in the early 1980's in Preston Brook Tunnel and West Hill Tunnel were the result of fill within shafts moving vertically, putting extra load onto the tunnel lining. If the full length of the tunnel was not reconstructed with a concrete segmental lining, then all the shaft areas would have to be individually treated with a competent lining, to strengthen these areas, and allow passing places.

Full ventilation is considered essential for a modern canal tunnel. Longitudinal ventilation is preferred, and if this is effective then there would be no need to re-open any of the vertical ventilation shafts currently backfilled and demolished on the surface. There could be a problem with methane leakage into the tunnel from the eastern portal but this is treated more fully in the next section. Unless the tunnel was made sufficiently large for two-way working over its full length, some traffic management system would also be required. To fulfill modern safety requirements, an emergency walkway would be provided wherever the original lining was replaced.

Full details of proposals for the restoration of the tunnel are given in Appendix 3.1.

4.1.4 Lapal Tunnel Eastern Portal

During the early 1960's the cutting to the eastern portal of Lapal tunnel, and the surrounding brickwork excavations, were used as a "temporary" dumping area for domestic refuse during an industrial dispute with the city refuse collectors. By this time the channel had been officially abandoned for 8 or 9 years and derelict for many years before that. Redevelopment was planned for the whole area. The presence of this convenient "unwanted" hole, solved the problem presented by the

industrial dispute. It does not appear that any accurate records were kept of the volume of material deposited, or the extent over which the refuse was laid. Once the useable volume of the hole was filled a clay capping was placed on top of the refuse and the whole area landscaped. The thickness of the clay capping was also in some doubt until determined in places during comparatively recent site investigations.

During the mid 1990's, large quantities of methane were detected in the foundations and cellars of surrounding properties and remedial measures were taken to contain the problem of methane arising from decomposition of the refuse. A slurry wall was placed parallel to the Stonehouse Brook to prevent migration southwards to the houses in Stonebrook Way. Over the rest of the site extensive methane drainage trenches were dug and vent stacks erected around the public open space which marks the site of the old eastern portal. Although the tunnel itself was not directly investigated, there can be little doubt that this methane is also present within the tunnel.

Besides the canal cutting it is also understood that the adjacent brickwork clay pits were also filled with domestic refuse, but the extent is unclear. In an easterly direction it is unlikely that the refuse was placed in the area now occupied by the building contractors depot as by this time the canal cutting was becoming shallower.

Two methods of dealing with this particular environmental and technical hazard are possible.

1. Removal of all decomposing material and restoration of the original cutting.
2. Removal of only that occurring directly on the Canal line by extending the canal tunnel, probably by cut and cover methods.

Most of the operations described above, and the removal of approximately 65,000m³ of fill which has been placed in the canal channel over the years, are seen as work to be carried out by contractors.

There is, in addition, a very large scope for volunteer input in the whole range of tasks necessary to restore the full waterway, including repairs to existing structures, towpath reconstruction, bank protection work and similar tasks.

4.3 Services

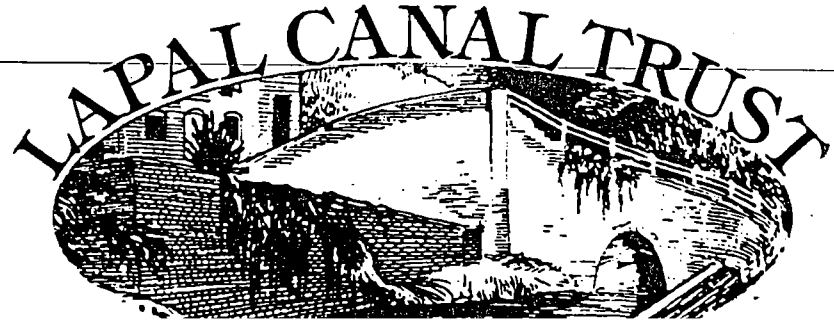
Numerous utility services have either been laid across or along the canal line since closure.

Those requiring significant engineering works for diversion include.

1. high pressure and medium pressure gas mains in the Manor Way/Fordrove area.
2. 275kv underground cables and induction loops at Manor Way.
3. Drainage arrangements in the Selly Oak Park and Weoley Castel areas.

In addition, numerous water, electricity, telephone and gas services cross the alignment and will require local diversion by the appropriate utility company.

5. RESTORATION COSTS



5. RESTORATION COSTS

5.1 Capital Costs

Restoration capital costs have been calculated with an accuracy based on the level of design or feasibility study completed. Full details appear in Appendix 4. All costs assume that the work is done by contractors. Some of the tasks are, however, suitable for voluntary labour and would afford opportunities for savings. Land or lease purchase costs are not included.

		£
1.	Hawne Basin to Newbank	
	Dredging of existing channel	
	Minor Works	100,000
2.	Newbank	
	Re-excavation through stockyard and factory	350,000
3.	New Bridge ± Mucklow Hill	1,200,000
4.	Leasowes Restoration (complete)	207,000
5.	Ladypool Narrows to Fordrove, including 2 bridges	330,000
6.	Fordrove to Manor Way	230,000
7.	Manor Way Crossing	
	(a) On-line culvert including alterations to road	2,500,000
	(b) Diversion of 275KV cables	500,000
	(c) Black Horse Car Park	100,000
8.	Black Horse to West Tunnel Portal	400,000
9.	Tunnel Refurbishment	17,500,000
10.	East Portal to Aggregate Stockpile Yard (Refuse tip)	2,070,000
11.	Stonehouse Brook – Aggregate Stockpile Yard	515,000
12.	Stonehouse Brook Syphon	155,000
13.	Selly Oak Park to Stonehouse Brook	850,000
14.	Selly Oak Park	350,000
15.	Harborne Lane Bridge Refurbishment, say	45,000
16.	Battery Park	820,000
17.	W & B Junction, say	80,000
	TOTAL	£28.3m

The tunnel restoration price is based on driving a new, 5.5m diameter, on-line, segmentally lined tunnel to allow two-way traffic. A single way tunnel, at 4.0m diameter would cost approximately £2m less, and a "hit-and-miss" repair, where every shaft position is reinforced for safety reasons, would cost about £12-£13m. This latter option would, however, involve operational difficulties and increased maintenance.

The costs given for item 7 – Manor Way Crossing refer to an on-line culvert crossing, but the preferred option of an aqueduct is calculated to be about the same value, exclusive of land costs.

Most of the expenditure above is on three major items,

1.	Lapal Tunnel	£17.5m
2.	Manor Way Crossing	£ 3.1m
3.	East Portal Works	£ 2.1m

The remaining £5.6 million is sufficient to restore approximately 4000 metres of canal, from the Selly Oak Junction with the Worcester and Birmingham Canal as far as Weoley Castle, and the section from Hawne Basin to Manor Way. This includes a complete new bridge at Mucklow Hill capable of taking modern highway loading.

The part costs are therefore:

1.	West Approach	£5.9m
2.	East Approach	£4.9m
3.	Tunnel	£17.5m
	TOTAL	£28.3m

Deducting the three major items, restoration of the majority of the length of canal in the open can be completed for:

1.	West Approach	£ 2.8m
2.	East Approach	£ 2.8m
		£ 5.6m

The figure for the west approach includes £1.2m for a new Heywood Bridge. Restoration of the original bridge could reduce this figure by up to £500,000.

All costs, except the Leasowes Section, which is completed, and the adjacent section, which has been costed in detail, are based on feasibility study level of design and should be treated as ±15%.

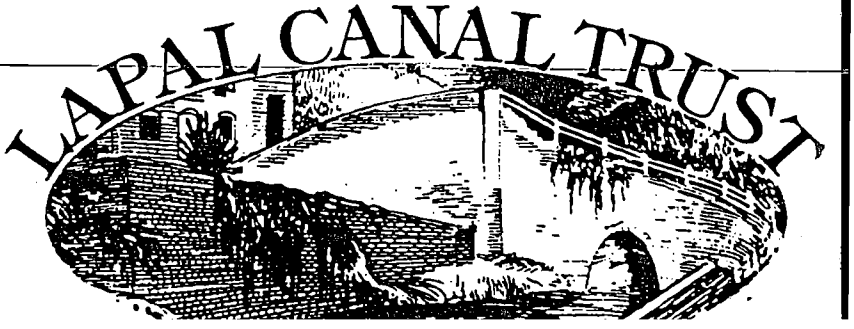
5.2 Phasing

With the exception of the Leasowes/Fordrove section, it is the Trust's stated intention to restore the canal incrementally from each end. On this basis the following phasing is likely.

Phase	Section	Restoration Cost	Land	Comments
1A	Leasowes, Halesowen	£207,000	DMBC	Completed
1B	Fordrove, Halesowen	£330,000	DMBC	Planning Consent Obtained
2	Batterry Park/Selly Oak Park	£1,395,000	Battery Park	Selly Oak Development Study
3	Hawne Basin – Leasowes	£1,650,000	Newbank Forge	
4	Selly Oak Park – Weoley Castle	£1,520,000	BCC	
5	Manor Way Crossing – West Portal	£3,730,000	Crossing & Portal Area	
6	Weoley Castle – East Portal	£2,070,000	BCC	
7	Lapal Tunnel	£17,500,000	Tunnel	

It is anticipated that phases 6 and 7 would be completed simultaneously

6. CONCLUSIONS



6. CONCLUSIONS AND RECOMMENDATIONS

The main conclusion drawn from this study is that there are no insurmountable engineering obstacles to the full restoration of the southern section of the Dudley No 2 Canal - The Lapal Canal.

Despite being closed for almost 50 years, the canal line has survived with only a very limited number of obstructions, and 90% of the land still in public ownership. Three obstructions are, however, considerable and will require significant sums of money to overcome.

The policy of the restoration body, the Lapal Canal Trust, is to restore to navigation incrementally from each end, Selly Oak Junction and Hawne Basin, leaving the largest obstruction, the Lapal Tunnel, until last. This strategy is sound from an engineering basis, as 85% of the length in the open can be restored for only 20% of the expected total cost, bringing significant lengths of usable canal into the national system.

The major source of water supply to this canal length is groundwater from the Lapal Tunnel. Connecting the two level end sections to the national system at Selly Oak and Hawne Basin extends the Birmingham Level, and the net water gain and loss should be in balance during the interim period before full restoration. Once restoration reaches the tunnel, there will be a positive water balance.

An opportunity has already been taken to restore an isolated length at the Halesowen end, through the Leasowes Park, as funds were available for this purpose. The creation of this "linear lake" was possible from an engineering point of view because it is located on an embankment and isolated from the general area drainage. This restoration can be extended as far as Fordrove Bridge, or even Manor Way. This is, however, an exception, and the Trust's stated intention in future phases to extend the head of navigation incrementally.

Even if it was considered desirable, post-closure design of the drainage system at Selly Oak, precludes the creation of a "linear lake" in Selly Oak Park similar to the Leasowes if neighbouring properties are to be protected from the type of flooding that

occurred soon after the original closure. For this reason, it is recommended that the Trust maintain their incremental policy and that this length is not re-watered until the connection with the Worcester and Birmingham Canal, through Battery Park, is restored. This is not a difficult engineering task, assuming that Harborne Lane Bridge is adequate for traffic conditions. For comparatively modest capital input, therefore, the canal could be re-opened as far as the end of Selly Oak Park. This restoration could make a very attractive feature of a re-developed Selly Oak, drawing to it high quality waterside development in the Battery Park area. Comparatively minor adjustments to the drainage system would provide both a vastly increased capacity for flood storage, and a useful water supply to this length.

Re-connection of the restored Leasowes Section at the Halesowen end faces the dual problems of the Newbank factory built over the canal line, and Mucklow Hill (Heywood) Bridge. Restoration through Newbank is not technically demanding as long as the land can be secured, but construction of a new road bridge, or restoration of the previous bridge, if this is possible, are both tasks requiring considerable resources. If the original bridge is still effective, and carrying load, as is implied by the drawings, then an upgrade to modern vehicle loadings will probably be required in the near future, and a new bridge, also providing a safe pedestrian crossing of Mucklows Hill as a bonus, will become a necessity.

Completion of the Leasowes section, through Fordrove Bridge to Manor Way, is not technically difficult, and as it is mainly covered by the existing restoration planning consent, will probably be completed as the next phase, although it is out of sequence.

Continued restoration of the Selly Oak Extension canal from Selly Oak Park to Weoley Castle is mainly a matter of removing fill from the trough, reinstating the canal infrastructure and revising the drainage layout. Two, possibly three, new accommodation bridges will be necessary. The indications from surveys of this length are that most of the original canal construction is still in place, beneath the fill. The exception is the Stonehouse Brook aqueduct, which will require reconstruction.

There are two viable options for crossing Manor Way. The first is an on-line culvert, which would require considerable accommodation works to the road, and the second

an aqueduct on a new line, requiring the co-operation and agreement of the landowners concerned. Both options have roughly the same construction costs, but the aqueduct is preferred as this would make a bold and impressive visual statement.

At the eastern portal of the Lapal Tunnel in California, restoration of the length through the remnants of the refuse tip would remove some of the pollution problems in this area. If a general restoration, on environmental grounds, was undertaken involving removal of all offending material, then the opportunity could be taken to reinstate the original portal cutting. Otherwise, the suggested cut-and-cover tunnel would allow reopening of the canal, while maintaining what has become during the past twenty years, an accepted public open space.

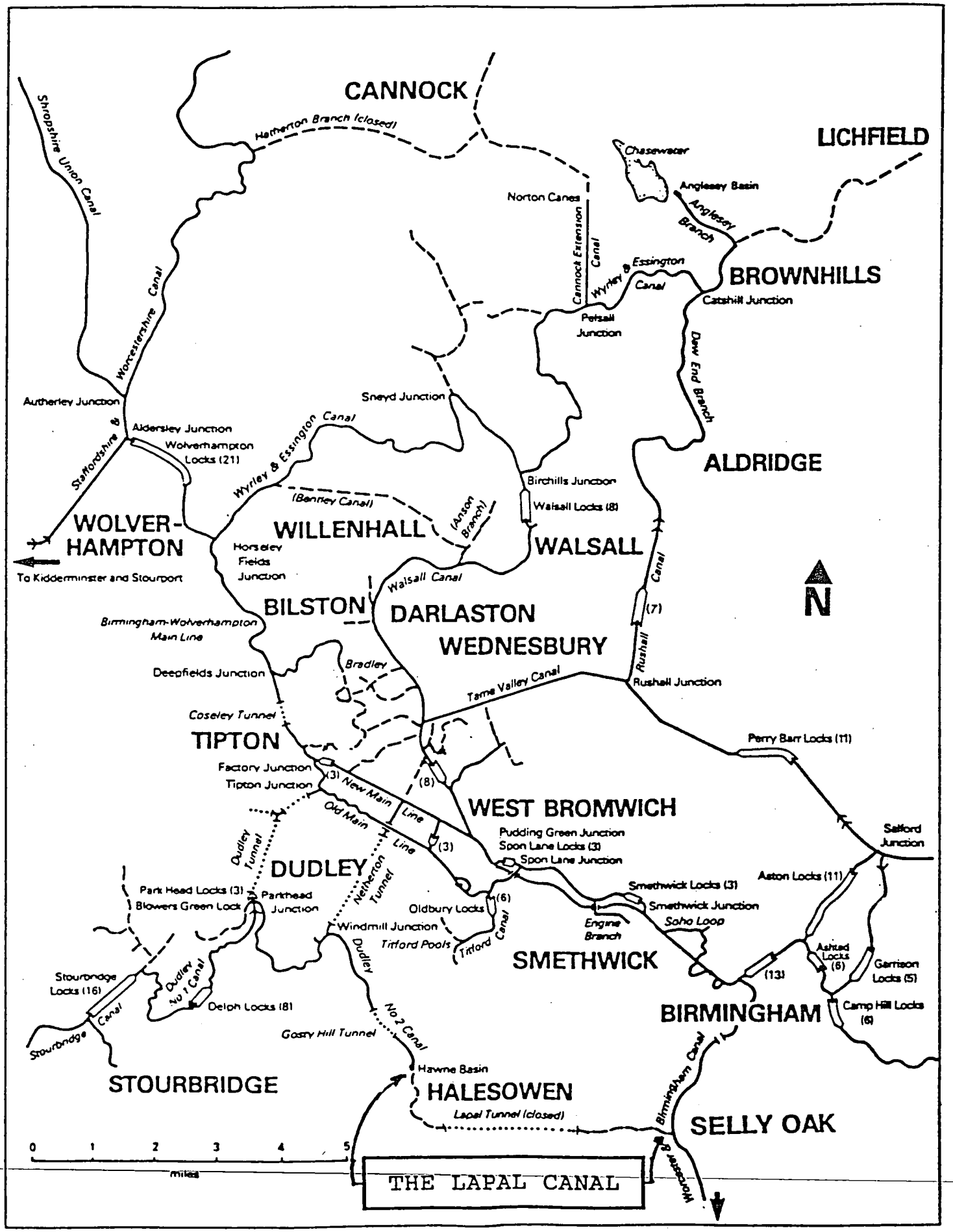
Re-opening of the Lapal Tunnel is a major task which could only be undertaken by specialist contractors. The suggested solution would provide a very high quality, modern tunnel, safe, light and well ventilated, which would attract through boat traffic. Slightly cheaper alternatives are possible, but carry with them the penalty of more difficult operation and/or increased maintenance.

It is therefore recommended that the Lapal Canal Trust:

- Maintain their stated policy of incremental extension of the head of navigation, at both ends of the Lapal Canal
- Complete the Leasowes restoration as far as the existing planning consent allows.
- Secure the route through Battery Park at Selly Oak, and Newbank, Halesowen.
- Start discussions with landowners on the possibilities of an aqueduct crossing of Manor Way
- Investigate the opportunities for funding of restoration work, mainly by contractors, but also using voluntary labour.
- Keep a watching brief on any potential developments along the canal line.
- Co-operate with Dudley Metropolitan Borough Council, Birmingham City Council, British Waterways, and the Inland Waterways Association to promote incremental restoration in the first instance, with the ultimate goal of full restoration.

APPENDIX 1

Alignment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WOLVER-
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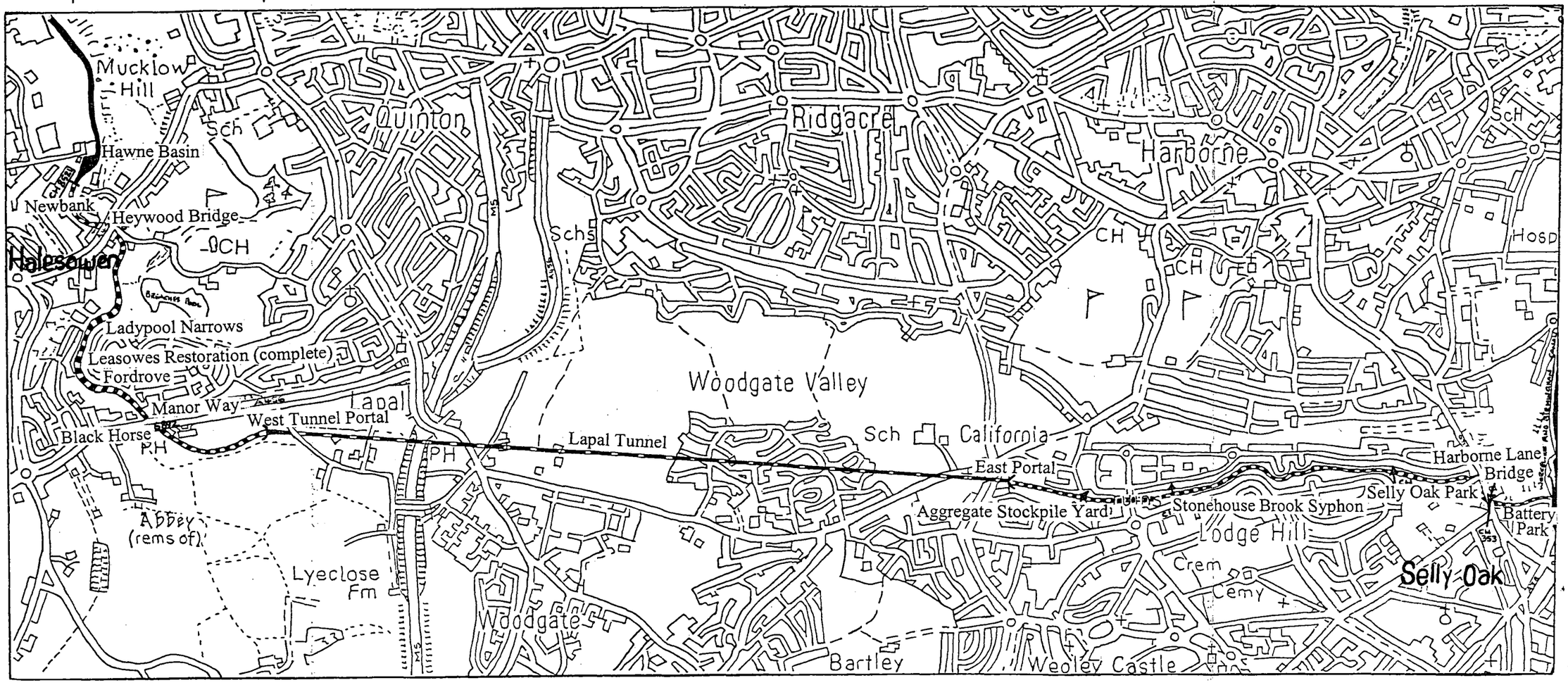
WEDNESBURY
TIPTON
WEST BROMWICH
DUDLEY
SMETHWICK
BIRMINGHAM
SELLY OAK
HALESOWEN
STOURBRIDGE
Shropshire Union Canal
Hatherton Branch (closed)
Chasewater
Anglesey Basin
Anglesey Branch
Norton Canes
Cannock Extension Canal
Wyrley & Essington Canal
Catshill Junction
Pelsall Junction
Dew End Branch
Worcestershire Canal
Autherley Junction
Aldersley Junction
Wolverhampton Locks (21)
Staffordshire &
Sneyd Junction
Birchills Junction
Walsall Locks (8)
(Bentley Canal)
(Anson Branch)
To Kidderminster and Stourport
Horseley Fields Junction
Walsall Canal
Birmingham-Wolverhampton Main Line
Deepfields Junction
Bradley
Tame Valley Canal
Rushall Canal
(7)
Rushall Junction
Coseley Tunnel
Factory Junction
Tipton Junction
(3)
New Main Line
Old Main Line
(8)
Perry Barr Locks (11)
Pudding Green Junction
Spon Lane Locks (3)
Spon Lane Junction
Salford Junction
Aston Locks (11)
Dudley Tunnel
Park Head Locks (3)
Blowers Green Lock
Parkhead Junction
Netherton Tunnel
Windmill Junction
Oldbury Locks
(6)
Titford Pools
Titford Canal
Smethwick Locks (3)
Smethwick Junction
Engine Branch
Soho Loop
Ashted Locks (6)
Garrison Locks (5)
(13)
Camp Hill Locks (6)
Stourbridge Locks (16)
Stourbridge Canal
Dudley No 1 Canal
Delph Locks (8)
Dudley No 2 Canal
Gosty Hill Tunnel
Hawne Basin
Lapal Tunnel (closed)
Birmingham Canal
Worcester &
N
0 1 2 3 4 5
miles
THE LAPAL CANAL

West Approach | Tunnel | East Approach



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client: LAPAL CANAL TRUST		project: LAPAL CANAL FEASIBILITY STUDY	drg. no. 307–01
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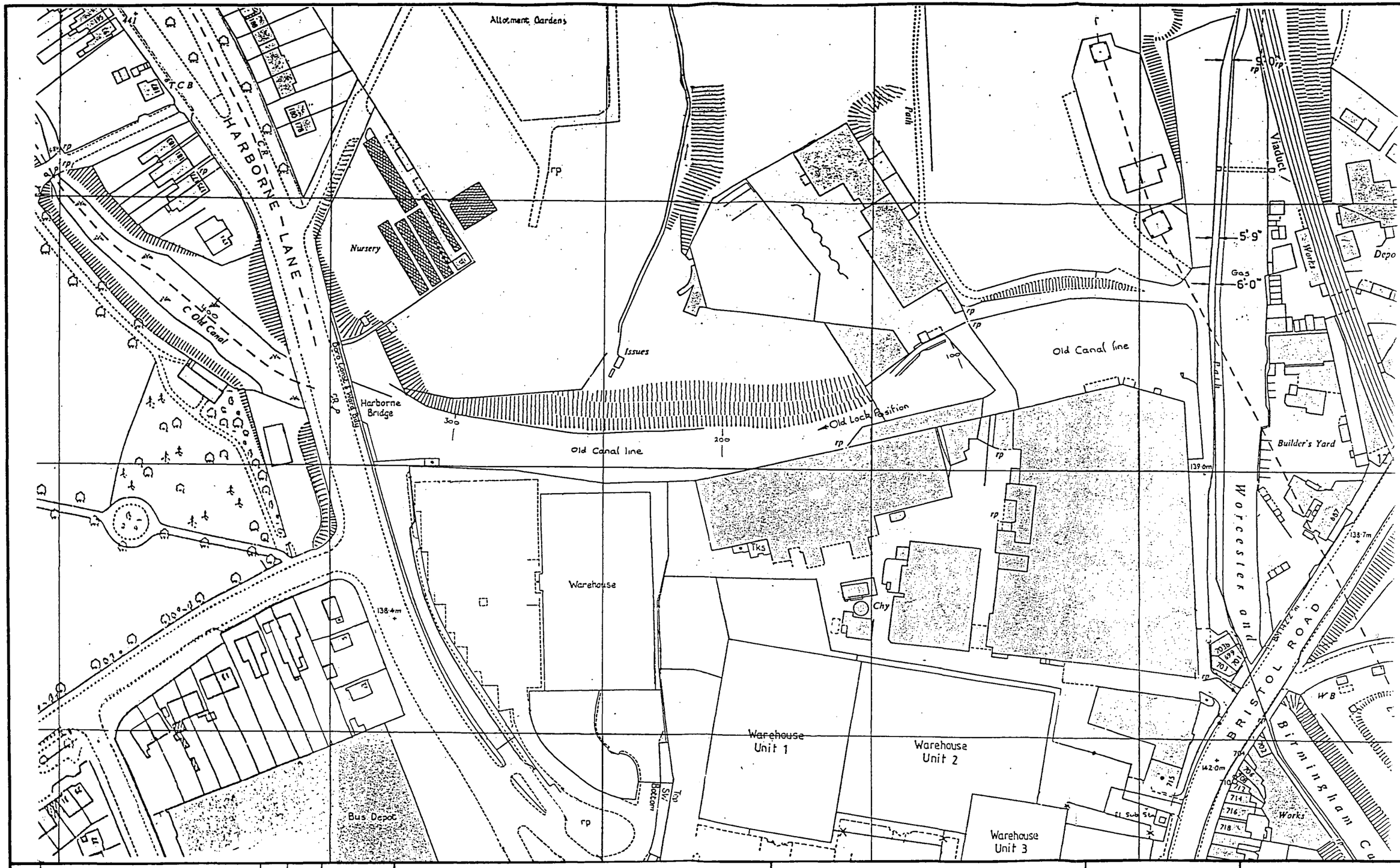
		drawn: M.R.J.P.	approved: G.P.



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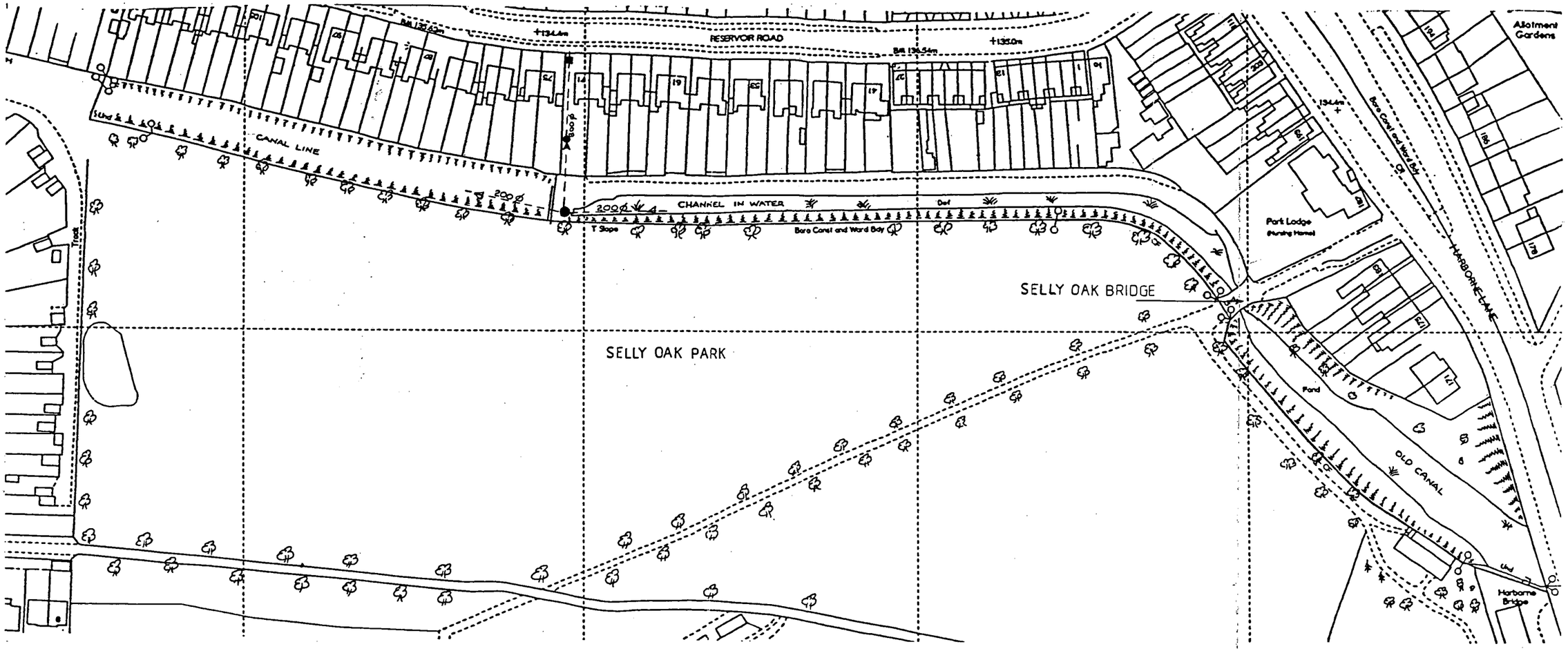
date	3 – 6 – 99
drawn	MRJP.
approved	GP.
scale	N.T.S.
drg. no.	307 - 02



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title CANAL ALIGNMENT.

date 1-6-99

drawn MRJP

approved GP.

scale N.T.S.

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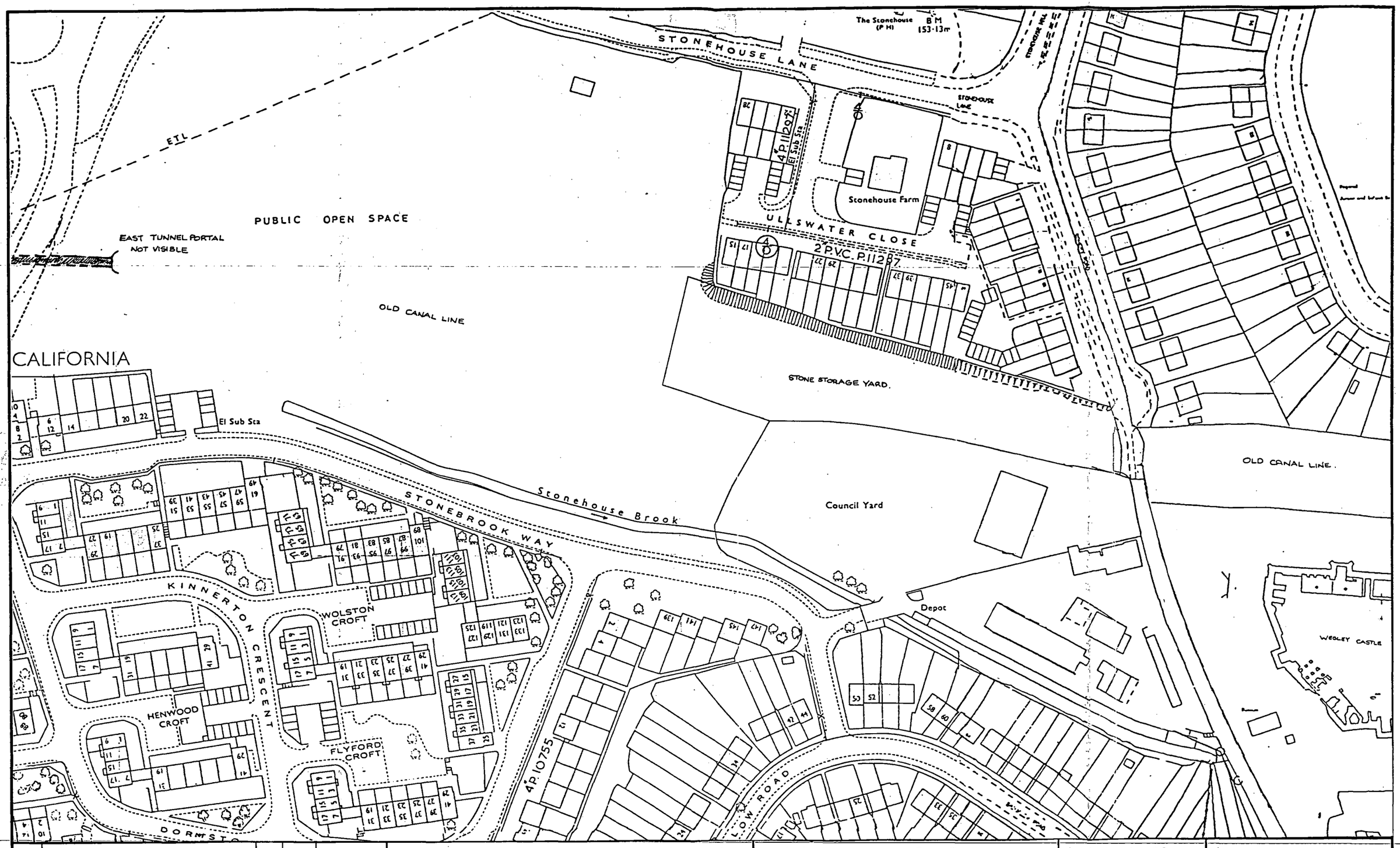

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approved	G.P.
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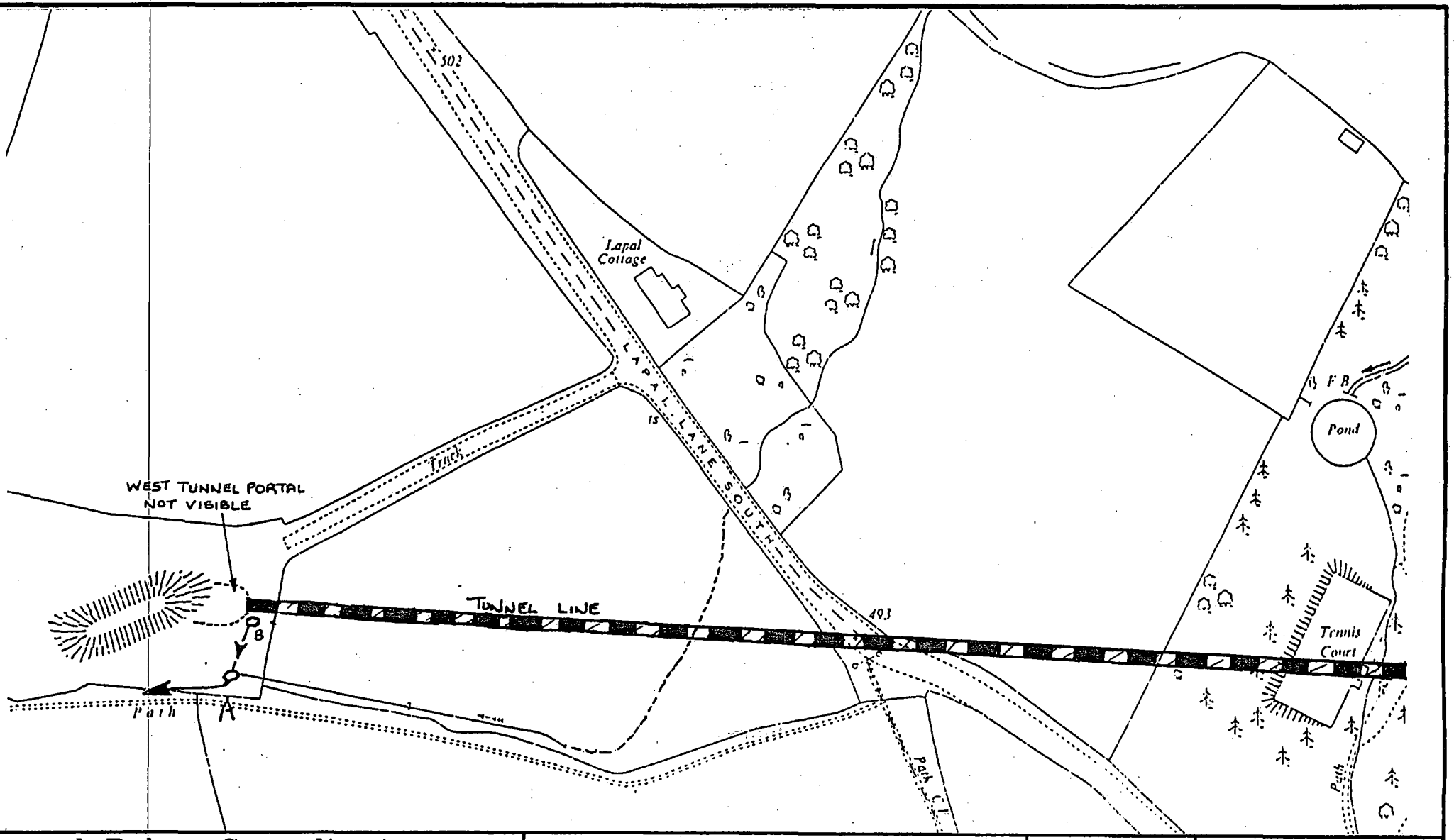

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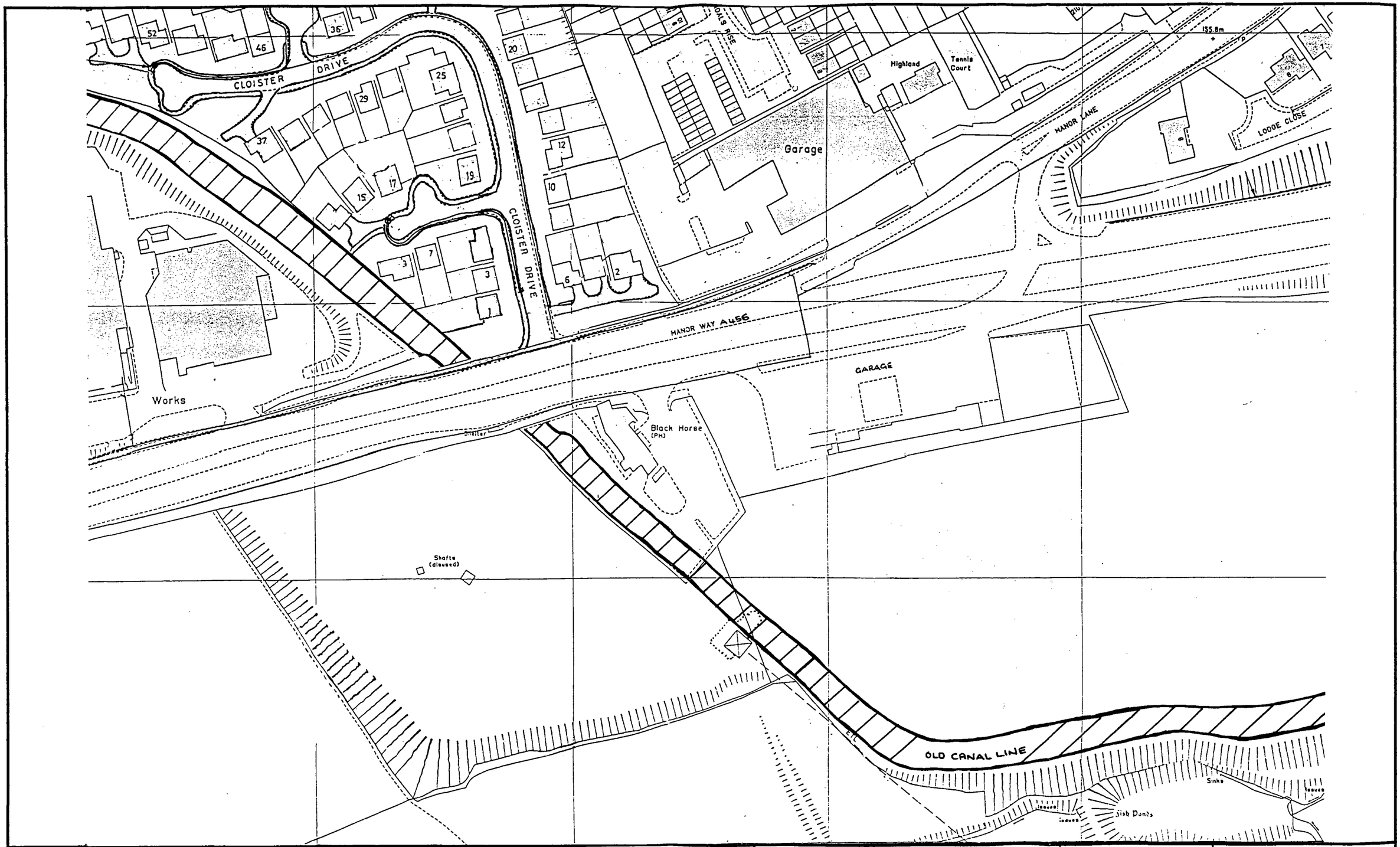

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project LAPAL CANAL FEASIBILITY STUDY

title CANAL ALIGNMENT

date 1-7-99

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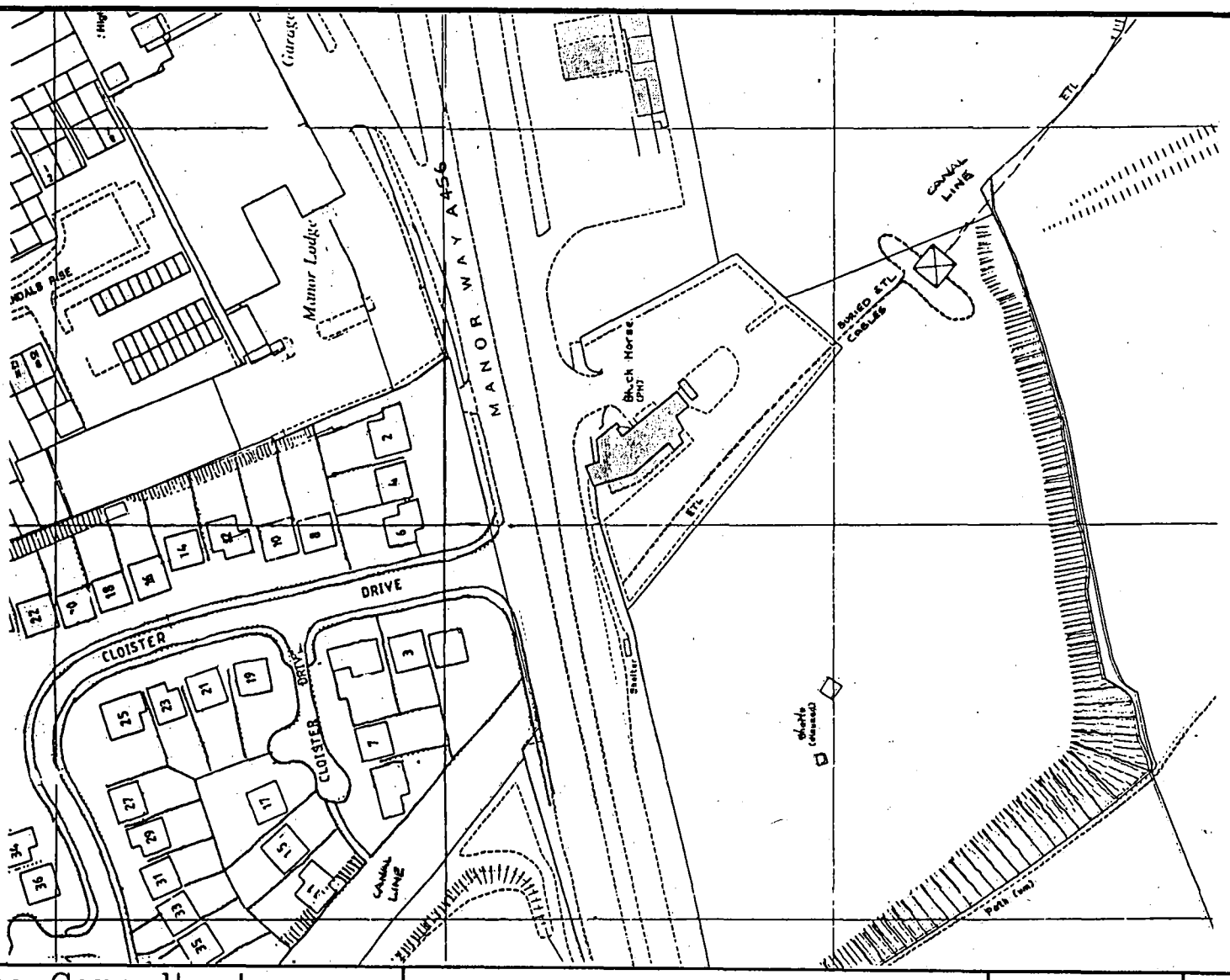
scale N.T.S.

drg. no. 307-10



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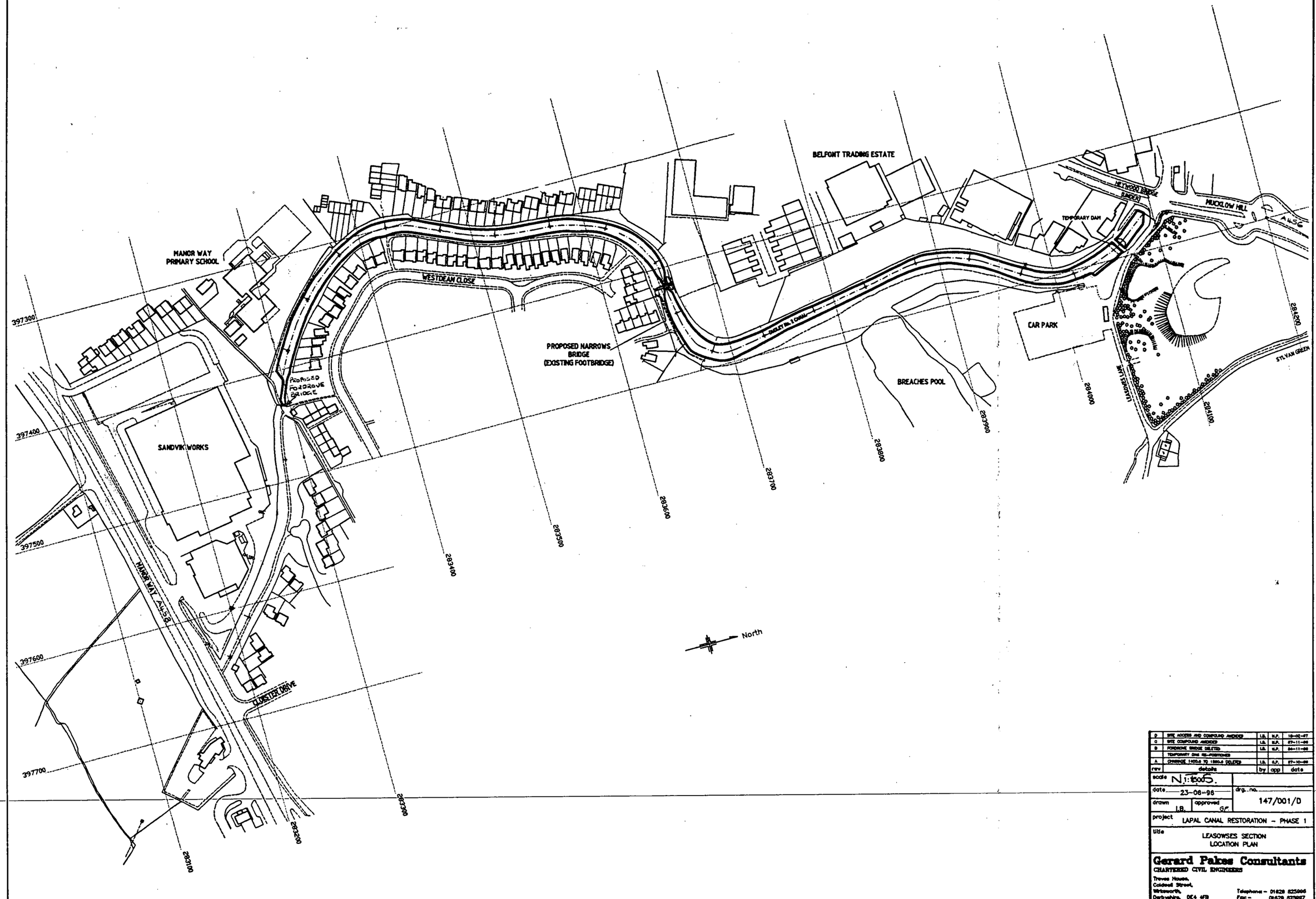

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C	SITE COMPOUND AMENDED	LB	M.P.	07-11-96
B	FOOTBRIDGE BRIDGE DELETED	LB	M.P.	04-11-96
	TEMPORARY DAM RE-POSITIONED			
A	CHANGE FROM TO	LB	M.P.	07-10-96

scale 1:1250.

date 23-08-96

drg. no. 147/001/D

drawn LB. approved GF.

project LAPAL CANAL RESTORATION - PHASE 1

title LEASOWSES SECTION LOCATION PLAN

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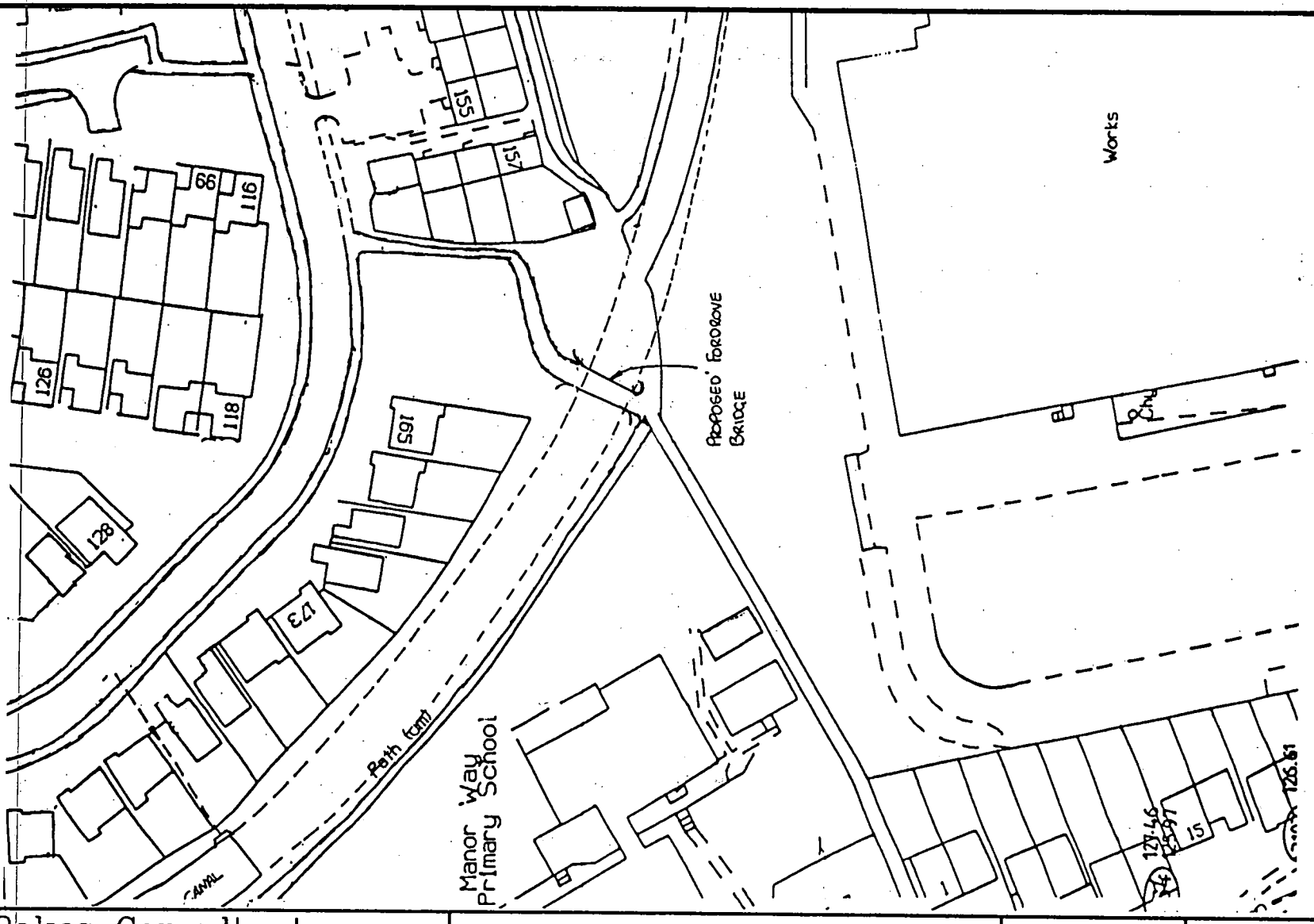

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project LAPAL CANAL FEASIBILITY STUDY		scale N.T.S.	date 3-6-99.
title SITE OF FORDROVE BRIDGE		drawn MRJP.	drg. no. 307-12
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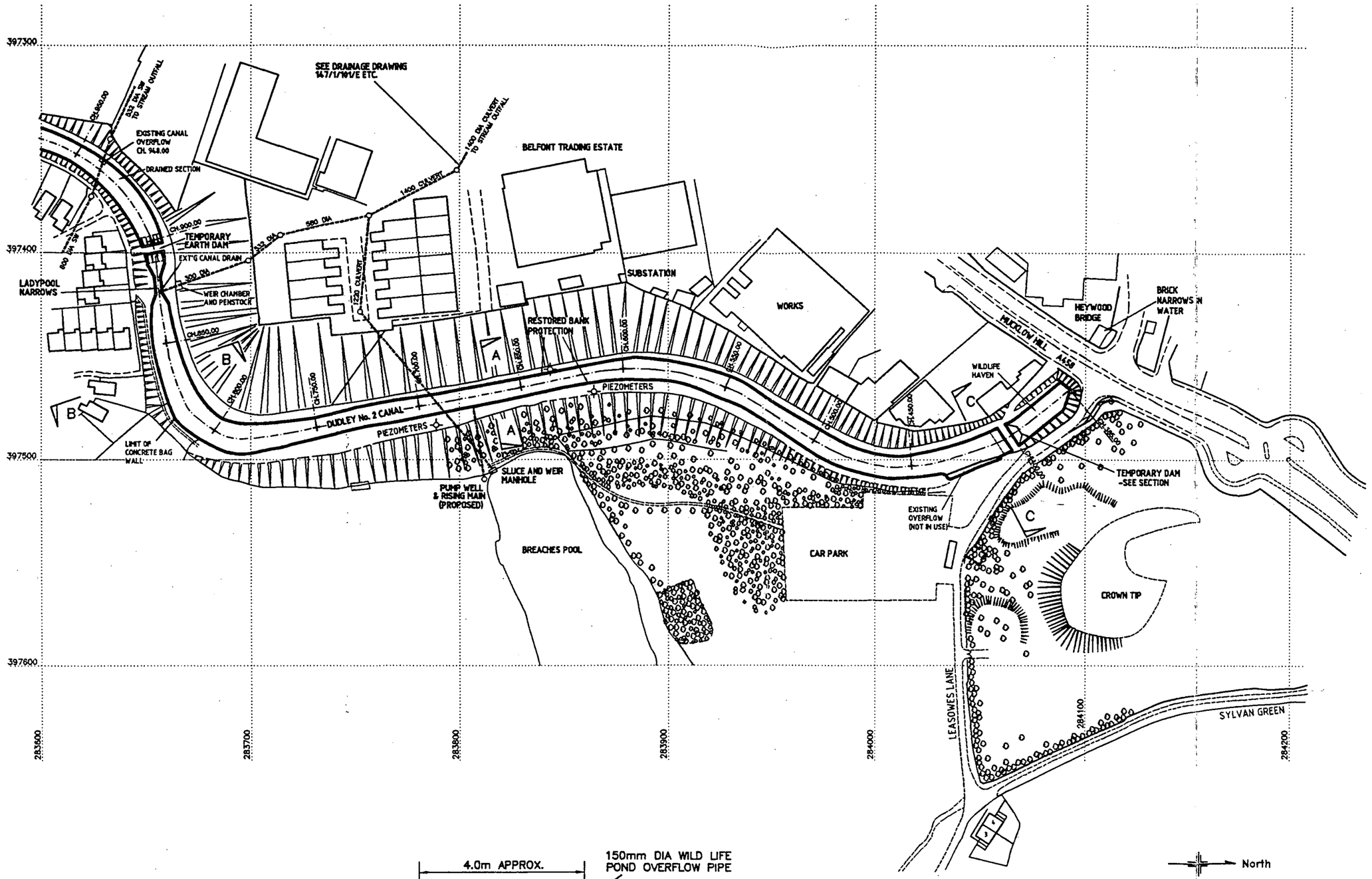

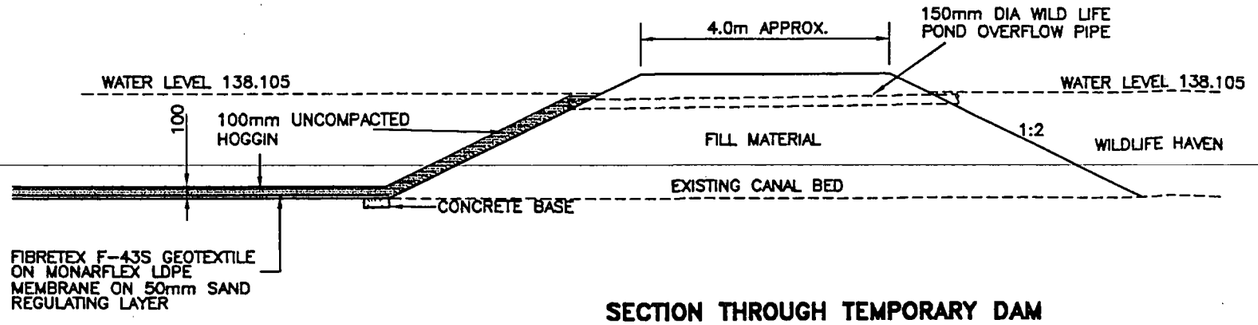

SECTION THROUGH TEMPORARY DAM

– PIEZOMETERS

AS BUILT RECORD DRAWING

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B	TEMPORARY DAM AT NARROWS ADDED	I.B.	M.P.	4-02-97
	ACCESS AND SITE COMPOUND AMENDED			
A	TEMPORARY DAM RE-POSITIONED	I.B.	M.P.	15-01-97
	SITE ACCESS AND HAUL ROAD AMENDED			

scale	1:1000, 1:50
date	28-08-96
drg. no.	147/1/102/E
drawn	I.B.
approved	G.P.
project	LAPAL CANAL RESTORATION – PHASE 1
title	LEASOWES AREA PLAN

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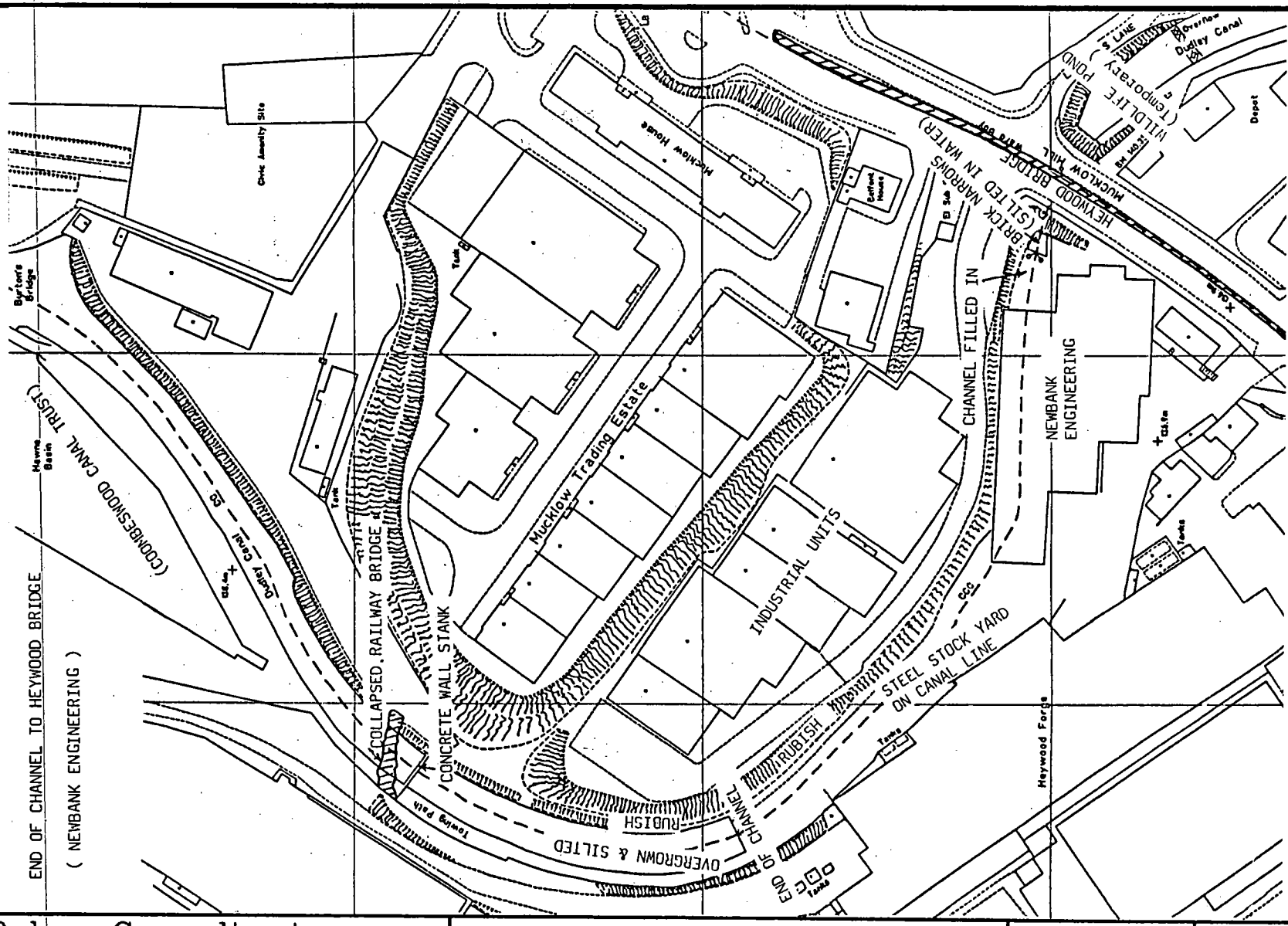

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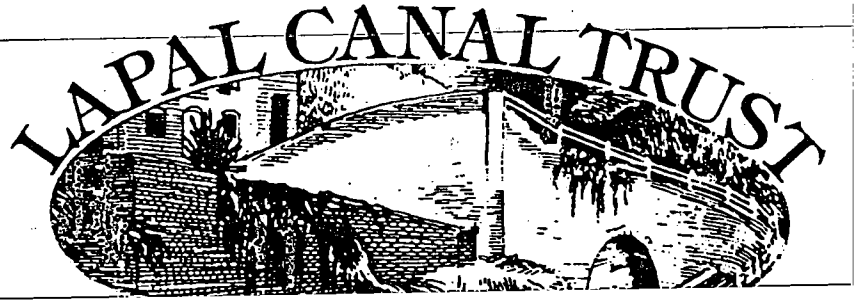
project LAPAL CANAL FEASIBILITY STUDY	scale N.T.S.	date 10 - 6 - 99
title CANAL ALIGNMENT.	drawn MRJP.	drg. no. 307-13.
	approved G.P.	

APPENDIX 2

Schedule of Features



LAPAL CANAL FEASIBILITY STUDY
SCHEDULE OF FEATURES

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
1	Worcester and Birmingham Canal to Harborne Bridge.	Sainsbury`s plc	0.00 to	
	(Battery Park Site)		341.00m	341m
	Canal and Basin is infilled with mainly rubble and brick from locally			
	demolished factories.The average depth of fill to original bed level is			
	approximatly 3.00m deep and is likely to contain some contaminated			
	material. The original five foot deep channel is still likely to be clay lined			
	under the fill material.			
2	Harborne Bridge	Birmingham City	341.00 to	
		Council	365.00m	24m
	The insitu cast concrete channel underneath the bridge is now partly			
	filled with general rubbish and rubble to a depth of 1.35m.			
3	Harborne Bridge to Weoley Park Bridge.	Birmingham City	365.00 to	
		Council	484.00m	119m
	The Channel and Wharf is infilled with soil and silt up to brick coping			
	level. There are some small streams that are in water with large areas of			
	marsh and vegetation . Most of the self seeding saplings and scrub has			
	recently been cut down and removed off site.			
	The original brick side walls are intact but would need minor repairs and			
	re pointing. The Elan aqueduct crosses underneath the channel.			
4	Weoley Park Bridge. (Selly Oak Bridge)	Birmingham City	484.00 to	
		Council	490.00m	6m
	The only remaining brick arch bridge on the Dudley Canal and oldest			
	bridge on the B.C.N.			
	The brick structure as a whole is in very good condition with only minor			
	repairs being needed. This work is scheduled for completion in the			
	summer of 1999. The channel is infilled apart from a 600mm wide			
	masonry drainage grip which is 80% silted up.			
5	Weoley Park Bridge to Selly Oak Park (West).	Birmingham City	490.00 to	
		Council	839.00m	349m
	For the first 209m the channel is in existence and contains water, but is			
	heavly silted and small self seeding trees and bushes are established			
	in the gently sloping sides and edges. The North Towpath side is built			
	on embankment and seperates the lower level houses and gardens of			
	Reservoir Road.The Towpath along this section is inaccessable due to			
	the spreading hedgerow. Midway across Selly Oak Park an earth bund			
	splits the canal into two distinct sections with a dual chambered brick			
	manhole placed in the south embankment.Excess surface water is			
	collected through 200mm dia perforated canal bed drains and exit			
	through a 800mm dia outlet drain.Sewer records indicate that the 800mm			
	dia drain passes beneath the canal bed. The thickness of puddle clay at			
	this crossing will need to be inspected. The remaining section of channel is			
	dry but once again is overgrown with self seeded trees and bushes.A gravel			
	footpath runs alongside the canal on the park side at the approximate			
	level of the towpath.			
	1			

LAPAL CANAL FEASIBILITY STUDY
SCHEDULE OF FEATURES

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
6	Selly Oak Park to Stonehouse Brook Culvert.	Birmingham City	839.00 to	
		Council.	2007.00m.	1168m
	The entire length of this section is infilled to approximaetly towpath level			
	and is now used as a walkway. The walkway disects a Council Estate with			
	gardens bounding the walkway on both sides (some encroachment).			
	The gravel / ash walkway is approximatly two meters wide and runs			
	central to the cutting. Hedges saplings and general scrub material			
	encroach the path in places. Alongside the walkway the canal sub drain			
	manholes are visible.			
7	Stonehouse Brook Culvert.	Birmingham City	2007.00 to	
		Council.	2013.00m	6.00m
	Originally the canal crossed over the Stonehouse Brook but now the canal			
	is infilled a concrete slab footbridge spans the 5.50m wide brick sided			
	culvert at approximatly towpath level.Clearance to water level is at 1.50m.			
8	Stonehouse Brook Culvert to Bottetourt road	Birmingham City	2013.00 to	
		Council.	2200.00m	187.00
	From the footbridge the channel is infilled to approximatly towpath level.			
	The houses to the north (Burnel road) are on higher ground causing the			
	walkway to be in slight cutting.The canal and towpath were approximatly			
	20m wide at this point but as with a patch of waste ground to the South			
	the area is now overgrown with saplings and bushes. It is also home to			
	the odd burnt out car wreck. On approaching Bottetourt road the ground			
	level rises to finish at approximatly 1.2m above toe path level.			
	Two 450 mm dia canal bed drains run centrally to Stonehouse brook.			
9	Bottetourt road to Weoley Castle footbridge.	Birmingham City	2200.00 to	
		Council.	2436.00m	236.00
	From the high ground at Bottetourt road and heading West the ground			
	slopes back to approximatly tow path level. The walkway runs central			
	to the infilled canal which is in slight cutting and and at about 30m wide.			
	The ruins of Weoley Castle are just over the boundary to the South.			
	Both sides of the walkway are overgrown with shrubs saplings and long			
	grasses.From chainage 2400m the ground again rises to meet Weoley			
	Castle footbridge, which has been infilled up to soffit level and become			
	heavly overgrown.			
10	Weoley Castle footbridge.	Birmingham City	2436.00 to	
		Council.	2444.00m	8.00m
	The brick arched footbridge is in use but the arch has been infilled up			
	to soffit level with rubble and soil. As far as can be seen the bridge is			
	in good structural condition and will only need minor repairs and some			
	pointing. 2 no 300mm dia canal bed drains pass through the arch.			

LAPAL CANAL FEASIBILITY STUDY
SCHEDULE OF FEATURES

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
11	Weoley Castle footbridge to California public open space.	Roadstone Co.	2444.00 to	
			2615.00m	171m
	Immediately after the bridge the ground level drops back down to			
	approximatly towpath level and is totally infilled. For the next 170m a			
	disused aggregate stockyard takes up the whole area of canal and towpath.			
	The canal line runs between a Council depot to the South and housing			
	built on embankment to the North. Concrete bases and storage bays,			
	derelict cabins,building material,rubble and scrap cover 2 / 3 of the area.			
	At the far West end of the yard a concrete pannel fence 2m high crosses			
	the canal line and at this point the depth of fill over the canal increases.			
12	California public open space to East tunnel portal.	Birmingham City	2615.00 to	
		Council.	2817.00m	202m
	The canal line heads East across public open space to the old California			
	portal. This land was once the site of a brickworks with the canal being			
	in deep cutting on the southern edge. In the late 1960s the canal and			
	surrounding area was infilled with rubbish and domestic refuse to			
	approximaetly 12m deep,before being grassed over and pathways formed.			
	Along these pathways and boundaries pole mounted Methene vents give			
	an indication of the contaminated material used in this filling operation.			
	High levels of Methene at 47% have been recorded in the East portal			
	tunnel drains and any excavation will have to be undertaken with the			
	utmost of caution.			
13	East tunnel portal to West tunnel portal.	British Waterways.	2817.00 to	
			6285.00m	3468m
	See separate sheet.			
14	West tunnel portal to Black Horse pub car park.	Mr C. Tudor.	6285.00 to	
			6789.00m	504m
	The West tunnel portal is now completely infilled to approximatly 8.5m			
	deep and has been returned to grazing land. A broken down brick wall			
	at ground level is the only evedence of any remaining structure and			
	would have probably been the remains of the canal workers cottages			
	There is a drainage manhole to the side which still removes water from			
	inside the old tunnel.The canal channel has been overfilled but although			
	the channel has now gone the towpath hedge is still visible in places and			
	indicates the canal route across the fields. The puddle clay lining is still			
	likely to be in place under the fill material.As the canal swings to meet the			
	Black Horse car park at chainage 6181m a High Voltage Electricity Pylon			
	stands on the towpath line and a 132 KV expansion loop lays across			
	the canal bed. Six single 132 KV cables then follow the canel line at 1.37m			
	deep West towards Manor Way.			
15	Black Horse pub car park.	Allied Domeneq	6789.00 to	
		(Leased from Dudley	6872.00m	83m
	Running along the South Western edge of the car park the canal is	M.B.Council).		
	infilled to approximaetly towpath level and surfaced with tarmac. 132 KV			
	cables run along the canal line at 1.37m deep .			

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
16	Manor Way (A456).	Dudley Metropolitan Borough Council.	6872.00 to 6912.00m	40m
	The A456 Manor Way is a four lane dual carriageway which crosses the original canal line at two different levels. The West bound carriageway being at a lower level than the East. This crossing was constructed in the early 1960`s with the canal bridge being demolished and the canal void infilled to create the extra width necessary for dualing.The present lower carriageway level is only 157mm above the working canal water level. Services run in both footways to be crossed and are at a depth just below canal water level.A high pressure gas main is located in the North verge.			
17	Manor Way (A456) to the site of Fordrove Bridge.	Dudley Metropolitan Borough Council.	6912.00 to 7175.00m	263m
	The canal line continues as walkway to the North West between a disused factory building and a housing estate.The walkway follows the contours of the hill with the large earth embankment being to the West .The sapling lined walkway is approximatly 16m - 20m wide and at towpath level, with a central tarmac path and maintained grass verges. The towpath hedge is still in existence but is now overgrown and unmaintained. There does not appear to be any buried services along this section.			
18	The site of Fordrove Bridge.	Dudley Metropolitan Borough Council.	7175.00m	
	The site of Fordrove Bridge sees the convergence of four pathways. The area has now been landscaped and grassed over with a scattering of small bushes and trees. The only visible signs of the old bridge structure is in the hedgerow where a few scattered bricks, at ground level, are from the South Abutment wall. The canal has been completely infilled with the channel being crossed by services including a 11KV cable and a high pressure gas main.			
19	The site of Fordrove Bridge to end of filled section	Dudley Metropolitan Borough Council.	7175.00 to 7313.00m	138m
	Although the channel has been infilled the towpath is still in place along the edge of the embankment and hedge. The ground slopes from the towpath side towards the houses to the North East, with an average depth of 0.65m above towpath. The puddle clay seal is still in place in the canal but could have been holed by the roots of self seeding trees. Numerous tree stumps will have to be removed and the puddle clay checked and repaired.			
20	End of fill to Ladypool Narrows	Dudley Metropolitan Borough Council.	7313.00 to 7660.00m	347m
	As with other sections of canal the line follows the contors of the ground with the towpath being on the West side embankment. The canal channel is visible but is heavly silted and overgrown with bushes and small trees growing into the upper East bank side. At times of heavy rain , water is held in the channel, but because of leakage and regulation the water never fills to working height. Houses have been built to both sides of the channel			

LAPAL CANAL FEASIBILITY STUDY
SCHEDULE OF FEATURES

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
20	continued			
	with some of the West lower side gardens encroaching into the			
	embankment and towpath. At chainage 7317m a headwall and 200mm dia			
	drain empty into the canal and although this is a surface water drain			
	detergent is sometimes present in the water. There are two pipe crossings			
	of the canal, at chainage 7403m a 225mm dia foul drain, and at 7954m a			
	532mm dia surface water drain. Both of these crossings are believed to			
	have severed the puddle clay lining and leak into the embankment.			
	Directly above the 532mm dia drain is a overflow / outlet chamber with a			
	150mm dia outlet,to regulate the water level in this section. Immediately			
	before the Ladypool narrows a temporary clay dam has been built to			
	separate the completed Leasows Park section.			
21	Ladypool Narrows	Dudley Metropolitan	7660.00m to	
		Borough Council.	7680.00m	20m
	This is the start of the renovated Leasows section. The original brick built			
	narrows has been repaired and repointed, a new concrete base laid and			
	the hardwood cill replaced. The emergency stop gate that would swing			
	shut if the embankment was breached will be fabricated and installed at a			
	later date.The original canal drain has been cleaned out and repaired to			
	the old outfall chamber where a modern penstock and weir has been			
	installed. The original brick outlet culvert has had to be relined with a			
	300mm dia Aqua pipe down to the bottom outfall manhole. As a			
	temporary measure a steel and timber bridge is to be installed for			
	pedestrian access .			
22	Ladypool Narrows to Leasows Outlet Weir.	Dudley Metropolitan	7680.00 to	
		Borough Council	8091.00m	411m
	The Leasows section of canal has now been fully restored, but due to the			
	age and condition of the 200 year old earth embankment, the original			
	puddle clay and masonry walls have been renovated with a more modern			
	system. A reinforced concrete retaining wall cast against the canal sides			
	and faced above water level in traditional brick was needed to distribute			
	loadings. To suplement the clay lining a waterproof geomembrane was			
	stuck down to the concrete base and protected with a geotextile matting			
	and a 100mm thick layer of stone. The towpaths have been raised and re			
	ashed up to brick coping level.To keep an eye on the stability of the			
	embankment both piezometors and satelite survey stations have been			
	installed to the embankment and towpath.			
23	Leasows outlet weir	Dudley Metropolitan	8091.00 to	
		Borough Council.	8117.00m	26m
	Although only minor repairs are needed to the weir structure the outfall			
	culvert is only 8m long before being severed. The original outfall			
	continued into an open channel down to the Breaches Pool, but was filled			
	in when the car park was constructed. The temporary outfalls can be used			
	until a new burried drain can be installed down to Breaches Pool.			
	until a new burried drain can be installed down to Breaches Pool.			
	5			

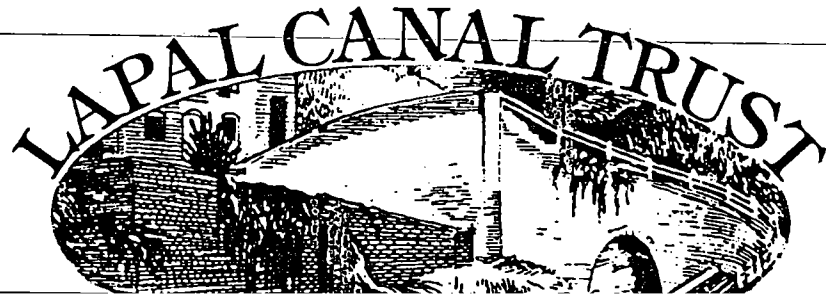
Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
24	Leasows outlet weir to Haywood Bridge Abutment.	Dudley Metropolitian	8117.00 to	
		Borough Council.	8162.00m	45m
	Straight after the outlet weir is another clay dam across the canal. This			
	was formed to create a wild life haven while the Leasowes resteration work			
	was in progress.The pond is heavly silted and overgrown with water			
	weed.The dam is also used as a temporary footpath.			
25	Heywood Bridge - Mucklows Hill.	Dudley Metropolitian	8162.00 to	
		Borough Council.	8192.00m	30m
	According to Dudley Borough Council Engineers and the drawings, the			
	canal bridge is in place under road fill for the A458, a four-lane dual			
	carriageway. Brick faced concrete retaining walls were built across the			
	channel at the north and south ends. A 300mm dia pipe with a 150mm			
	concrete bed and surround for drainage was laid on the canal bed 900			
	mm below original water level.The void below the bridge arch was then			
	filled with approved granular material. The channel between retaining			
	walls was filled to level and the dual carriageway constructed to 13.41m			
	wide.			
26	Heywood Bridge to Factory wall.	Leased from Newbank	8192.00 to	
			8209.00m	17m
	From the brick faced abutment wall is the remains of the brick narrows			
	which is still in water and collects the rain run off from the factory roofs.			
	This 6 m section is silted, overgrown and contains rubbish. A sheet			
	piled cofferdam then cuts off the canal with the remainder of the canal			
	being completely filled over and overgrown.			
27	Factory (Sterl Pallets) to the end of channel.	Leased from Newbank	8209.00 to	
			8394.00m	185m
	For the first 75m a factory has been built on the channel line. The end			
	walls are brick up to 2m high with asbestos sheeting as clading above.The			
	side walls are constructed from pre cast concrete retaining wall units, with			
	brick walls continuing to the roof. A problem could be the toe of the			
	retaining wall units which seems to be over the canal line. The factory			
	floor is a concrete slab at about towpath level, but where there are recesses			
	for machinery,in the canal line, ground water seepage is visible. The clay			
	lining is still likely to be in place and holding on to some water. The rest			
	of the factory land is a hardstanding for a steel stock yard that contains			
	numerous steel racks and loose material. The channel line has once again			
	been filled to approximatly towpath level.			
28	The end of channel to the concrete stank	British Waterways	8394.00 to	
			8488.00m	94m
	From the end of the steel stock yard the channel quickly comes into water,			
	but is extremely silted and overgrown. Bushes and small trees have grown			
	out from the embankment sides and meet mid channel.This area also			
	seems to be used as a rubbish dump with large pieces of furniture, scrap,			
	carpets and pallets etc in abundance. At chainage 8488 m a concrete			
	stank wall has been built across the channel.			
	6			

LAPAL CANAL FEASIBILITY STUDY
SCHEDULE OF FEATURES

Ref	Section / Description / Condition / Remarks	Landowner	Chainage	Length
29	Concrete stank to Hawne Basin.	British Waterways.	8488.00 to	
			8521.00m	33m
	From the stank to Hawne Basin the channel is in water. The bank sides			
	are overgrown with bushes and saplings which is reducing the width of the			
	water, and the channel contains silt and quantaties of rubbish.			

APPENDIX 3

Restoration Proposals



APPENDIX 3.1

Lapal Tunnel

LAPAL CANAL TRUST

REPORT ON THE CONDITION OF THE LAPAL TUNNEL

1. INTRODUCTION

This report is based upon information available from British Waterways report of the tunnel conditions dated July 1991, plus other miscellaneous contemporary information.

At this stage no detailed research of public or other records have been undertaken in order to verify or expand upon the supposed conditions.

No site investigation has been carried out.

2. HISTORICAL

2.1 Geology

The geological plan, Sheet 168, indicates that the tunnel is located in the upper coal measures strata, overlain by a thin capping of glacial drift including boulder clays. The drift deposits are up to 7m thick.

The western end of the tunnel is located in the Halesowen beds of the upper coal measures. These are mainly shales but do include some sandstones and thin coal. The Halesowen beds extend for the first 300m of the tunnel from the western portal. The remainder of the tunnel is located in the succeeding Keele beds which are predominantly red marls and thin flagstones and sandstone.

The canal records indicate that during construction large quantities of water and running sand were encountered.

2.2 History

The Lapal Tunnel is well known as being of extremely restricted cross section. Various authorities differ but some reference works say it is more restricted than Dudley Tunnel, and some say it is almost the same dimensions.

Information in the British Waterways Report indicate that the tunnel was 4.1m high with a headroom above water level of 2.44m and a width of 2.36m. One length, between two of the working shafts, may have been 2.97m wide. The profile is a narrow horse-shoe shaped structure, and the tunnel is said to be lined throughout in brick. The brickwork lining is stated to be 225mm thick generally, including the invert, but provision for brickwork up to 350mm in soft ground is made. The actual brickwork thickness is unknown.

Throughout the life of the tunnel, maintenance was extremely difficult due to "subsidence". It seems clear from the desriptions and from more recent surveys, the problem was actually one of convergence. The high, narrow shape of the tunnel is structually unstable in this strata but the science of rock mechanics is comparatively new, and was imperfectly understood during the time the tunnel was constructed. Convergence, or a squeezing of the tunnel dimensions, often including heave of the invert, occurs when the combined strength of the tunnel lining and surrounding rock is insufficient to resist the superincumbent loads. The result is a distortion of the tunnel profile. In extreme cases this can lead to a fracture of the side wall, causing roof falls in soft strata.

Canal records indicate the tunnel being repaired in 1801, only three years after completion. Again in 1805 the tunnel was closed for four months for rebuilding of about 100m of side wall. In 1891-92 and 1898-99 approximately 12% of the total length of the tunnel was reconstructed.

In 1917 a serious side wall failure occurred which blocked the tunnel and the ground migrated back 2.3m behind the lining. In 1922 a further collapse occurred and the tunnel was closed.

An inspection of the tunnel in 1924 indicated that, in addition to the fall areas, some 16% of the tunnel length required reconstruction. A further inspection in 1939 confirmed that the conditions found some 15 years earlier were still extant.

The last known entry to the tunnel is in 1961 when a party of canoes entered the tunnel from the eastern portal and succeeded in penetrating about 2000 metres into the tunnel. They were stopped by a side wall collapse and major distortions. These findings confirm the surveys undertaken in 1924 and 1939.

2.3 Shafts

Georgian tunnelling techniques required the construction of a large number of shafts as it was considered difficult to align a tunnel accurately for more than about 150-200m from each access. On this basis the 30 or so shafts named in various authorities appear to be a likely total of construction shafts. The ordnance survey maps record numerous spoil heaps at intervals along the tunnel line, but at this stage no attempt has been made to locate the remainder of the shafts, and the condition of them is unknown.

One shaft at about the central point was left open for ventilation purposes, and the shaft tower was there until 1977 but it was reportedly demolished, and the shaft infilled, during surface works in 1978.

Much of the surface above the tunnel was redeveloped in the 1970's to provide for a large housing estate, and all evidence of the tunnel construction within this area has disappeared.

3. CONDITION OF TUNNEL

On the basis of the historical evidence, including that of the more recent investigations and inspections, the condition of the tunnel is expected to be poor.

Throughout its life the tunnel obviously suffered from convergence due to the load of the overburden being too great for the structural strength of the coal measures strata and the comparatively thin brick lining. The 72% of the length regarded as in fair condition are obviously those parts which coincide with a greater strength contribution from the surrounding rock.

The running sand referred to in the construction records is difficult to understand. It is not usual in carboniferous rock strata to encounter areas of ground sufficiently soft to be fluid under the presence of ground water. These may be explainable by some of the softer marls which occur within the Keele beds, in which case they are fairly limited in length. It is presumably in these areas that sufficient overburden pressure has been applied to the brick lining to cause total collapse and, certainly from contemporary records, ground has actually flowed into the tunnel, presumably leaving voids outside.

It is reported that where the tunnel crosses underneath the M5 motorway, the tunnel has been void grouted with cement PFA grout in order to stabilise the whole structure. This report does not appear to be confirmed in contemporary records, and a study of the M5 construction drawings would be necessary to ascertain this.

There are no records of coal mining in the Halesowen beds beneath the western end of the tunnel, but this would have to be checked from mining records. It appears unlikely.

The three inspections of the tunnel during this century indicate broadly similar conditions. It therefore appears that the convergence effects have probably ceased for most of the tunnel and, if it is still standing, the tunnel would presumably be reasonably stable. Short of some intense seismic activity, therefore, it would appear that a general collapse of the whole tunnel length is unlikely, although isolated sections connected with the existing collapse may still occur.

The level of ground water within the tunnel is unknown, although from surface evidence the general ground water table should be well above the tunnel crown. If the tunnel is drained then the water level will be at or below tunnel invert. If not, then the tunnel may be completely submerged. From the point of view of preserving the tunnel structure, the latter would probably be preferable.

4. SHAFTS AND PORTALS

4.1 Shafts

The condition of the shafts is entirely unknown. Most were presumably backfilled on completion of the tunnel, and it is impossible to say whether this backfill has been incorporated into the surrounding strata or whether it is sitting as a column within the shaft, supported by the tunnel lining. It is probable that side wall collapses are initiated at shaft positions.

The surface position of many of the shafts can also only be surmised, although this can be done with some degree of certainty if the postulated method of tunnel construction is taken into account.

4.2 Portals

Both portals of the tunnel have been totally backfilled and are now impossible to distinguish. The extent of demolition of the portal structures is unknown but provision was made, apparently, for drainage of the tunnel at both ends. At both eastern and western end of the tunnel, evidence can be found of drainage pipes which may be keeping the water level within the tunnel at on or about the original water level. The low rock cover at the portals increases the risk of settlement at these points, if the original structure is inadequate.

5. POTENTIAL PROBLEMS

5.1 Tunnel

It has been noted in Section 3 above that the probability of a total tunnel collapse is small, but that localised further tunnel collapses can occur.

Eventually all unsupported voids underground will migrate to the surface, causing a settlement profile which depends on the shape and depth of the tunnel and the strata in which the tunnel is built. In rock tunnels such as Lapal, this migration can take geological time, but where soft ground is present settlement at the surface can appear quite rapidly.

The extent to which the present collapses have caused surface settlement is unknown but could be investigated, at least theoretically.

There is therefore always a potential for surface settlement above the tunnel line, albeit a small risk over most of the length. Considering the depth of the Lapal Tunnel, except close to the portals, the resultant settlement trough would be very shallow and hardly noticeable by the time the surface was reached. Significant structural damage to the buildings above the tunnel therefore is unlikely as a result of a total tunnel collapse, although in some places slight damage, such as tension cracking, could occur, or may have already occurred without being noticed.

If the report of grouting of the tunnel underneath the M5 Motorway is correct then this has prevented such an occurrence where the tunnel crosses the motorway.

5.2 Shafts

A far greater risk of subsidence arises from the presence of backfilled construction shafts.

The fact that these extend to close under the ground surface and are often backfilled with material which is not keyed into the shaft walls allows a sudden and rapid collapse causing extensive surface damage.

In recent times shaft collapses on canal tunnels have caused both the demolition of the post office at Dutton, on the Preston Brook Tunnel and the tragic accident in the Wasthill Tunnel where two contractors undertaking renovation work were killed.

The fact that the sites of most of the shafts are unknown, and many of them could possibly be under buildings constructed during the 1970's with scant regard to the presence of the tunnel and its shafts, involves a fairly high element of risk. Collapse of a shaft filling does however usually require some form of trigger, this could either be a seismic event or significant change in the ground water level. Restoration work on the tunnel is also a potential source of shaft material collapse. The extent of shaft stabilisation work carried out during the development over the tunnel in the 1970's is unknown but it may be that the building regulation records with Birmingham City Council indicate the extent of the work carried out.

5.3 Methane Gas

Methane Gas is naturally present in all coal measures rocks and, being lighter than air, will migrate towards the surface. The Abbeystead disaster in the North West of England, was a result of Methane migrating through over 2,000 ft of rock above the coal measures.

In addition to the naturally occurring methane it is understood that the eastern portal cutting of the Lapal Tunnel was used as a refuse tip during a dustmen's strike in the 1960'/70's period. Domestic refuse is a very rich source of methane and it is also understood that Birmingham City Council have recently carried out extensive methane drainage works in the area of the eastern portal in order to prevent a potential gas build-up. There is, however, a very real risk that the tunnel contains methane gas either, or both, from the natural carboniferous rocks or from the domestic refuse tip. Methane gas is explosive at certain levels of concentration in the air but is easily dispersed and diffused if methane drainage is correctly designed. Should the gas be at a concentration of between 2.5% and

5% within the tunnel then measures should be taken to vent this off in order to prevent a potentially disastrous explosion should accidental ignition occur. The potential for leakage of methane towards the tunnel will be increased if free drainage conditions exist, but while the tunnel remains completely sealed the chances of ignition are very low indeed.

5.4 Groundwater

Groundwater was intended to drain from both portals when the tunnel was abandoned, although the actual arrangements are at present unclear. Water appears to be draining into watercourses at both portals which could emanate from the tunnel.

Groundwater from coal measures strata can be acid and iron-rich, which leaves orange coloured deposits on contact with oxygen in freshwater. Under the Environment Bill, presently in Parliament, there may be obligations placed on dischargers to prevent "pollution" of this type. This should be borne in mind as a potential problem until such time as the groundwater is used for maintaining the canal level, and thereby diffused sufficiently to avoid this phenomenon.

6. RESTORATION PROBLEMS

Restoration of the tunnel will require some of the problems outlined above to be solved. Over-stressed tunnel lining will require replacement with a support system capable of carrying the loads imposed.

While over certain lengths of the tunnel the current lining is apparently adequate, long lengths will require relining with a more circular section and a more competent structure. This work will involve excavation of the disturbed ground at the side of the tunnel through the area where collapses have occurred, an extremely hazardous process. There is a risk that during construction operations a progressive collapse of the presently standing tunnel could be triggered and the design will have to be such as to prevent this.

The same restoration work can also trigger the collapse of the fill material currently hanging in the shafts, resulting in rapid and often highly damaging settlement at the surface, especially where development has taken place over a shaft site.

Any investigation work in the tunnel would have to be preceeded by precautions to ensure that methane gas is either not present, or has been expelled.

7. FURTHER RECOMMENDED WORK

7.1 Further desk studies are recommended on the problems associated with the tunnel. These would include an investigation of the construction records to the M5 Motorway to confirm, or otherwise, that grouting had taken place over this length of the tunnel.

7.2 An investigation of the building control records for the construction of the housing estate and schools above the tunnel to see what precautions, if any, had been taken with construction shafts.

7.3 An exercise to predict in theory the positions of each of the construction shafts over the tunnel from the topographical information available.

7.4 Further discussions with the persons who entered the tunnel last in 1967 in order to try to predict the state of the tunnel lining some 25-30 years later.

7.5 A "walk over" survey to observe any possible effects of the tunnel on the existing development and topography. On conclusion of all possible desk studies, it would then be recommended that a surface survey be undertaken in order to confirm the suppositions made regarding the position and condition of the shafts.

7.6 A theoretical back-analysis of the structural strength of the tunnel as constructed. This would, of necessity, be a very approximate exercise, but would nevertheless be of value in predicting future behaviour.

7.7 Discussions with Birmingham City Council on the extent of their methane drainage work at the east portal and their liability towards any methane in the tunnel.

7.8 Finally, it is suggested that before any man-access is contemplated, a large diameter borehole is constructed into the tunnel and a remote vehicle equipped with a video camera is allowed to survey as much of the tunnel as possible in order to ascertain the actual condition. The cost of this latter operation could be several tens of thousands of pounds but it is not necessary to carry it out until such time as detailed restoration design work is contemplated.

8. CONCLUSIONS

Purchase of the tunnel from British Waterways will involve the Trust in certain obligations, including damage to property caused by the presence and effects of the tunnel.

Although there is a risk that both the tunnel and the shaft could be the cause of further settlement and therefore damage to buildings above, this risk is considered to be small and, until such time as restoration work commences in earnest, there is only a small probability that any damage to third party properties might occur.

It is recommended that insurance is taken out against such an eventuality.

The potential problems of methane and groundwater drainage should be further investigated.

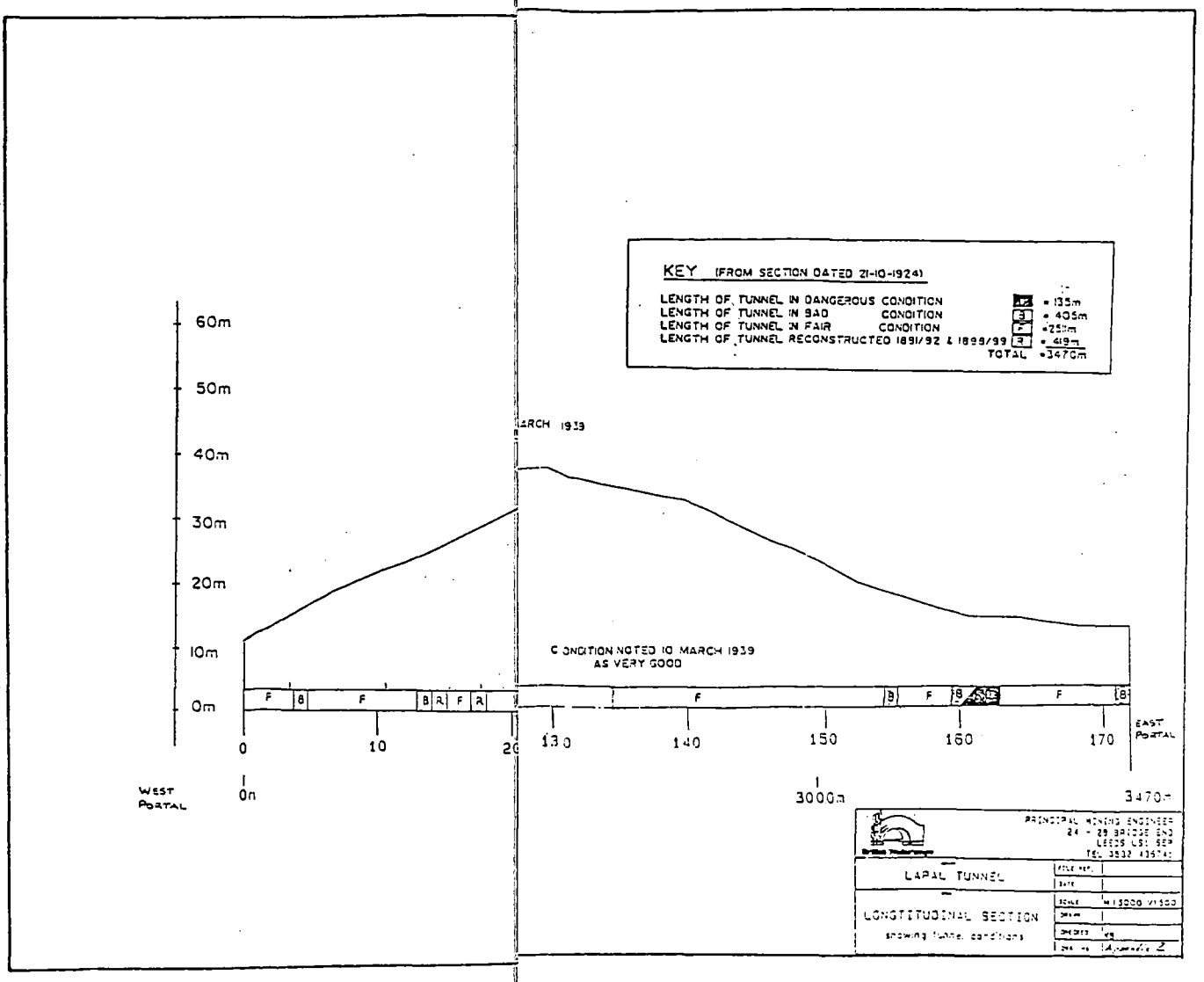
During preparation work and design work for restoration all risks will be increased. The insurance cover should be adjusted accordingly.

During restoration work itself, which is envisaged to be a contract operation, the contractor's insurances should be extended to cover the risks involved in carrying out the work, including the possibility of damage to third party properties.

Once repaired and renovated, the risk of damage to third party properties from the presence of the tunnel is extremely small, but insurance will then be required for the use of the tunnel by the public.

Assuming that third party insurance can be obtained at a reasonable rate, and there does not appear to be any reason why this should not be possible, then it is for the Trust to decide if they should purchase the tunnel from British Waterways as a pre-cursor to eventual restoration.

GERARD PAKES CONSULTANTS
9 January 1995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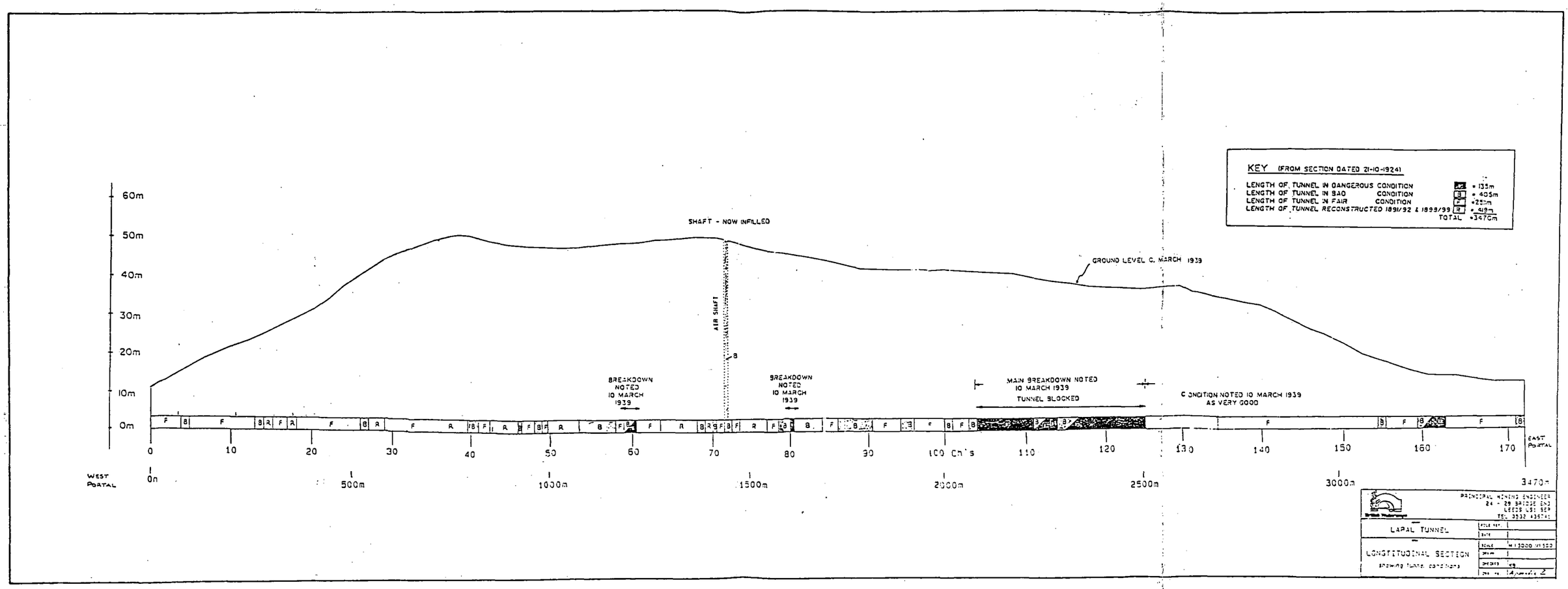
LENGTH OF TUNNEL IN DANGEROUS CONDITION = 135m
LENGTH OF TUNNEL IN BAD CONDITION = 405m
LENGTH OF TUNNEL IN FAIR CONDITION = 25m
LENGTH OF TUNNEL RECONSTRUCTED 1891/92 & 1899/99 = 419m
TOTAL = 3470m
60m
50m
40m
30m
20m
10m
0m
ARCH 1939
CONDITION NOTED 10 MARCH 1939 AS VERY GOOD
F B F B R F R F F B F B F B
0
10
130
140
150
160
170
EAST PORTAL
WEST PORTAL
0m
3000m
3470m
PRINCIPAL MINING ENGINEER
24 - 28 BRIDGE END
LEEDS LS1 6EP
TEL 0532 435741
LAPAL TUNNEL
LONGITUDINAL SECTION
showing tunnel conditions
SCALE H 1:3000 V 1:300
Appendix 2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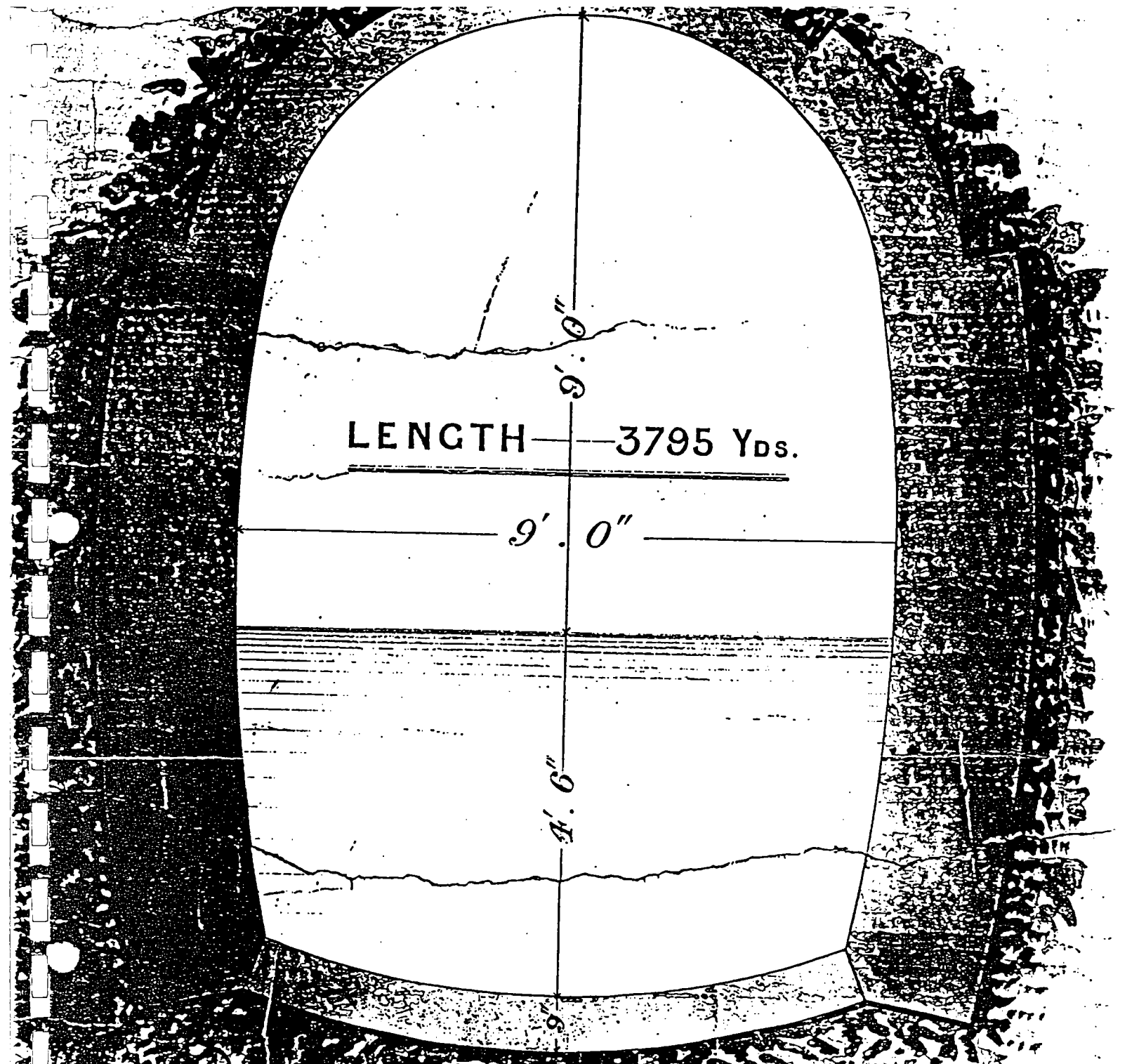
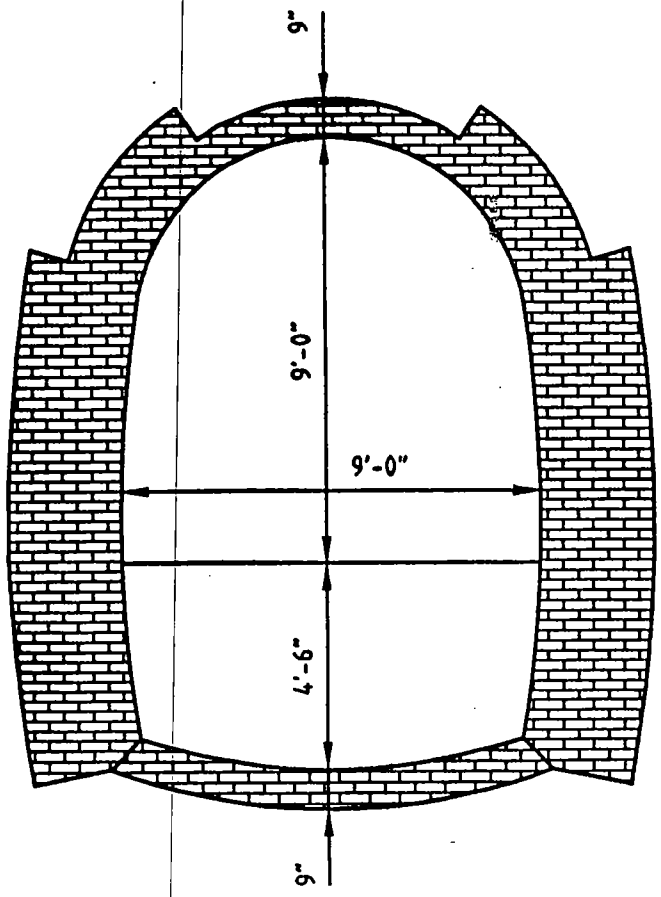
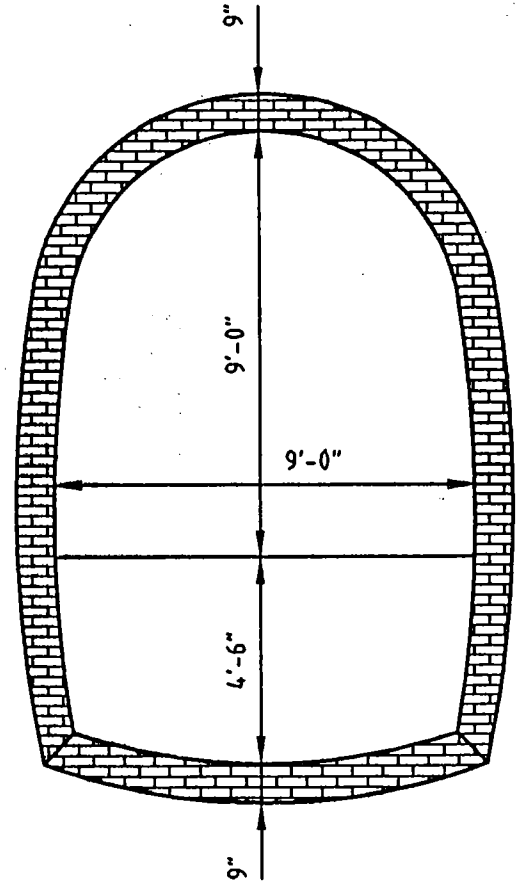
LENGTH OF TUNNEL IN BAD CONDITION B = 405m
LENGTH OF TUNNEL IN FAIR CONDITION C = 2551m
LENGTH OF TUNNEL RECONSTRUCTED 1891/92 & 1899/99 D = 419m
TOTAL = 3470m
60m
50m
40m
30m
20m
10m
0m
SHAFT - NOW INFILLED
AIR SHAFT
GROUND LEVEL C. MARCH 1939
BREAKDOWN NOTED 10 MARCH 1939
BREAKDOWN NOTED 10 MARCH 1939
MAIN BREAKDOWN NOTED 10 MARCH 1939 TUNNEL BLOCKED
CONDITION NOTED 10 MARCH 1939 AS VERY GOOD
0 10 20 30 40 50 60 70 80 90 100 Chs 110 120 130 140 150 160 170
WEST PORTAL
EAST PORTAL
0m 500m 1000m 1500m 2000m 2500m 3000m 3470m
PRINCIPAL MINING ENGINEER
24 - 28 BRIDGE END
LEEDS LS1 5ER
TEL. 0532 435741
LAPAL TUNNEL
LONGITUDINAL SECTION
showing tunnel conditions
SCALE H 1:2000 V 1:200
Appendix 2



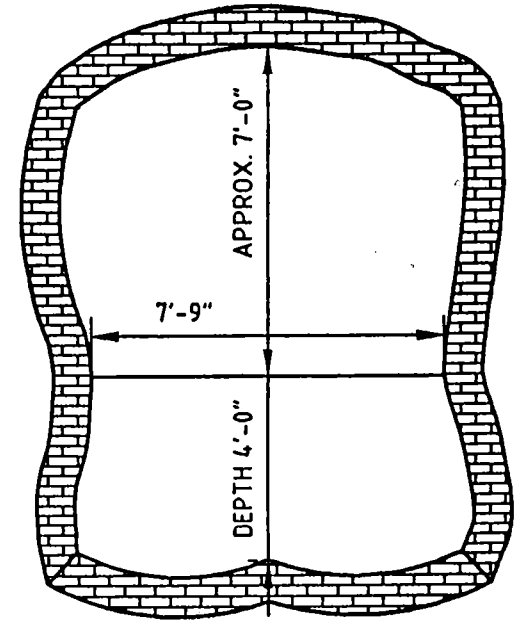
1800



CROSS SECTION
AS ORIGINAL RECORDS



CROSS SECTION
AS PROBABLY BUILT



CROSS SECTION
AS SURVEYED ON
PART OF LENGTH

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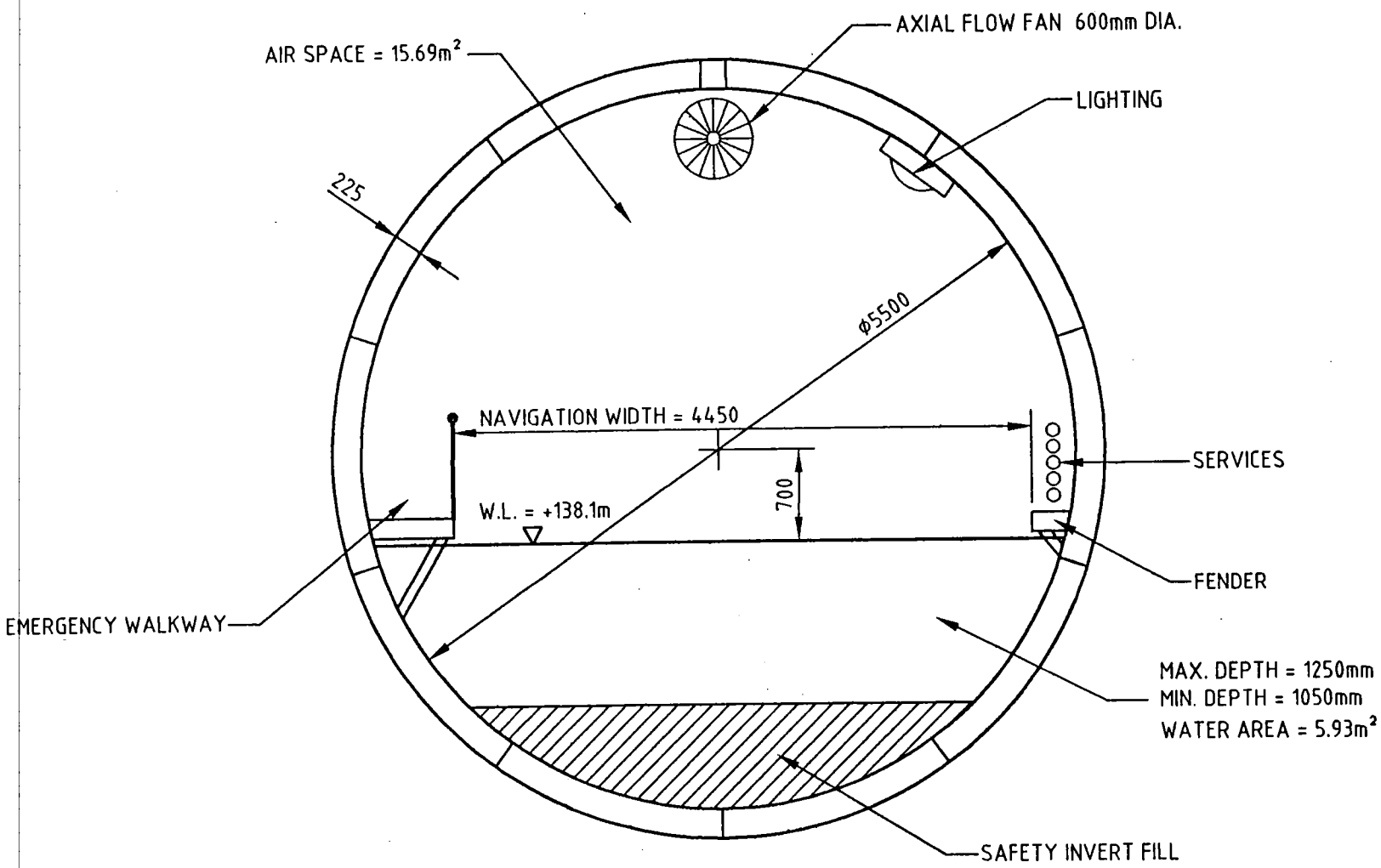
project	LAPAL CANAL RESTORATION	scale N.T.S.	date 1–02–96
title	CROSS SECTION THROUGH ORIGINAL TUNNEL	drawn M.B	drg. no. 147/03/10/01
		approved MP.	



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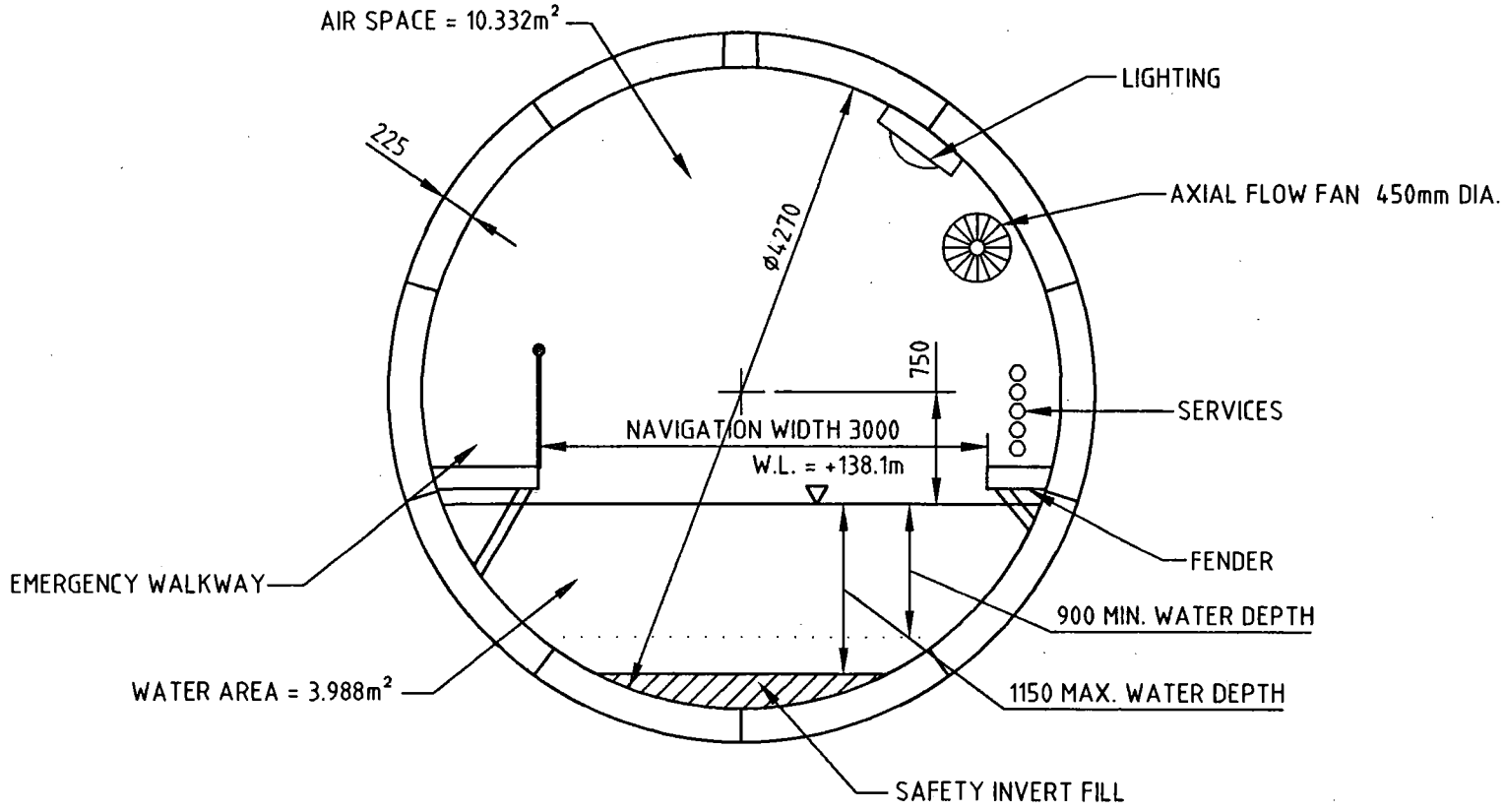
project	LAPAL CANAL RESTORATION	scale 1:50	date 1–02–96
title	LAPAL TUNNEL DOUBLE TUNNEL CROSS SECTION	drawn M.B	drg. no. 147/04/01/1
		approved	



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project	LAPAL CANAL RESTORATION	scale 1:50	date 21–07–99
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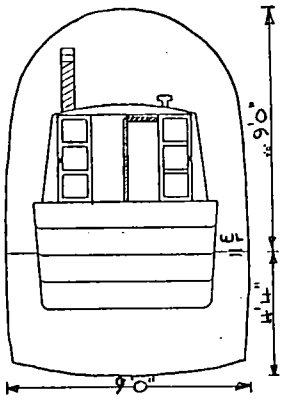
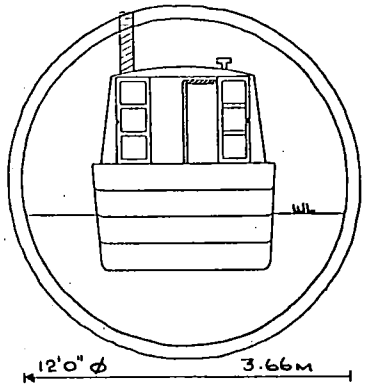
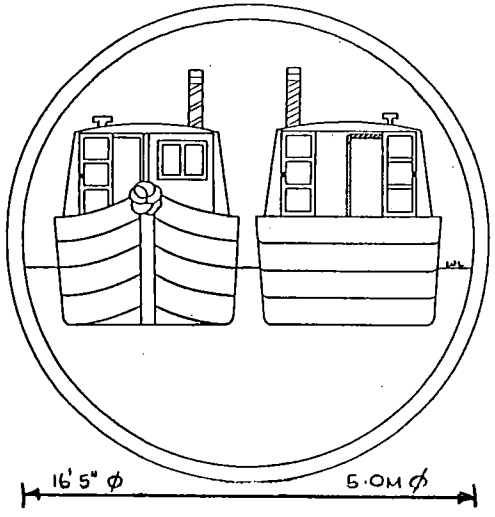
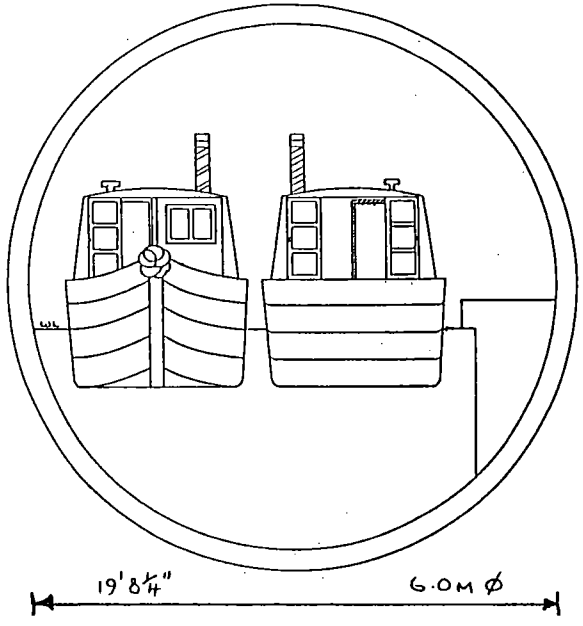
		approved MP.	147/04/01/2–A



LAPAL TUNNEL 3795 YARDS.







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project LAPAL CANAL FEASIBILITY STUDY	scale N.T.S.	date 3-5-92
title LAPAL TUNNEL PROPOSALS	drawn MP.	drg. no. 370-30
	approved GP.	

APPENDIX 3.2

Manor Way Aqueduct

LAPAL CANAL TRUST

PROPOSED RESTORATION OF DUDLEY NO 2 (LAPAL) CANAL

AQUEDUCT CROSSING OF THE A456 MANOR WAY HALESOWEN

1. INTRODUCTION

The Dudley No 2 Canal was opened in 1798 and extended from the Dudley Canal at Park Head, near Netherton, to the Worcester and Birmingham Canal at Selly Oak, forming a through route around the south west quadrant of the Black country/Birmingham conurbations. Through navigation ceased in 1917 when a roof fall caused the closure of the Lapal Tunnel. The canal was abandoned between Hawne Basin and Selly Oak in 1953. The full length of the canal is 8.5 km, of which 3.5 km consist of the Lapal Tunnel.

The Lapal Canal Trust was formed in 1990 to conserve and eventually restore the canal to navigation. The Trust is a limited company and a registered charity. As well as drawing together local conservation, industrial archeology and navigation interests, the Trust has reached an agreement with Dudley Metropolitan Borough Council to lease and manage those parts of the canal within the council's jurisdiction.

One of the obstructions to the restoration of navigation is the crossing of the canal line by the A456 dual carriageway (Manor Way) to the south east of Halesowen. This crossing was constructed in the early 1960's in connection with the A456 dualling and construction of the M5, when the existing Manor Lane Canal Bridge was demolished and the canal infilled. The present carriageway level is only slightly above canal water level.

2. AQUEDUCT PROPOSAL

To restore navigation across Manor Way, an aqueduct crossing has been proposed. The necessary clearance above the carriageway for a major highway is 5.27 metres, and to obtain this clearance with only minor carriageway adjustments would involve relocation of the canal line some 110 metres west of the original position.

The northern approach to the aqueduct would be within the site owned by Sandvik, and the southern approach in fields owned by Mr C Tudor. The co-operation of both landowners will be necessary.

The ideal alignment is shown on the attached drawing. On the north side, the line of the canal would be coincidental with the wall line of the currently derelict factory building, east of the main Sandvik building, and it would rejoin the existing canal adjacent to the end of Cloister Drive, on the canal section at present scheduled for restoration. On the south side, there is more flexibility in alignment, as the approach could curve across the site originally occupied by Manor Colliery, to rejoin the original line to the south east of the Black Horse Public House.

3. CONSTRUCTION

A steel aqueduct structure is recommended, in order to span the full width of Manor Way without a central pier. The southern abutment would be at the rear of the footway, and a pier would probably be necessary in the north road verge, with a second span across the Sandvik access road.

The location of the north abutment would depend on the landowner, as two main options are possible.

(a) to continue the aqueduct across the site on two further piers, to allow access underneath to the site east of the canal. The abutment would then be located at the site boundary.

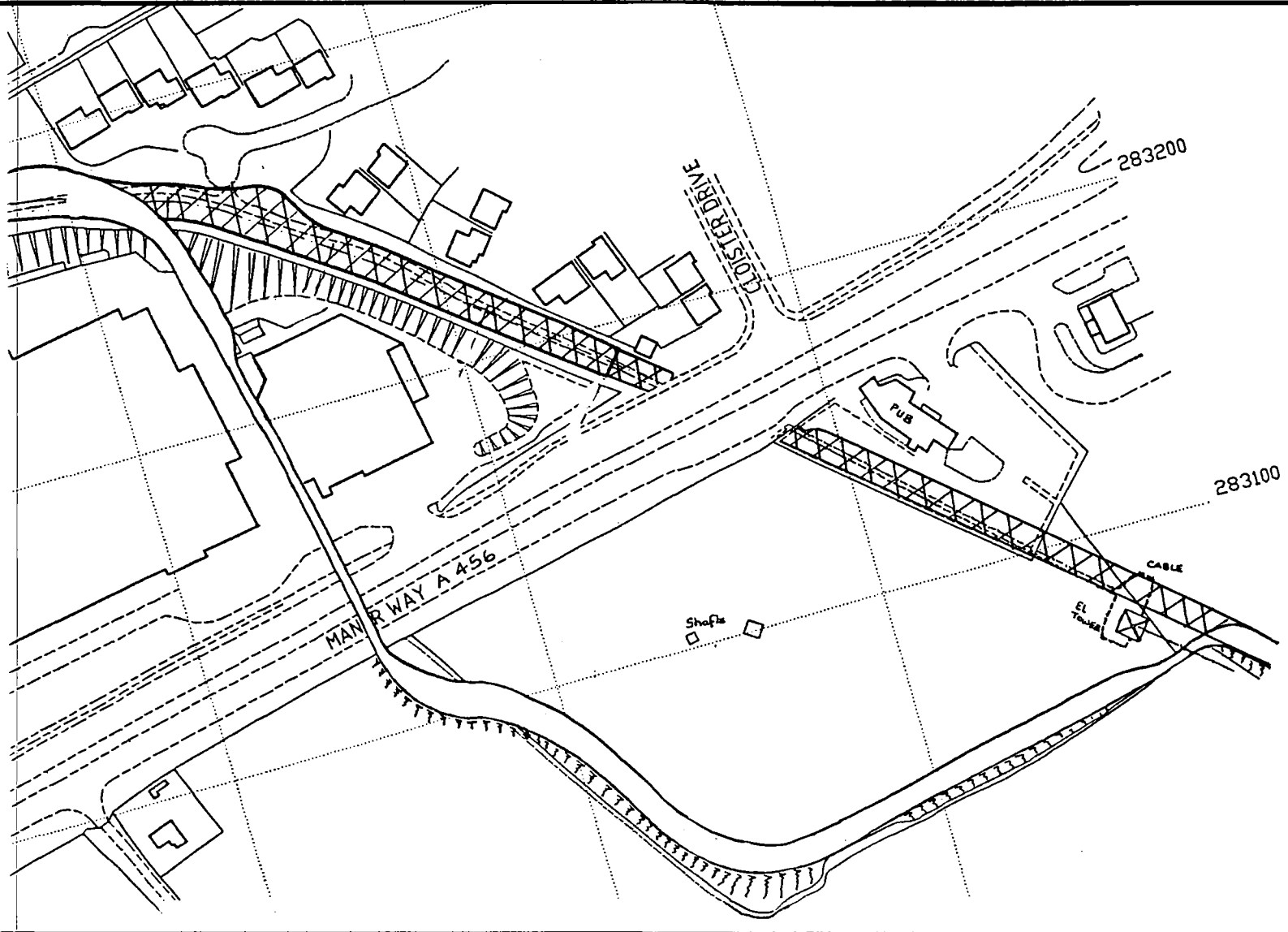
(b) to form the canal channel on an embankment and retaining wall, to allow infilling of the area east of the canal to the level of the existing ground. This area, including, if required, the original canal line, would then be available for redevelopment, possibly for housing. In this option, only two aqueduct spans are used, and the north abutment would be adjacent to the Sandvik access road.

Dudley Metropolitan Borough Council require a pedestrian crossing of Manor Way, and access could be provided to the towpath by steps at each abutment allowing the aqueduct to fulfill this role.

4. CONCLUSION

The proposal to cross Manor Way by means of an aqueduct, with no major alterations to the road vertical alignment is technically feasible, but will require full co-operation of adjacent landowners.

GERARD PAKES CONSULTANTS
10 MAY 1996



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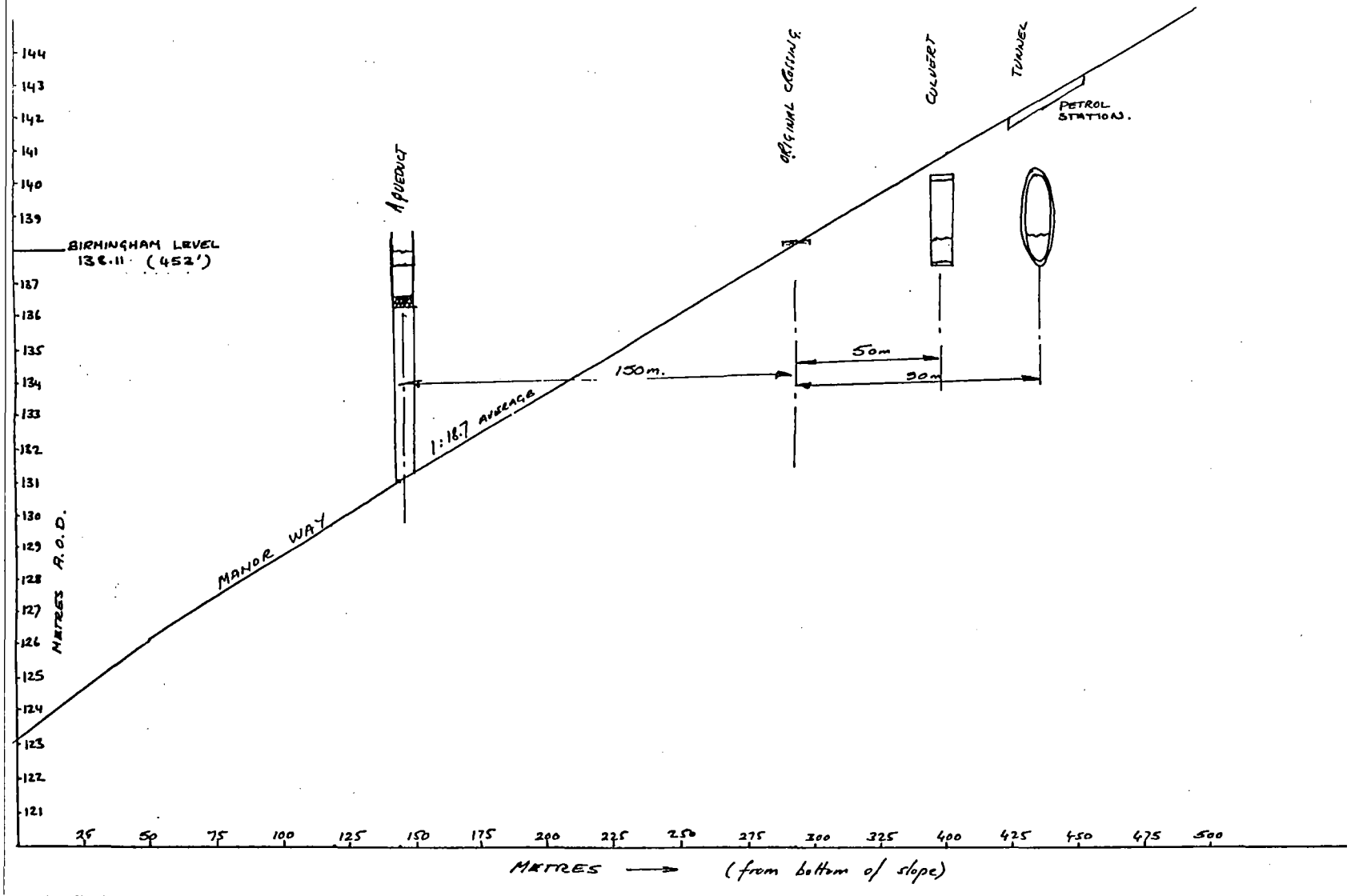
project LAPAL CANAL FEASIBILITY STUDY		scale N.T.S.	date 13-7-99
title MANER WAY CROSSING		drawn MRJP.	drg. no. 307-20
		approved GP.	



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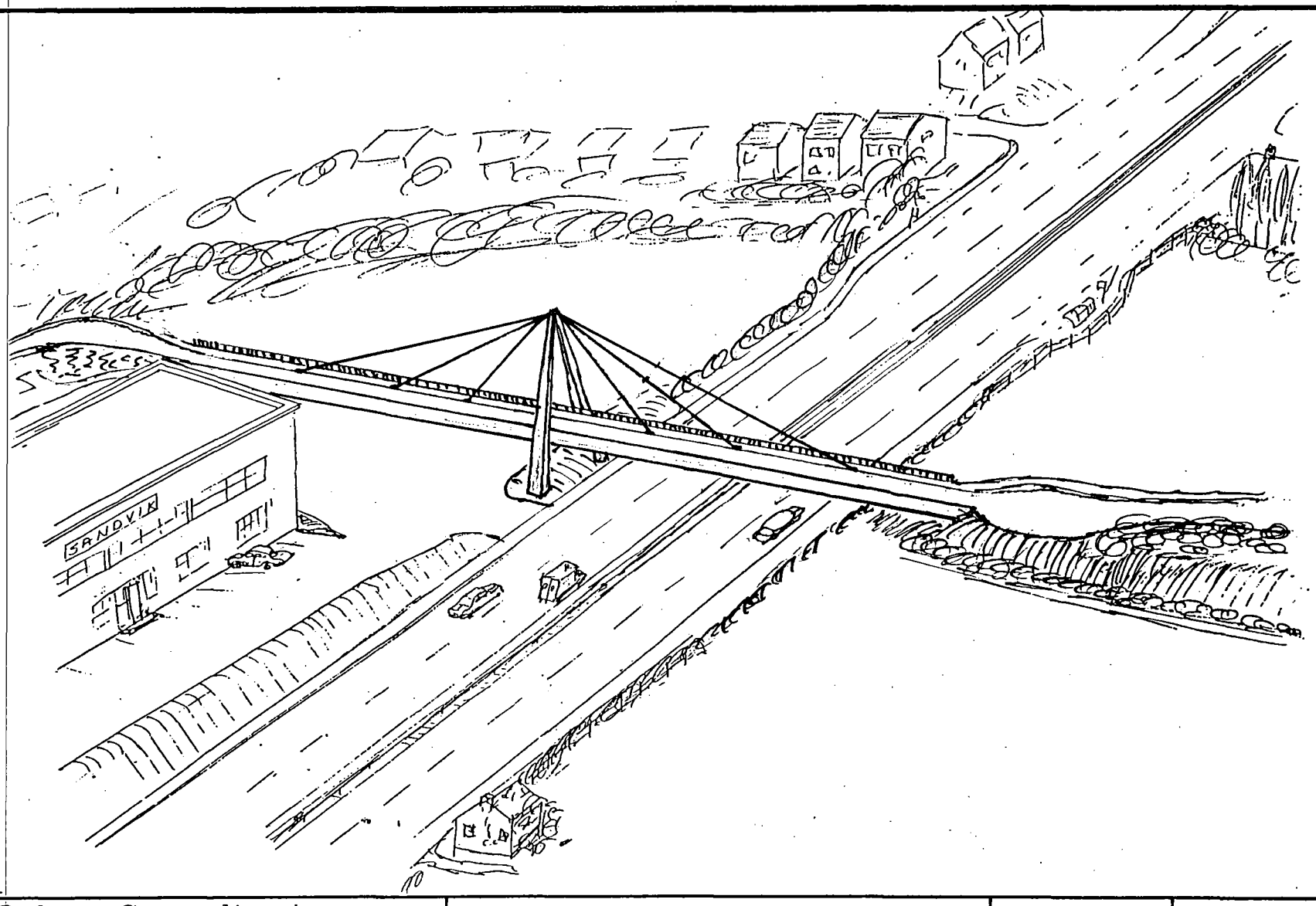
project LAPAL CANAL FEASIBILITY STUDY		scale N.T.S.	date 2-3-99
title MANOR WAY CROSSING		drawn M.R.J.P.	drg. no. 307-21
		approved GP.	



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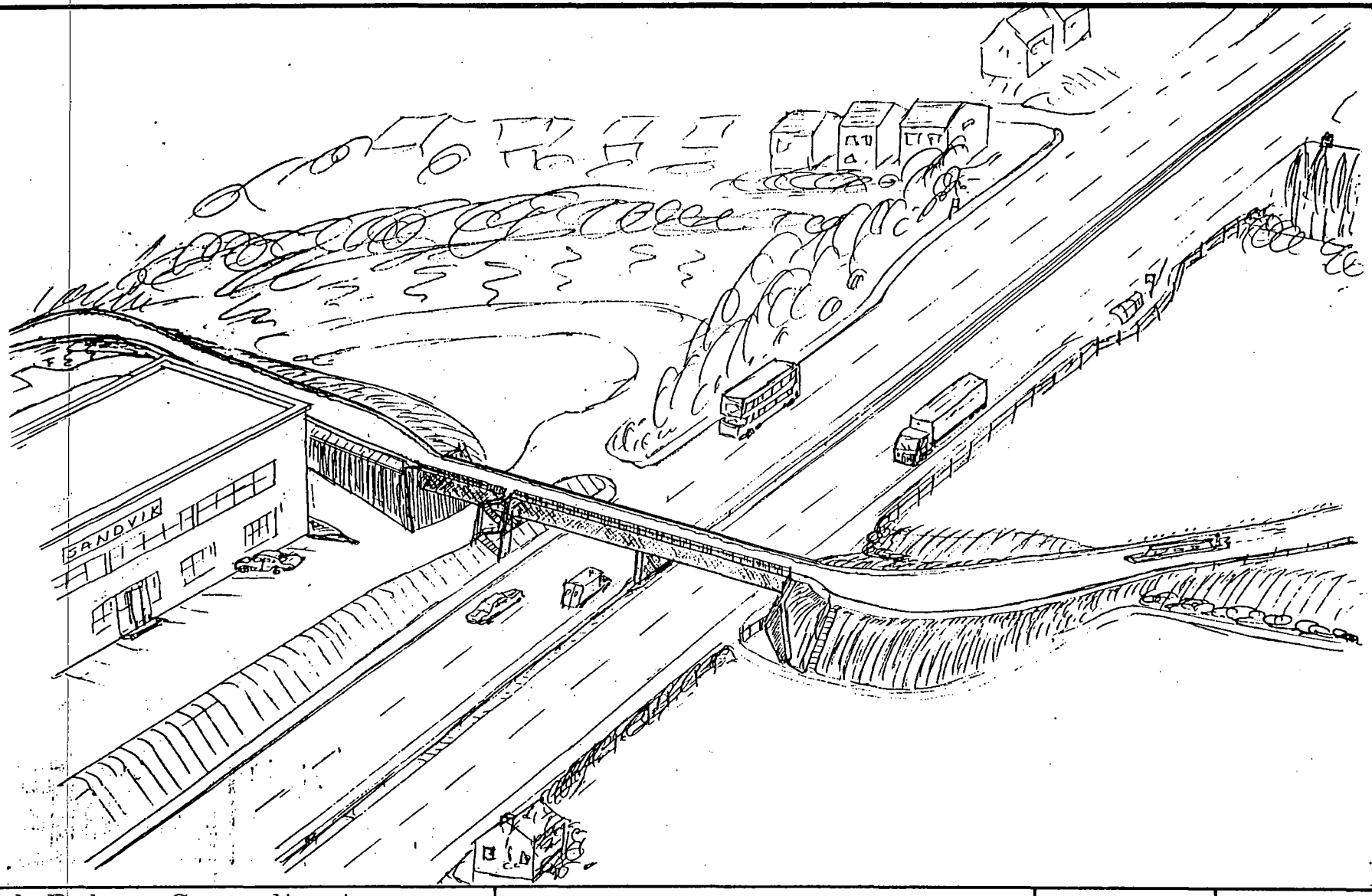
project LAPAL CANAL FEASIBILITY STUDY		scale NTS	date 1-7-99
title MANOR WAY CROSSING		drawn GP.	drg. no. 307-22
		approved MRSP.	



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project LAPAL CANAL FEASIBILITY STUDY	scale N.T.S.	date 6-3-95.
title MANOR WAY CROSSING	drawn G.P.	drg. no. 307-24.
	approved M.P.	

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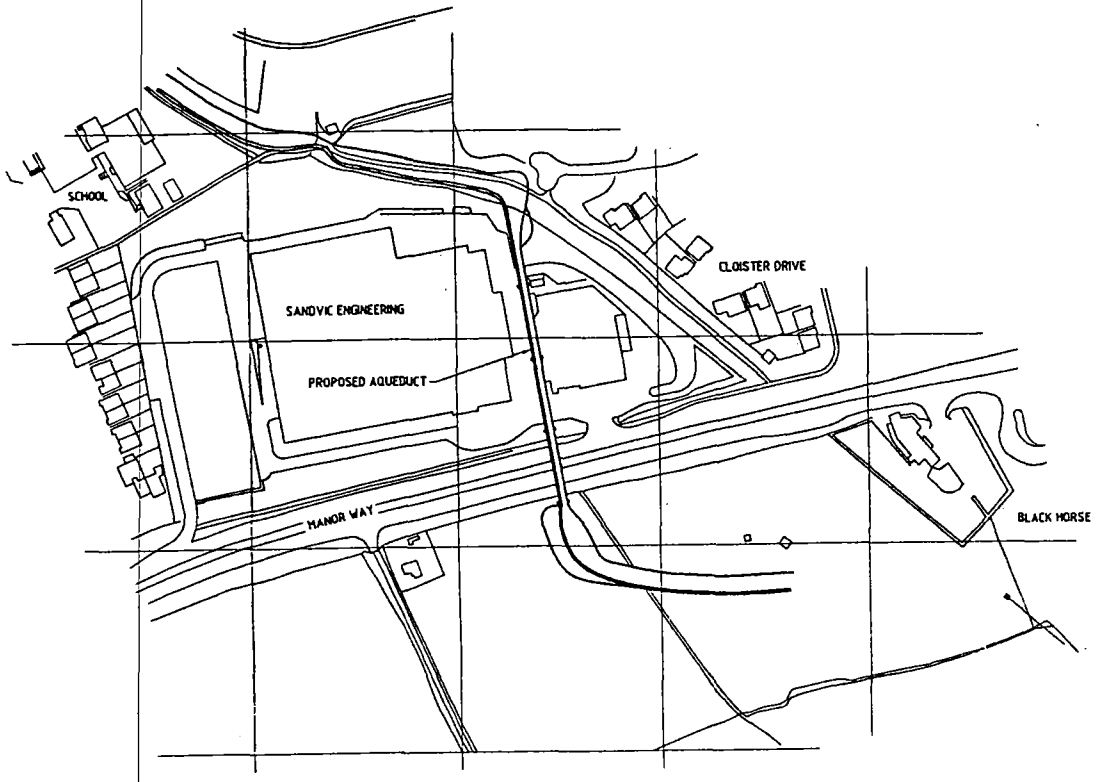
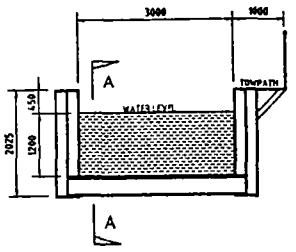


PLAN



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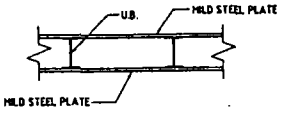
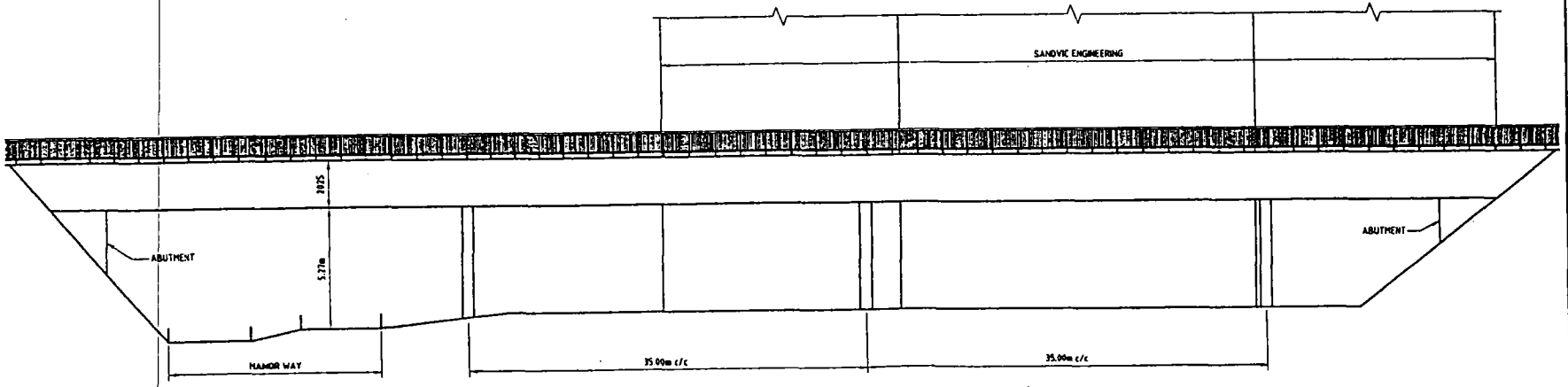


SECTION A–A



ELEVATION
(1:200 HORIZONTAL, 1:100 VERTICAL)

rev	details	by	app	date
scale	1:25, 1:50, 1:1250			
date	10-05-98			
drawn	I.B.	approved		
project	LAPAL CANAL RESTORATION – PHASE 1			
title	PROPOSED AQUEDUCT PLAN, ELEVATIONS AND SECTIONS			
drg. no.	147/010			

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APPENDIX 3.3

Manor Way Culverts

LAPAL CANAL TRUST

PROPOSED RESTORATION OF THE DUDLEY No 2 (LAPAL) CANAL

CROSSING OF A456 DUAL CARRIAGEWAY
MANOR WAY, HALESOWEN

Introduction

The Dudley No 2 Canal was opened in 1798 and extended from the Dudley Canal at Park Head, near Netherton, to the Worcester and Birmingham Canal at Selly Oak, forming a through route around the south west quadrant of the Black Country/Birmingham conurbations. Through navigation ceased in 1917 when a roof fall caused the closure of the Lapal Tunnel. The canal was abandoned between Hawne Basin and Selly Oak in 1953. The full length of the canal is 8.5 km, of which 3.5 km consists of the Lapal Tunnel.

The Lapal Canal Trust was formed in 1990 to conserve and eventually restore the canal to navigation. The Trust is a limited company and a registered charity. As well as drawing together local conservation, industrial archeology and navigation interests the Trust is close to reaching an agreement with Dudley Metropolitan Borough Council to manage those parts of the canal within the council's jurisdiction.

One of the obstructions to the restoration of navigation is the crossing of the canal line by the A456 dual carriageway (Manor Way) to the south east of Halesowen. This crossing was constructed in the early 1960's in connection with the A456 dualling and construction of the M5, when the existing Manor Lane Canal Bridge was demolished and the canal infilled. The present carriageway level is only slightly above canal water level.

The following report gives basic details of the crossing that will be necessary to restore navigation to the original structure gauge, and is intended to register the Trust's interest in this section of highway, should reconstruction or alteration be considered.

A:LAPAL2
1.02.94

LAPAL CANAL TRUST

PROPOSED RESTORATION OF THE DUDLEY No 2 CANAL

CROSSING OF THE A456 TRUNK ROAD
MANOR WAY, HALESOWEN

1. NAME OF SCHEME:

Restoration of the Dudley No 2 (Lapal) Canal - Manor Way Crossing.

2. PROJECT DESCRIPTION:

2.1 The crossing is required in order to restore to navigation the section of the Dudley No 2 Canal between Leasowes Park, Halesowen and the Western Portal of the Lapal Tunel.

3. NAME OF PROJECT AND DTP ROAD NUMBER:

MANOR WAY CROSSING.

3.1 Location of crossing
Under A456 approximately 1400 metres west of Junction 3 of M5.
NGR SO 39762833

3.2 Carriageway construction.

Not known. To be investigated.

4 TUNNEL GEOMETRY

4.1 Length
Overall Approximately 45 metres, of which 38 metres is under existing carriageway.

4.2 Cross Section

Rectangular, approximately 3.66 metres wide, 4.1 metres high internal dimensions.
External dimensions dependent on detailed structural design.

4.3 Structure and Form of Tunnel

Reinforced concrete box culvert.
Minimum cover under carriageway: To be agreed

Water level	138.1m AOD
Crossing soffit level	140.8m AOD
Invert level	136.7m AOD
Gradient -	Level

4.4 Proposed arrangements for inspection and maintenance

Routine inspections from within cluvert.
Maintenance from within culvert (dewatering possible)

4.5 Materials and finishes

Reinforced concrete, F2 internal finish.

4.6 Safety measures

Towpath with handrail on west side.
Grab chains on east side.

5. IMPOSED DESIGN LOADS

5.1 Carriageway Loading

5.1.1 HA Full loading in accordance with BD 37/88 (BS 5400).

5.1.2 HB Loading 45 units in accordance with BD (BS 5400)

5.1.3 Exceptional abnormal loading - by agreement.

5.2 Loading imposed by other structures: Nil

6 GEOLOGICAL CONDITIONS

6.1 Site Investigations

6.1.1 Desk study of existing records will be part of the detailed design.

6.1.2 Additional site investigation as deemed necessary.

6.2 Designers Interpretation of Site Investigation

An Engineers Statement of Ground Conditions will be prepared as part of the detailed design.

6.3 Mining or Mineral Extraction

Coal mining was carried out adjacent to the crossing until 1930/1940. Detailed study of mining records will form part of the detailed design. Some site investigation may be necessary.

7 CROSSING SYSTEM AND METHOD OF CONSTRUCTION

7.1 Basis of the Design

In situ reinforced concrete box culverts to BS 8110 and BS 5400

7.2 Proposals for Continued Safe Use of the Carriageway

Traffic management systems to be agreed.

7.3 Effects on the Carriageway

The existing dual carriageway crosses the line of the canal immediately above the original and intended water level. Restoration of the canal navigation will therefore involve raising the carriageway level by approximately 3.5 metres above existing.

It is envisaged that this would be carried out as part of any major reconstruction of this section of the A456 highway.

7.4 Use of Explosives

Explosives are not envisaged.

7.5 Methods to be adopted to monitor effects of crossing

To be agreed.

7.6 Relevant Documents

BS 5400 - (1980) Steel, Concrete and Composite Bridges. Specification for Highway Works 1986

7.6.1 No departure from the above standards are to be incorporated.

7.6.2 Aspects not covered by 7.6

BS 6164 (1990) Code of Practice For Safety in Tunnelling in the Construction Industry.

8 DESIGN AND CHECK CERTIFICATION

8.1 Engineer responsible for design:

G Pakes, B.Eng, C.Eng, FICE, MIMgt
Gerard Pakes Consultants
Town Hall Clock Tower
Wirksworth
Derbyshire
DE4 4EU

8.2 Checking to be undertaken by:

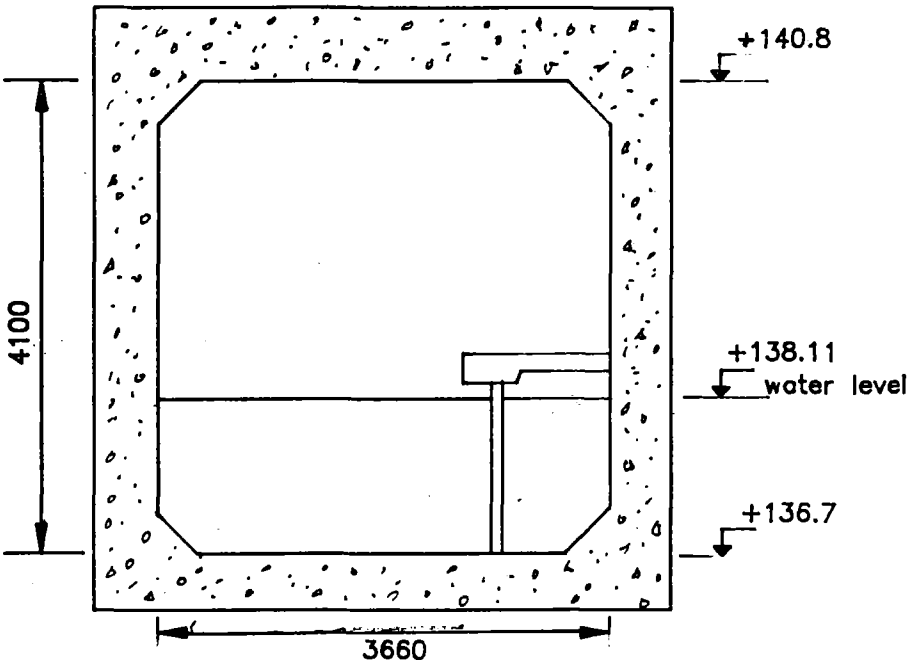
To be agreed

9 DRAWINGS AND DOCUMENTS

Drawing No 147/001 - Preliminary Plan and Sections
Drawing No 147/002 - Cross Section

MANOR WAY

Carriagway construction to be agreed



rev	details	by	app	date

scale N.T.S.	
date 1/2/94	147/02
drawn As / approved	
project	LAPAL CANAL MANOR WAY CROSSING
title	TYPICAL CROSS SECTION

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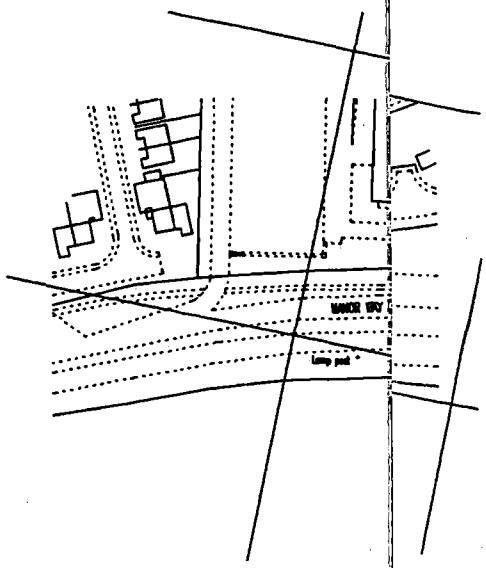

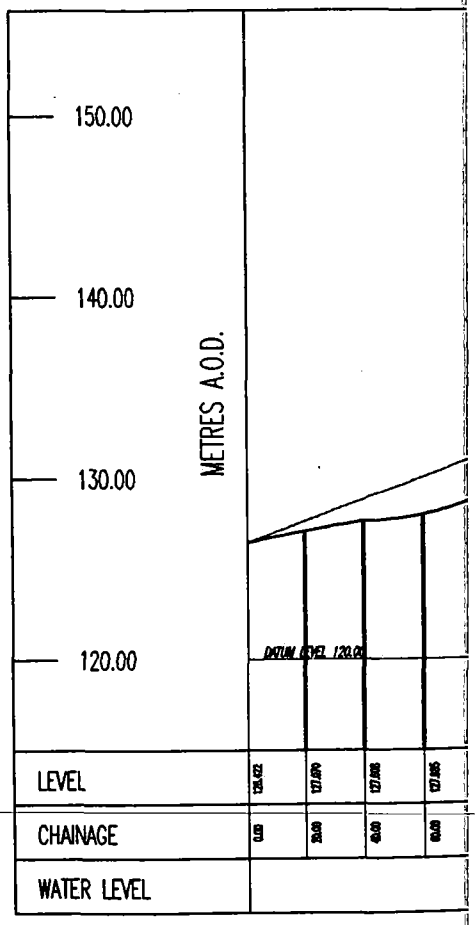

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scale	1:1250		
date	25-11-93	dwg no.	147/01
drawn D.I.B.	approved		
project	LAPAL CANAL MANOR WAY CANAL CROSSING		
title	PLAN AND LONG SECTION		

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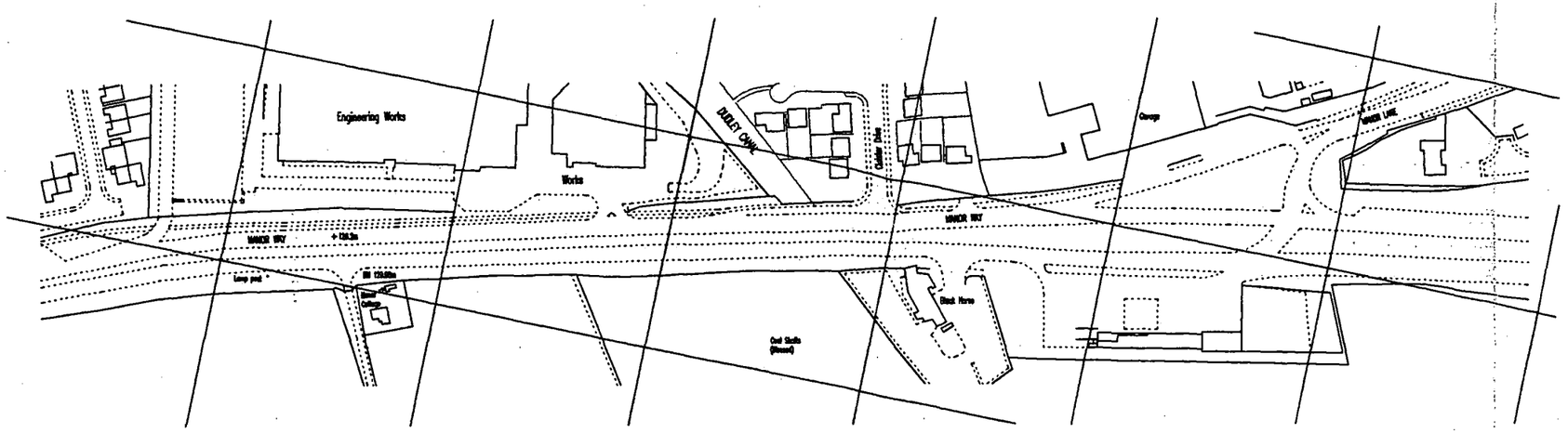
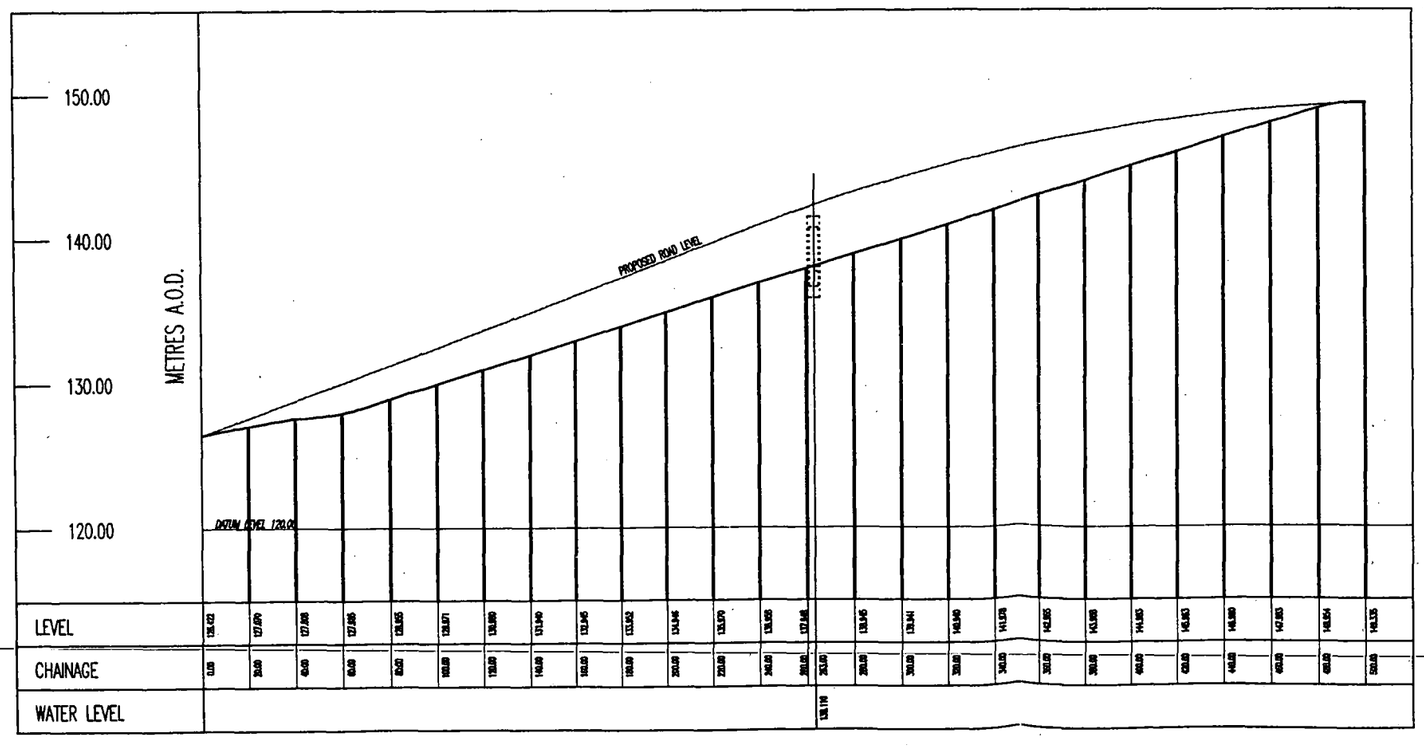


PLAN



LONGITUDINAL SECTION (HORIZONTAL 1:1250 VERTICAL 1:200)

rev	details	by	app	date
scale	1:1250			
date	25-11-93	dwg no.	147/01	
drawn	D.I.B.	approved		
project	LAPK CANAL MANOR WAY CANAL CROSSING			
title	PLAN AND LONG SECTION			

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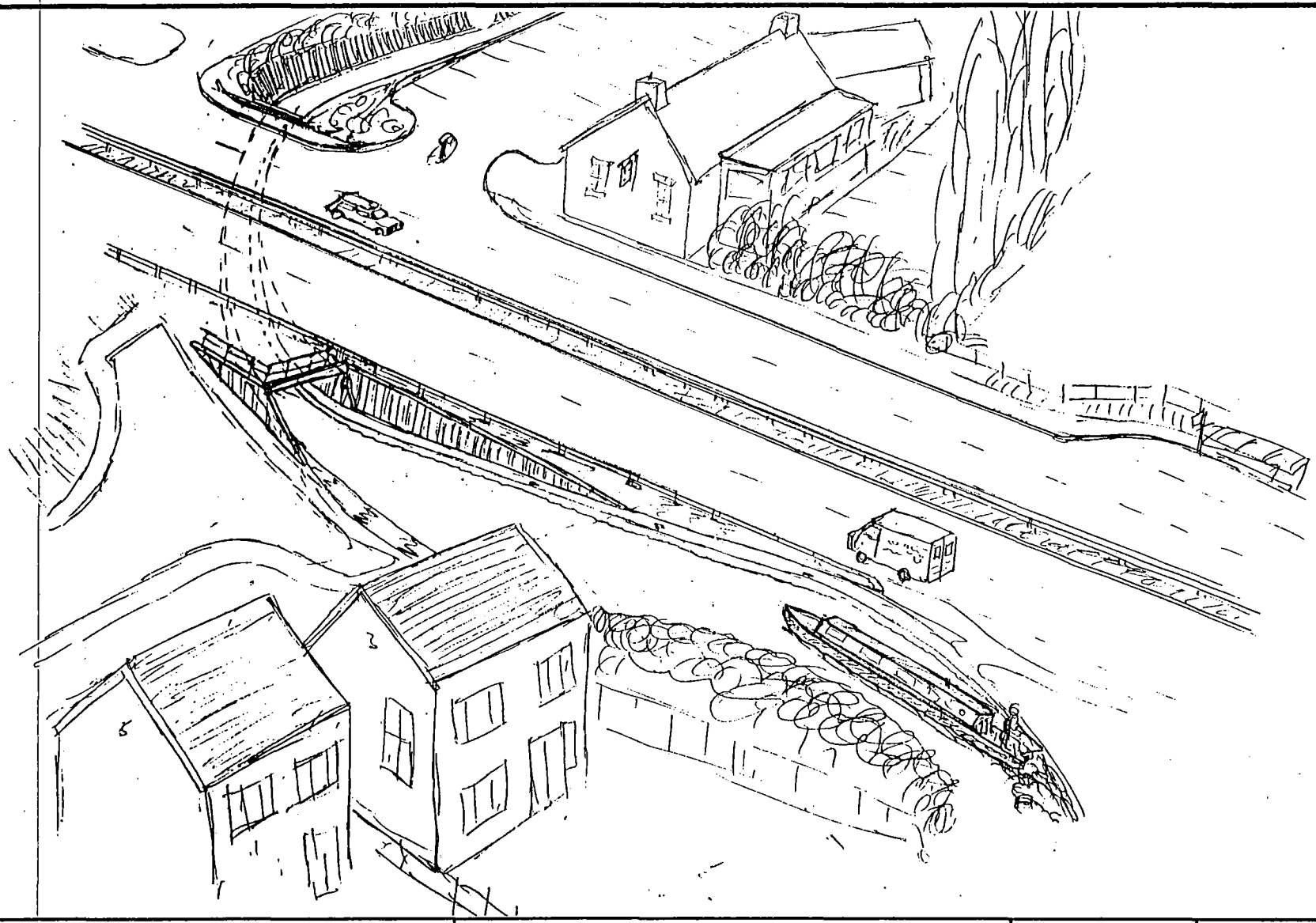

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project LAPAL CANAL FEASIBILITY STUDY

scale N.T.S.

date 5-3-95

title
MANOR WAY CROSSING.
SEE SECTION 4.1.2.3

drawn GP.

approved M.

drg. no.
307-23.

APPENDIX 3.4

Heywood Bridge
(Mucklows Hill)

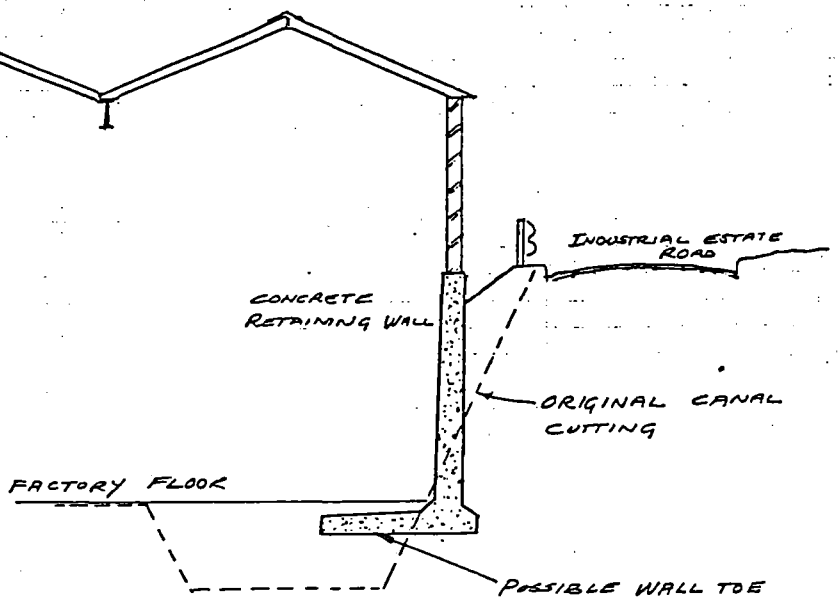


FIGURE 2.

NEWBANK ENGINEERING CROSS-SECTION

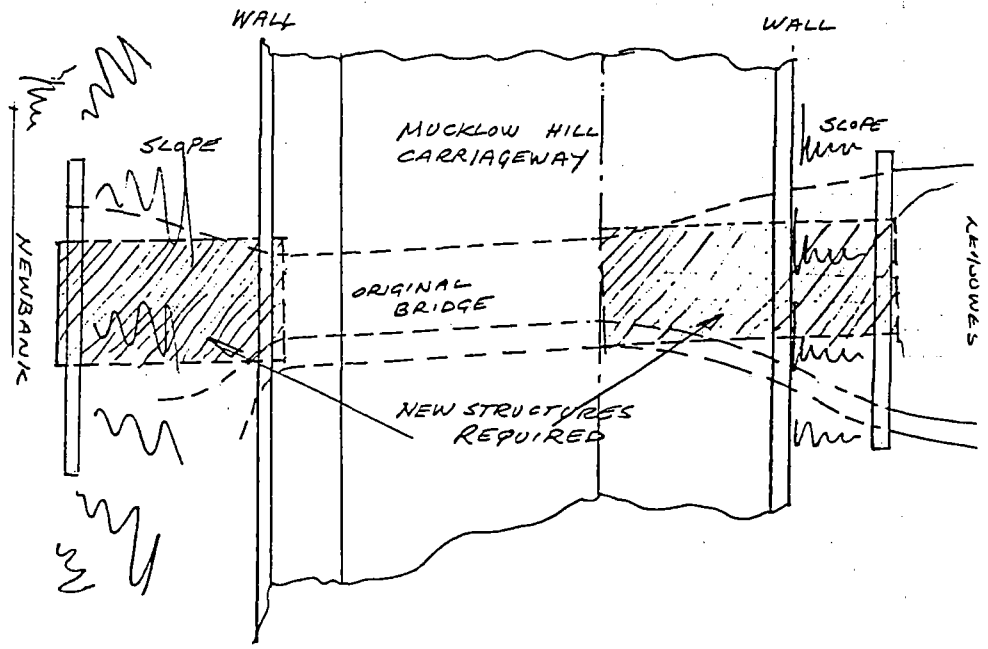
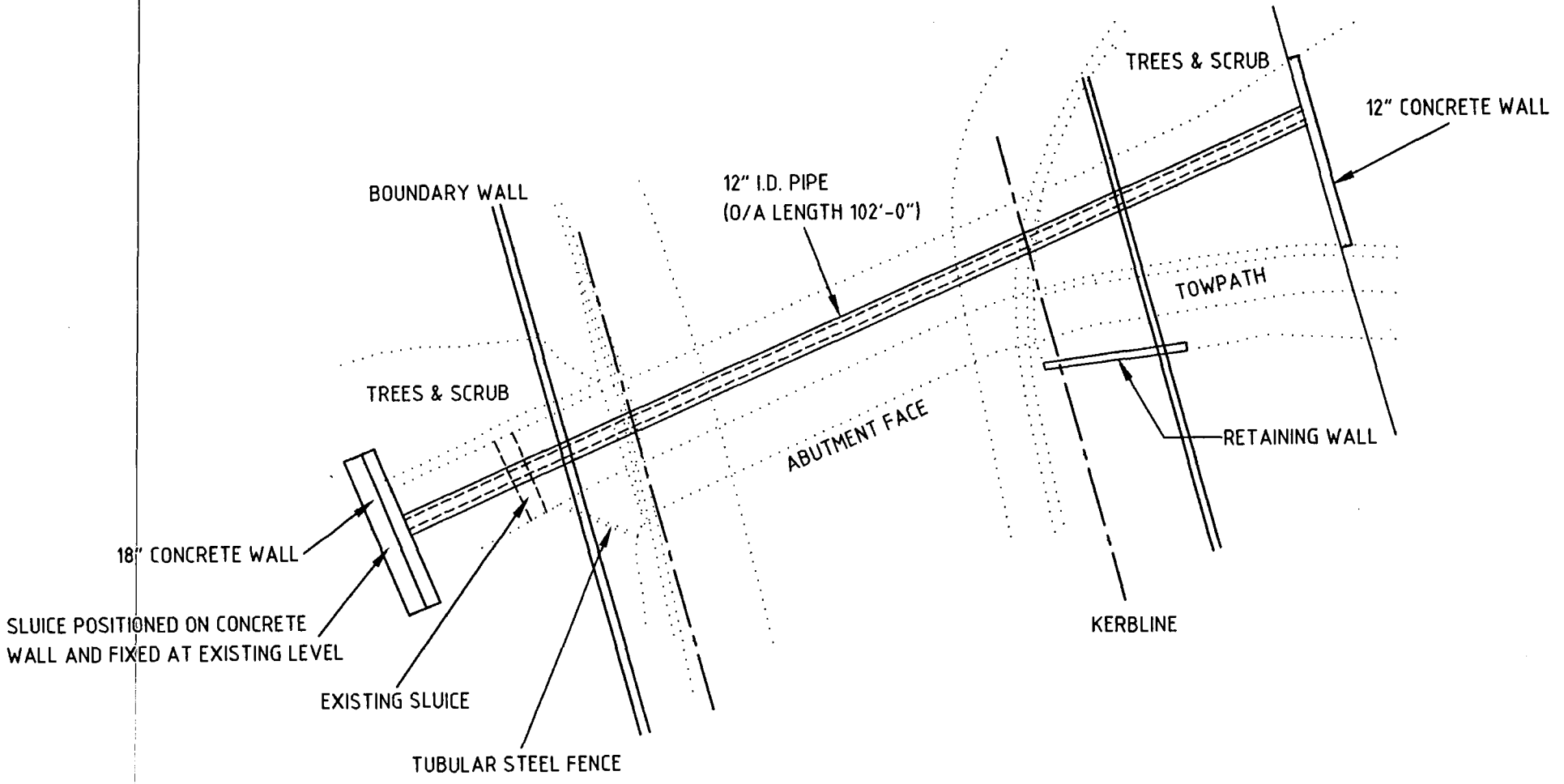


FIGURE 3

MUCKLOW HILL BRIDGE PLAN



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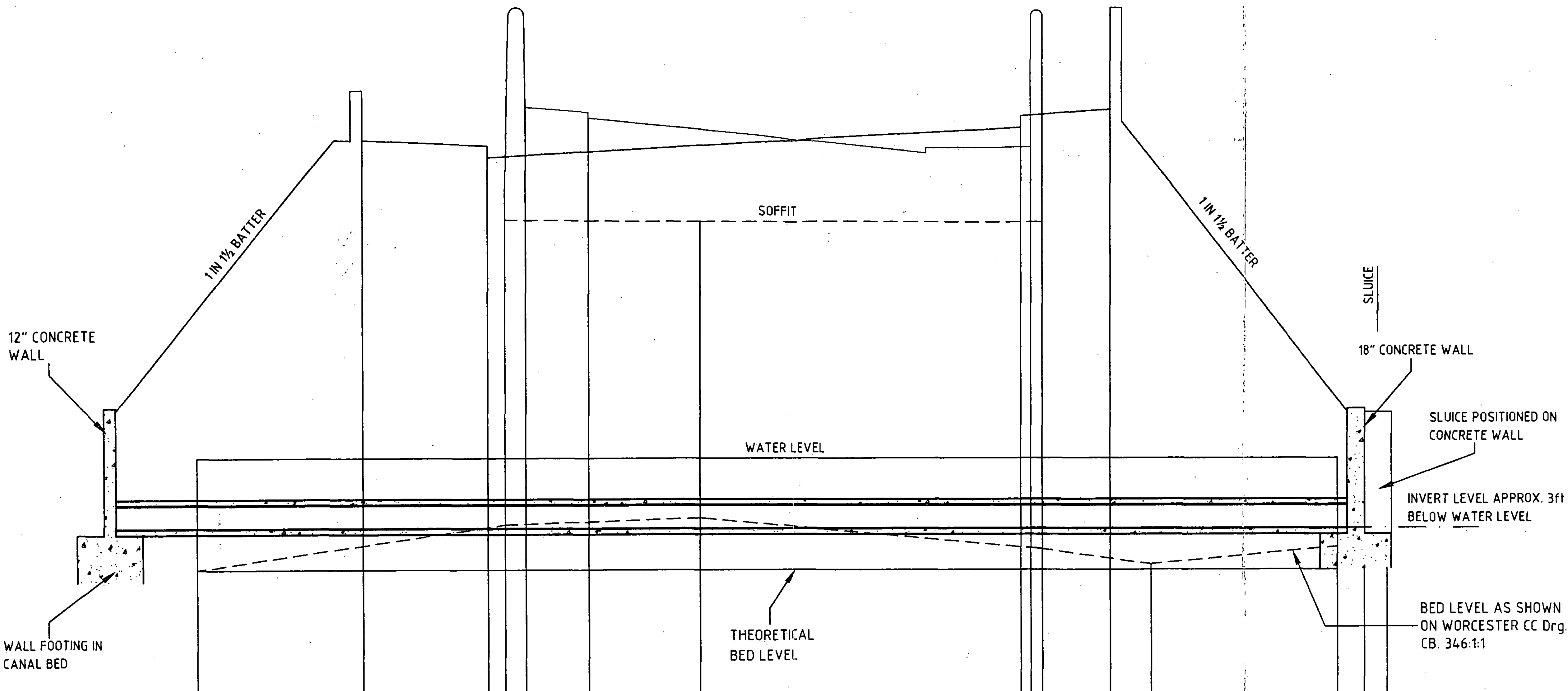
project	LAPAL CANAL RESTORATION	scale N.T.S.	date 12-02-96
title	HEYWOOD CANAL BRIDGE PLAN	drawn M.B	drg. no. 147/03/03/1
		approved	

TO BE READ IN
CONJUNCTION WITH Drgs.
147/03/03/1, 2, 3 & 4



PROPOSED LEVELS		142.26	142.19									142.58				142.66			
EXISTING ROAD LEVELS					143.96	142.69	142.62	142.55		142.09	142.16		142.17	143.88					
EXISTING SOFFIT LEVELS				141.22					141.20						141.19				
CANAL BED LEVELS	136.64			137.23					137.32						136.91		136.94	136.70	136.39

rev	details	by	app	date

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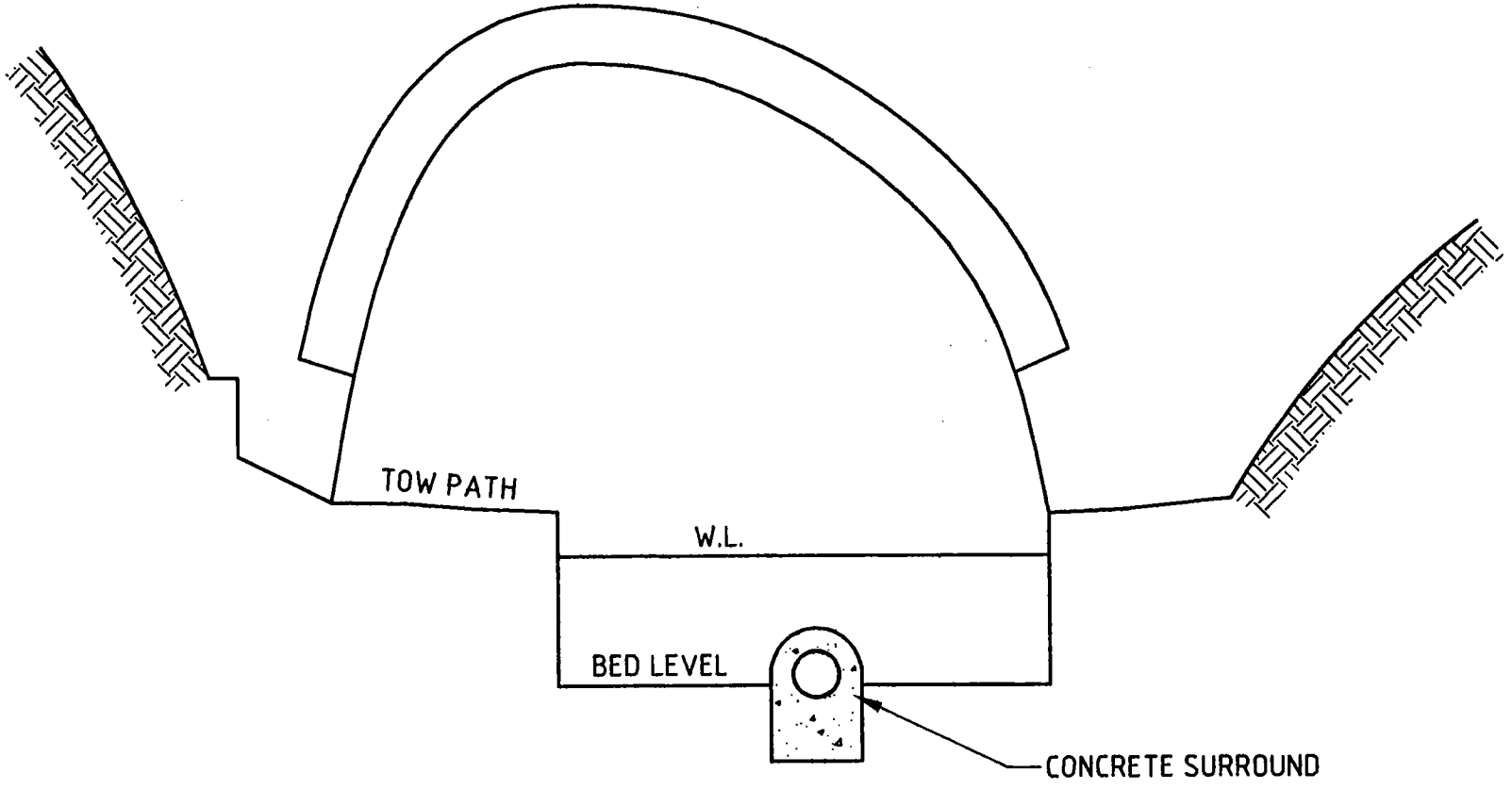
project LAPAL CANAL RESTORATION

title HEYWOOD CANAL BRIDGE
LONGITUDINAL SECTION

date 19–02–96
drawn MB
approved
scale N.T.S.

drg. no. 147/03/03/5

TO BE READ IN
CONJUNCTION WITH Drgs.
147/03/03/ 1,3,4,& 5



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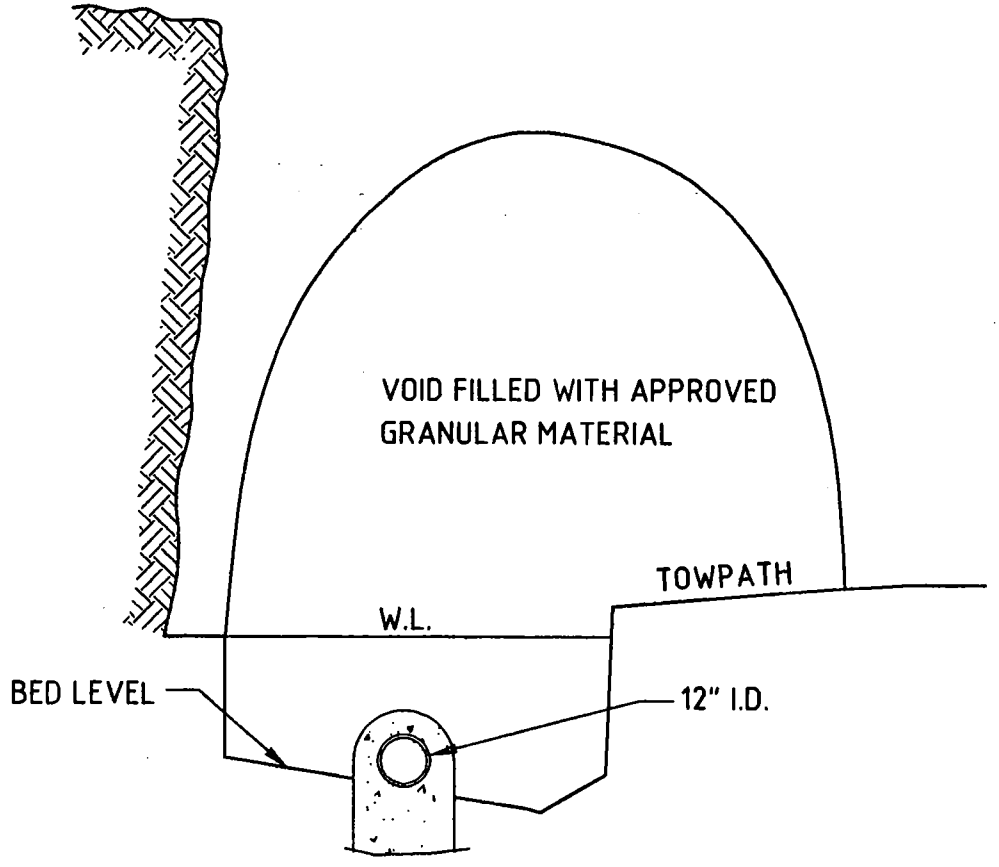
project	LAPAL CANAL RESTORATION	scale N.T.S.	date 9-02-96
title	HEYWOOD CANAL BRIDGE SOUTH ELEVATION	drawn M.B	drg. no.
		approved	147/03/03/2

TO BE READ IN
CONJUNCTION WITH Drgs.
147/03/03/1, 2, 4 & 5



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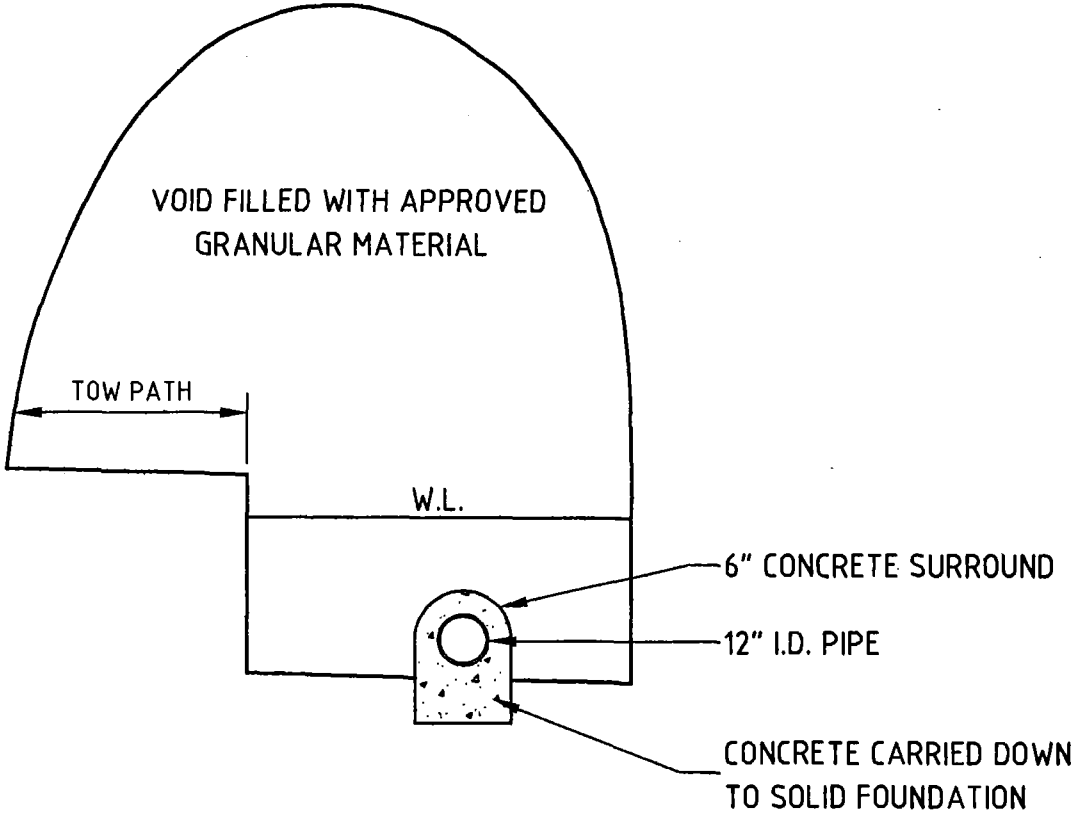
project	LAPAL CANAL RESTORATION	scale N.T.S.	date 21-02-96
title	HEYWOOD CANAL BRIDGE NORTH ELEVATION	drawn M.B	drg. no.
		approved	147/03/03/3

TO BE READ IN
CONJUNCTION WITH Drgs.
147/03/03/1, 2, 3 & 5



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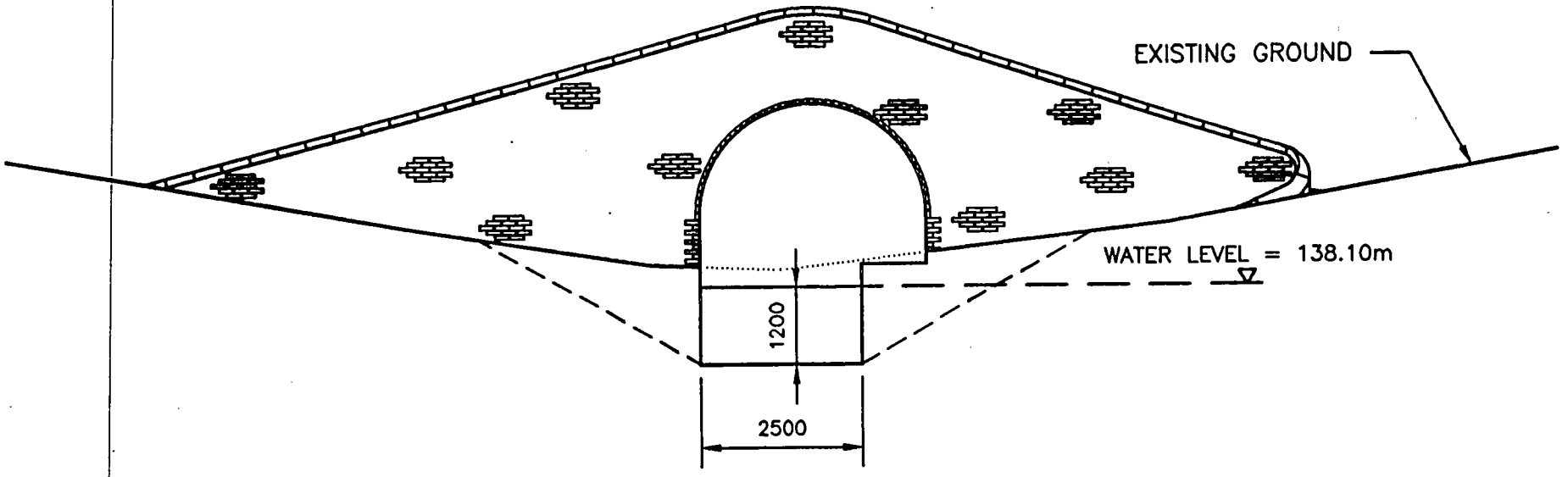
project	LAPAL CANAL RESTORATION	scale N.T.S.	date 15-02-96
title	HEYWOOD CANAL BRIDGE CROSS SECTION BENEATH ARCH	drawn M.B	drg. no.
		approved	147/03/03/4

APPENDIX 3.5

Accommodation Bridges etc



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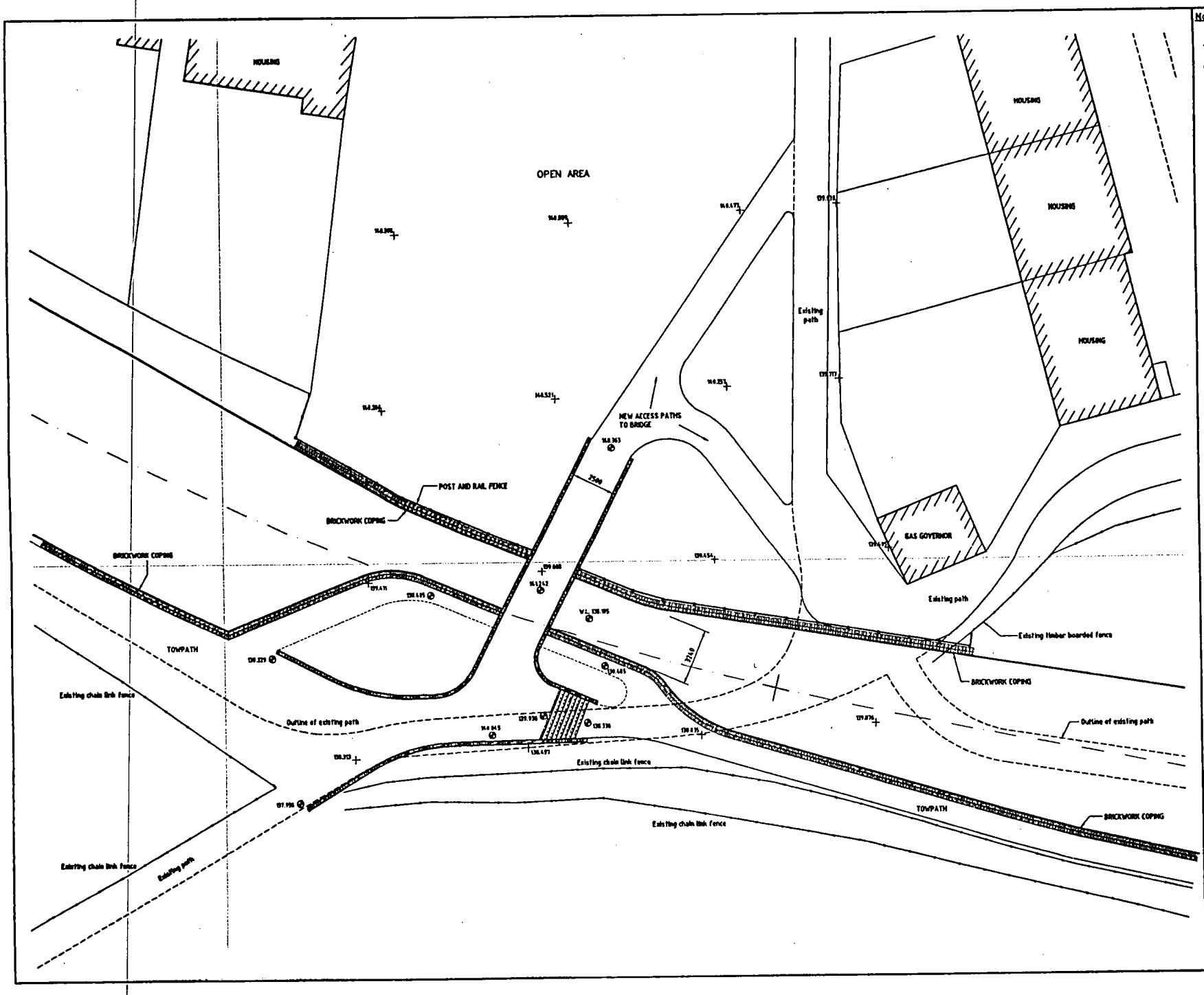
project LAPAL CANAL - LEASOWES SECTION		scale 1:100	date 2-07-95
title	PROPOSED CROSS - SECTION FORDROVE BRIDGE	drawn M.B	drg. no. 147/SK02/A
		approved	



Notes:-

+ EXISTING GROUND LEVELS

⊕ PROPOSED GROUND LEVELS

FOR PLANNING PURPOSES ONLY NOT FOR CONSTRUCTION

rev	details	by	app	date
scale	1:100			
date	24-05-96		dwg. no.	147/006
drawn	LB	approved	GP	

project: LAPAL CANAL RESTORATION - PHASE 1

title: LEASOWES SECTION NEW FOOTBRIDGE PLAN

Gerard Pakes Consultants
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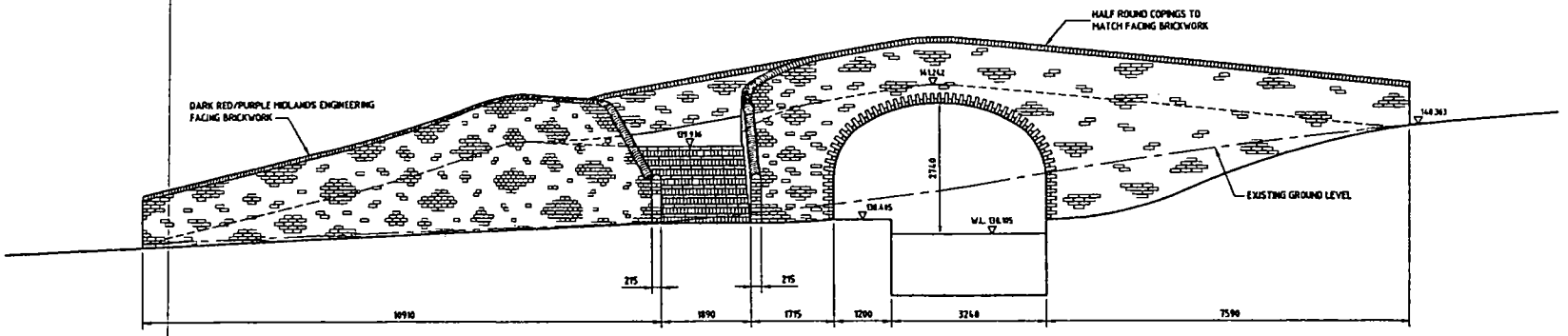
Fax - 01629 [illegible]

Notes: -



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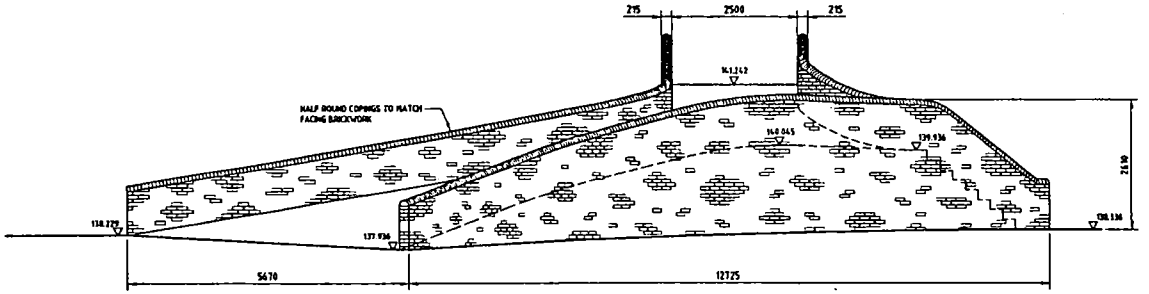
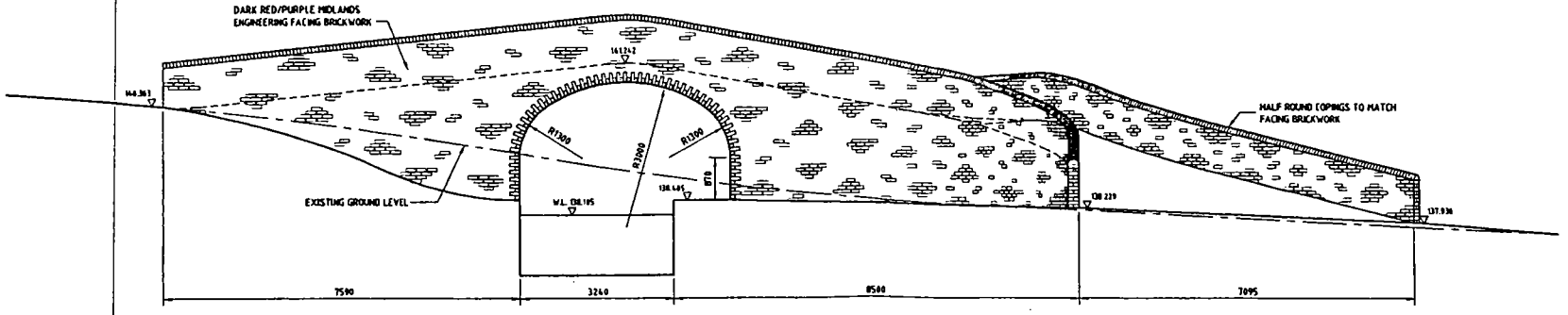


SOUTH WEST ELEVATION



NORTH WEST ELEVATION

FOR PLANNING PURPOSES ONLY NOT FOR CONSTRUCTION

rev	details	by	chd	date

scale 1:50
date 24-05-96
drg. no. 147-007
drawn LB
approved
project LAPAL CANAL RESTORATION - PHASE 1
title NEW FORGROVE FOOTBRIDGE ELEVATIONS

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Telephone - 01629 823000
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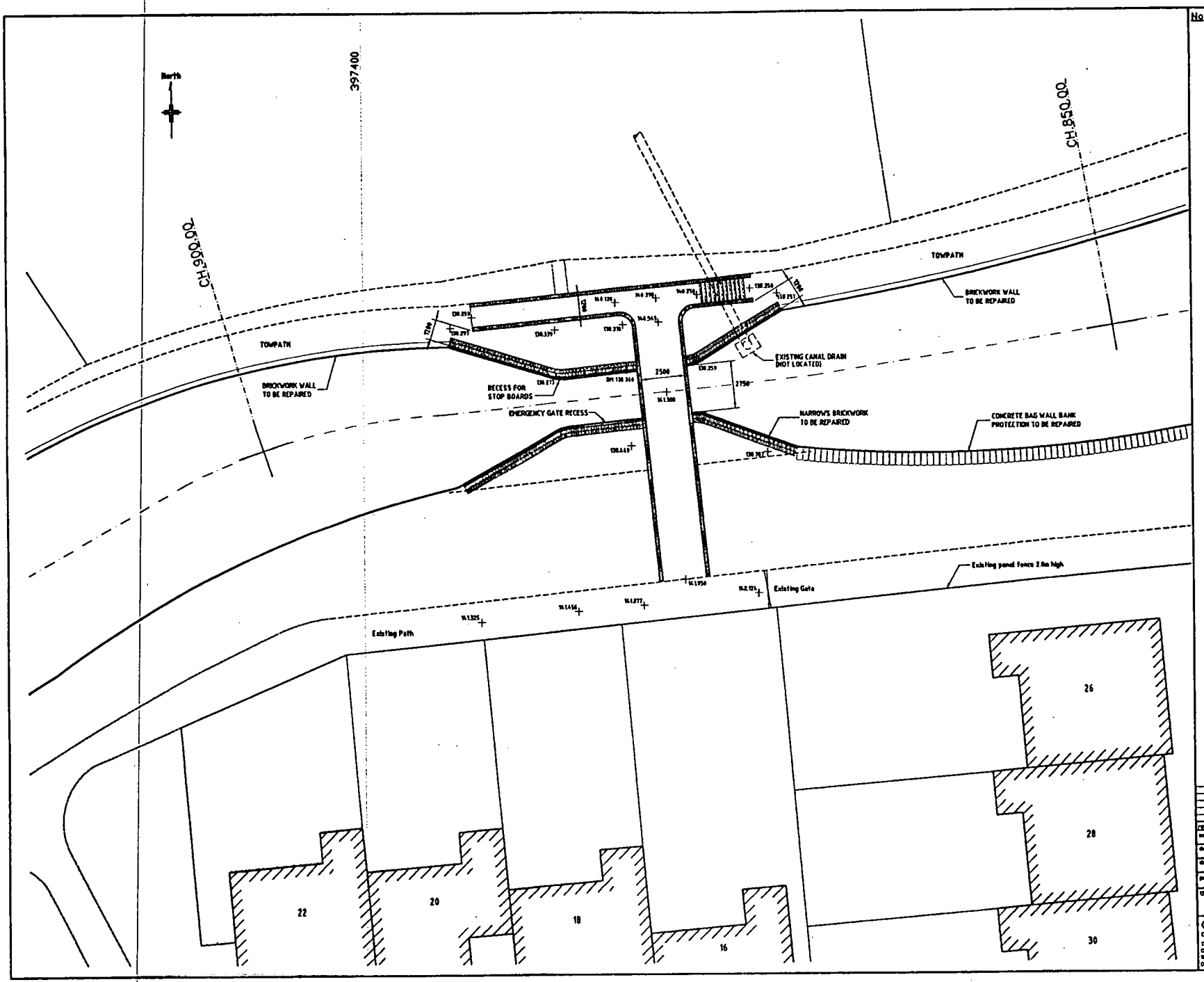

Notes:-

FOR PLANNING PURPOSES ONLY NOT FOR CONSTRUCTION

rev	details	by	app	date
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date	20-04-06		dwg. no.
drawn	M.R.	approved	147/004
project	LAPAL CANAL RESTORATION - PHASE 1		
title	LEASOWES SECTION NEW NARROWS FOOTBRIDGE PLAN		

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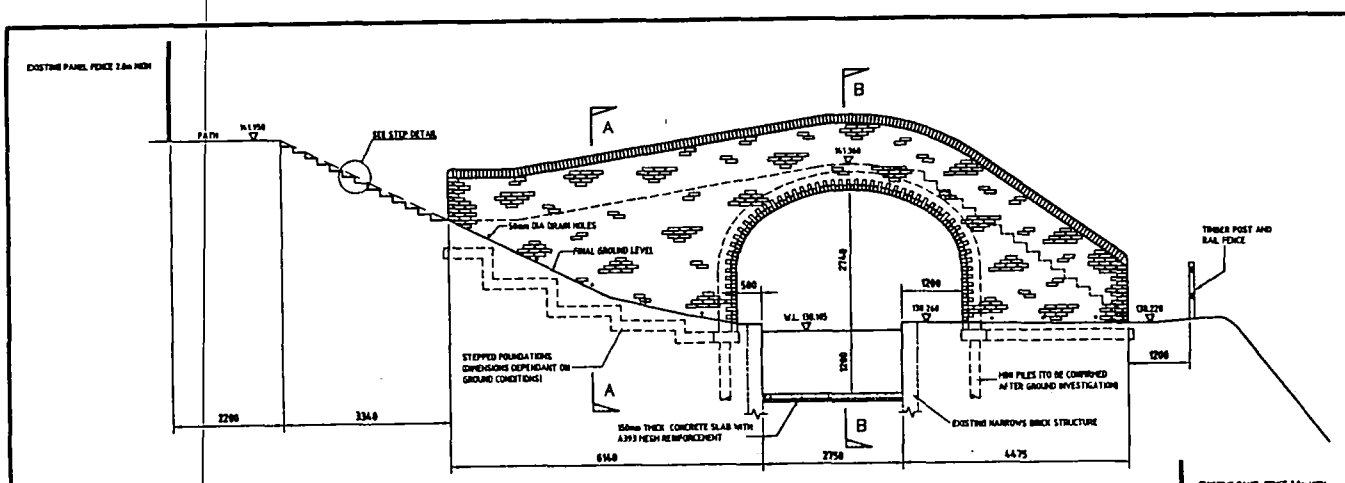
Fax - 01439 [illegible]



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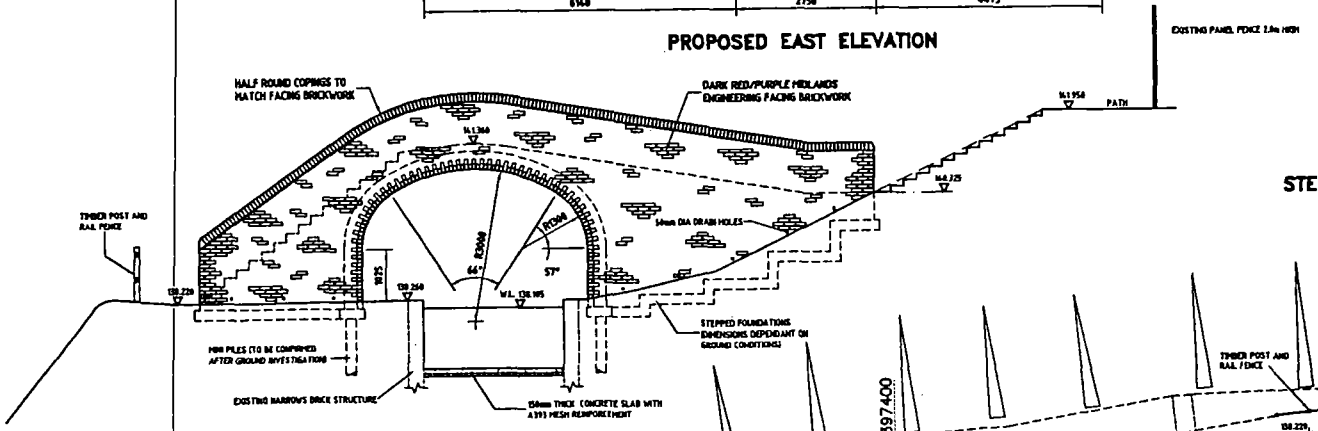

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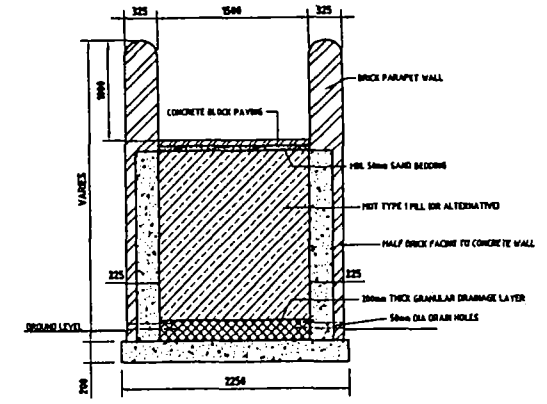
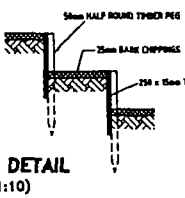
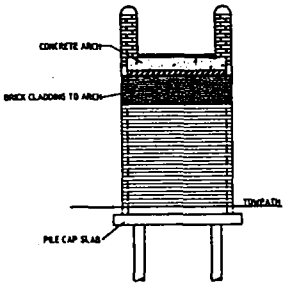


SECTION A–A



STEP DETAIL
(1:10)



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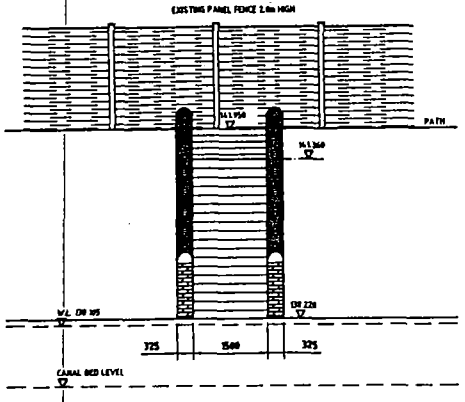

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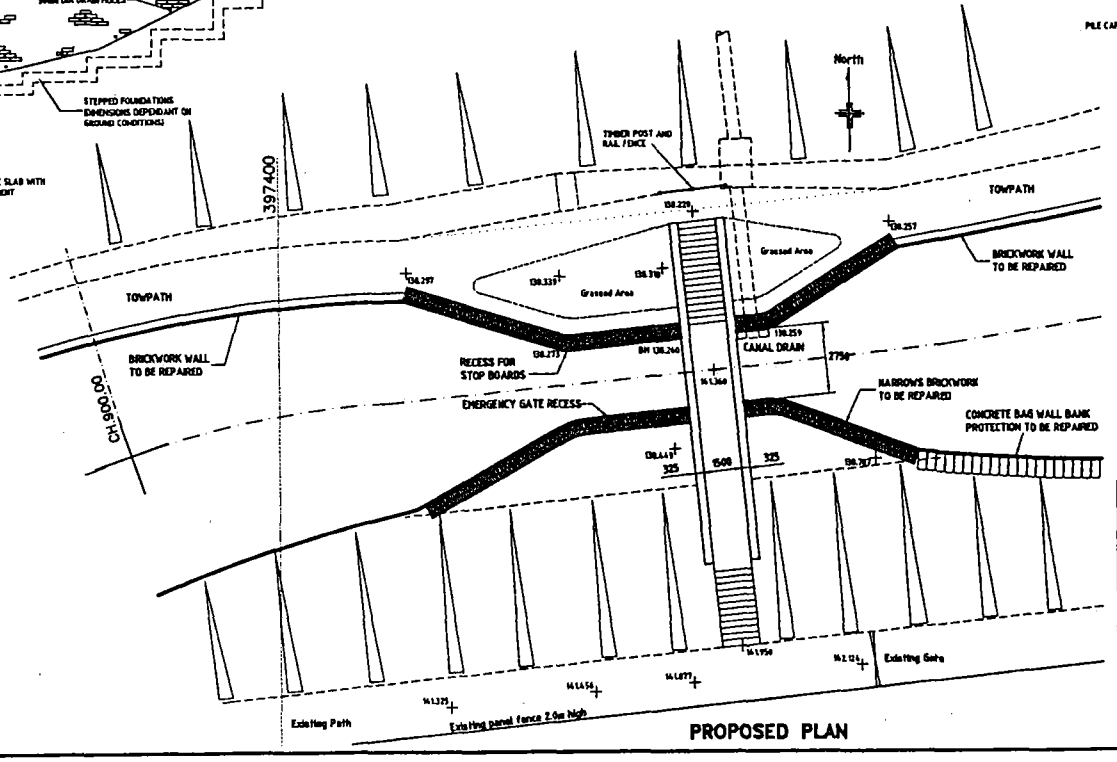

PROPOSED PLAN

rev	details	by	dpa	date
A	POSITION OF EXISTING CANAL DRAIN AMENDED	BJL	BLP	28-10-98

scale	1:25, 1:50, 1:100
date	28-01-97
drawn	J.B.
approved	D.C.
drg. no.	147/1/113/A
project	LAPAL CANAL RESTORATION - PHASE 1
title	LEASOWES SECTION ALTERNATIVE NEW NARROWS FOOTBRIDGE PLAN AND ELEVATIONS

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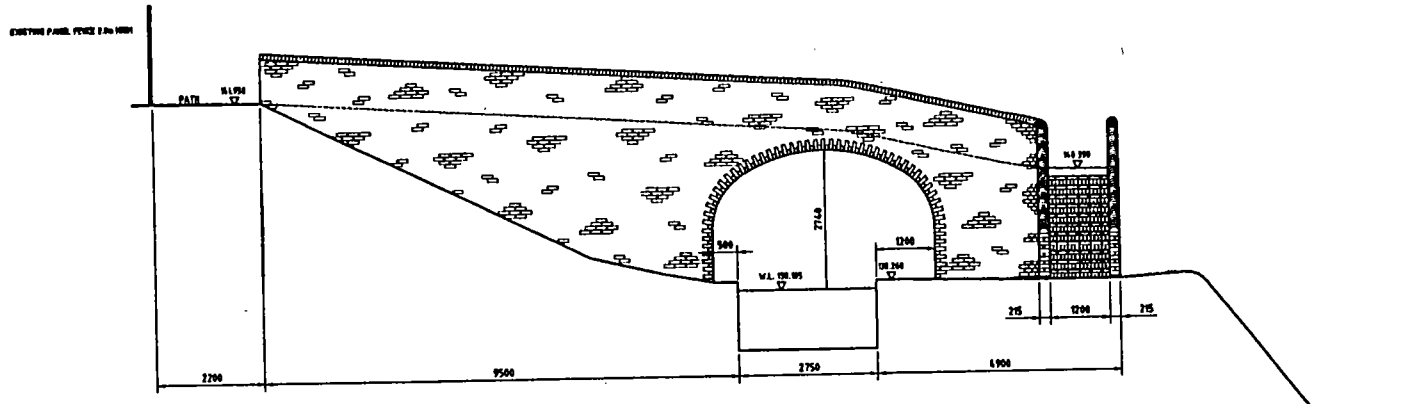
Fax - 01629 822897

Notes:-



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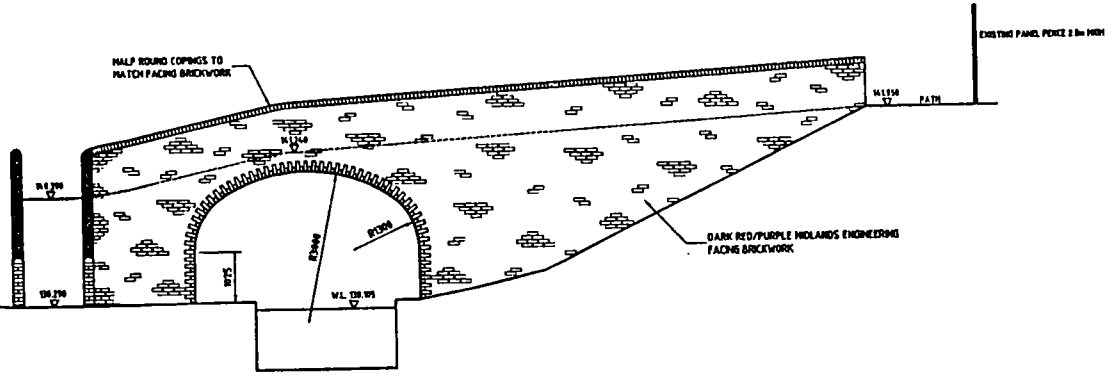
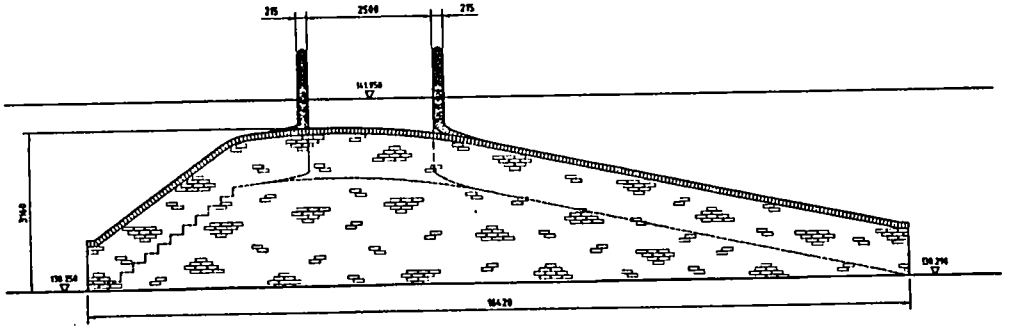


PROPOSED WEST ELEVATION



PROPOSED NORTH ELEVATION

FOR PLANNING PURPOSES ONLY NOT FOR CONSTRUCTION

rev	details	by	app	date
scale 1:50				
date 30-04-06				drg. no. 147/005
drawn LB	approved GP			

project LAPAL CANAL RESTORATION - PHASE 1

title LEASOWES SECTION NEW NARROWS FOOTBRIDGE ELEVATIONS

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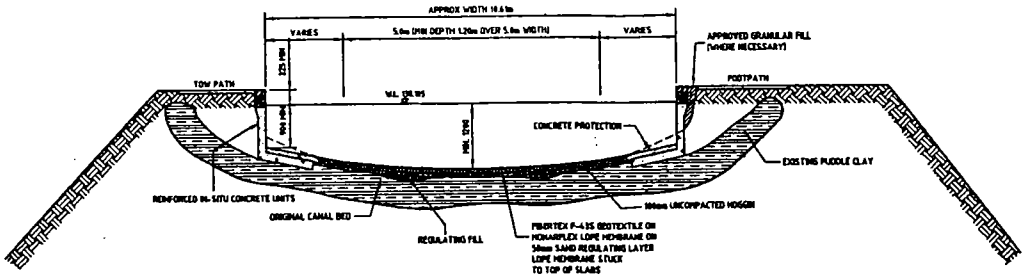
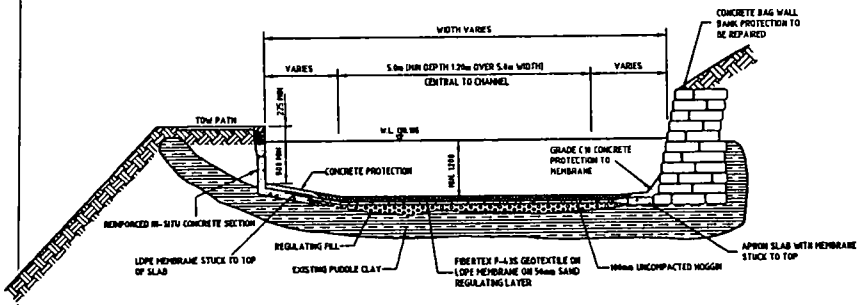
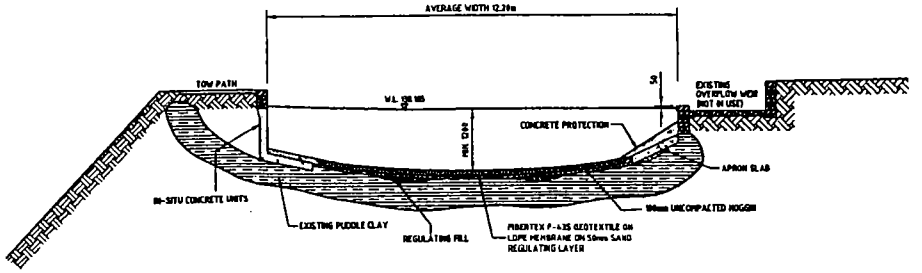


SECTION A–A



SECTION B–B



SECTION C–C

Notes:-

THE PUDDLE CLAY SHOWN ON THIS DRAWING HAS BEEN INTERPRETED FROM TRIAL PIT INFORMATION

AS BUILT RECORD DRAWING

rev	details	by	app	date

scale	1:50
date	22-09-98
drawn	S.H.
approved	
drg. no.	147/1/121

project: LAPAL CANAL RESTORATION – PHASE 1

title: CROSS SECTIONS

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Fax – 01629 825007

APPENDIX 4

Capital Costs

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
1	Hawne Basin to Newbank site. 127m	
	Dredging of existing channel	
	127m * 14m av width * 1.05m deep = 1867 Cu m	
	1867 * £48 per Cu m excavation & disposal	£89,616.00
	Puddle Clay	
	120 Cu m * £ 50 per Cu m	£6,000.00
	Miscellaneous items	
	break out concrete bund and dispose , Scrub clearance etc	£4,384.00
		£100,000.00
2	Newbank site to Mucklows Hill. 202m	
	Excavation of infilled channel & disposal	
	Steel Stock yard, 110m * 14m * 1.55m = 2387 Cu m	
	Factory internal, 75m * 12m * 1.60m = 840 Cu m.	
	Waste Ground, 11m * 14m * 1.60m = 123 Cu m.	
	Narrows 6m * 4m * 0.90m = 22 Cu m.	

	3372 Cu m. * £ 50 per Cu m	£168,600.00
	Extra for breaking out reinforced concrete bases	£21,220.00
	Puddle Clay 1300 Cu m * £ 50 per Cu m	£65,000.00
	Removal and replacement of factory walls, provision of gates etc.	£15,000.00
	Internal alterations to factory structure.	£60,000.00
	Clearance of steel stock to gain access to the channel line	£18,000.00
	Removal of steel piles from Narrows	£2,180.00
		£350,000.00
3	Mucklows Hill Bridge. 30m	
	Excavation and disposal	
	4.5 * 30 * 3.30 = 446 Cu m	
	12.75 * 3.3 * 0.5 * 2 * 30 = 1262 Cu m	
	2.0 * 1.0 * 25 * 2 = 100 Cu m	
	= 1808 Cu m	
		£79,100.00
	Insitu Concrete Culvert	
	(4.50 * 0.50) * 2 + (3.50 * 0.50) * 2 = 8 squ m	
	30m long = 240 Cu m * £ 750	£180,000.00
	Placing	£180,000.00
	Cont	

COSTINGS

Ref	Costings	Value £
3	Cont	
	Concrete foundation and piers	
	2.8 * 1.0 * 10 * 4 = 112 Cu m	
	2.0 * 1.0 * 25 * 2 = 100 Cu m	
	= 212 Cu m	
	212 Cu m * £ 750 per Cu m	£159,000.00
	Piling to Foundations.	£58,000.00
	Fill to Roadworks 2500 Cu m * £ 30 Cu m	£75,000.00
	Bridge deck concrete , reinforcement , formwork etc.	
	30 * 20 * 0.50 m = 300 Cu m * £ 750 per Cu m	£225,000.00
	Diversion of services	£38,000.00
	Miscellaneous	£48,000.00
	Temporary Works	£76,000.00
	Traffic Management	£47,000.00
	Waterproof and protection to channel.	£8,500.00
	Fencing	£6,400.00
	Miscellaneous	£20,000.00
		£1,200,000.00
4	Leasows Resteration Phase 1	
	Completed in 1999 for a cost of £207000.00	£207,777.00
	Leasows Park Wildlife pond	
	Excavate and remove silt and weeds to new section of canal	
	Volunteer labour	£0.00
		£207,000.00
5	Ladypool Narrows to Fordrove Bridge.	
	Ladypool Narrows Bridge including excavation , mini piling , concrete , reinforcement ,	
	brickwork , fill material , surfacing and paving .	£40,000.00
	Fordrove Bridge as above	£55,000.00

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costings	Value £
5	Cont	
	Excavation and disposal of silt	
	347 * 12 * 0.40m = 1666 Cu m * £ 20 per Cu m	£33,300.00
	138 * 7 * 1.75m = 1690 Cu m * £ 20 per Cu m	£33,700.00
	Waterproof menbrane , geotextile , sand and stone protection	
	347 * 17 = 5900	
	138 * 11 = 1520	
	= 7420 Sq m * £ 12 per Sq m	£89,040.00
	Gabions protection to embankments	
	485 * £ 75 per m	£36,375.00
	Service diversions	
	High pressure gas and electric	£8,700.00
	Brickwork walls and copings	
	485 * 0.225 = 109 * £80 per m	£8,730.00
	485 * £ 14 per m	£6,790.00
	Surfacing and paving	£10,000.00
	Fencing	£2,000.00
	Miscellaneous items	£6,365.00
		£330,000.00
6	Fordrove to Manor Way 263m	
	Excavation and disposal of (some possibly contaminated material)	
	263 * 7 * 1.70m = 3130 Cu m * £ 30 per Cu m	£156,500.00
	Waterproof membrane , geotextile , sand and stone protection	
	263 * 11 = 2900 Sq m * £12 per Sq m	£34,800.00
	Gabions embankment protection	
	263 * 2 sides * £75 per m	£39,450.00
	Brick wall and copings	
	263 * 2 sides = 526m * 0.225 = 118.35 * £ 80 per m	£16,832.00
	Safety fencing	
	263 * 2 sides = 526m * £ 50 per m	£26,300.00
	Miscellaneous items	£17,000.00
		£230,000.00
	3	

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
7a	Manor Way on line crossing 40m	
	Excavation and disposal	
	20 * 4.25 * 3.15 = 268 Cu m	
	20 * 4.25 * 3.45 = 293 Cu m	
	420 * 1.60 * 0.60 = 403 Cu m	
	964 Cu m * £ 36 per Cu m	£34,704.00
	Fill material	
	200 * 6.0 * 17.0 * 0.50 * 2 = 20400 Cu m * £30 per cu m	£612,000.00
	Concrete, formwork and placing	
	8 Sq m * 40 = 320 Cu m * £ 750 per Cu m (Culvert)	240,000.00
	Placing 320 Cu m * £ 750 per Cu m	£240,000.00
	100 * 4 no * 4 * 0.50 * 0.50 * £ 750 per Cu m	£300,000.00
	Brick facings 100 * 4 * 4 * 0.50 = 800 * £60 per Sq m	£480,000.00
	Copings 400 m * £ 25 per m	£10,000.00
	Surfacing 16 * 300 = 4800 Sq m * £ 60 per Sq m = £ 288000 + 30 %	£374,400.00
	Traffic diversions	£188,000.00
	Purchase of property etc	£120,000.00
	Temporary works	£250,000.00
	Lighting	£19,500.00
	Safety equipment	£21,200.00
	Fencing 400 * £52 per m	£19,800.00
	Drainage	£22,396.00
		£2,500,000.00
7b	275 K V Cable diversion	£500,000.00
7c	Black Horse car park 83m	
	Excavation and disposal	
	10 * 83 * 1.45 = 1200 Cu m * £ 25 per Cu m	£30,000.00
	Waterproof membrane and stone protection	
	14 * 83 = 1162	
	10 * 83 = 830	
	= 1992 Sq m say 2000 Sq m * £ 12 per Sq m	£24,000.00
	Cont	

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
7c	Embankment protection (Gabions etc)	
	83 * 2 sides * £ 75 per m	£12,450.00
	83 * 2 * 6 * £ 8 per m	£7,968.00
	Brickwork walls	
	83 * 2 sides = 166 8 0.50 sq m = 83 * £ 80 per m	£6,640.00
	83 * £ 14	£1,162.00
	Fencing 83 * £ 25 per m	£2,075.00
	Surfacing to paths	£3,000.00
	Miscellaneous items	£12,705.00
		£100,000.00
8	Black Horse to West tunnel portal 504m	
	Excavation and disposal	
	504 * 10 av * 2.5 av =12600 Cu m * £ 18 per Cu m	£226,800.00
	Waterproof membrane and protection	
	14 * 504 = 7056 Sq m * £ 12 per Sq m	£84,672.00
	Tow Path	
	504 * 3 * £ 15 per Sq m	£22,680.00
	Embankment protection	
	504 * £ 6 = £ 3024	
	504 * £ 75 = £ 37800	
	= £ 40824	£40,824.00
	Diversion of canal around services	£16,064.00
	Miscellaneous items	£8,960.00
		£400,000.00
9	Tunnel Refurbishment 3468m	
	(see detailed sheets)	
		£17,500,000.00

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
10	East portal to aggregate stockpile yard (Old refuse tip) 202m	
	Excavation and disposal	
	202 * 6 * 7.3 = 8850 Cu m * £ 50 per Cu m	£442,500.00
	Piling 202 * 2 sides * 7.5 = 3030 Sq m * £ 250 per Sq m	£757,500.00
	Concrete culvert (6 * 0.5) * 2 + (3.5 * 0.5) * 2 = 9.5 Sq m	
	202 * 9.5 Sq m = 1919 Cu m * £450 per Cu m	£863,000.00
	Miscellaneous items	£7,000.00
	Access Shaft (large) included in Tunnel	
	Brick faced portal included in Tunnel	
		£2,070,000.00
12	Aggregate stockpile area to StoneHouse Brook culvert 602m	
	Excavation and disposal	
	140 * 7.0 * 1.8 = 1764 Cu m	
	100 * 7.0 * 2.13 = 1491 Cu m	
	150 * 7.0 * 1.8 = 1890 Cu m	
	20 * 3.0 * 3.18 = 191 Cu m	
	= 5478 Cu m	
	+ 20 * 3.0 * 1.65 = 99 Cu m	
	155 * 7.0 * 1.7 = 1845 Cu m	
	= 7323 Cu m * £ 25 per Cu m	£183,075.00
	Extra for breaking out reinforced concrete bases	
	100 * 7.0 * 0.3 = 210 * £ 25 per Cu m	£5,250.00
	Waterproof membrane	
	562 * 11.0 = 6182 Sq m	
	40 * 7.0 = 280 Sq m	
	= 6462 Sq m * £ 12 per Sq m	£78,000.00
	Embankment protection or concrete wall protection	
	602 * 2 = 1204 m * £ 75 per m	£93,300.00
	Brickwork	
	602 * 2 = 1204 * 0.50 = 602 Sq m * £ 80	£48,160.00
	Towpath / Cycleway surfacing	
	602 * 3.0 * £ 20 per Sq m	£36,120.00
	Cont	

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
	Cont	
11	Diversion of services in channel	£15,000.00
	Lighting	£20,000.00
	Bridge repair	£26,095.00
	Miscellaneous items	£10,000.00
		£515,000.00
12	Stonehouse Brook Syphon	
	Excavation and disposal	
	6 * 2 * 4 = 48 Cu m * £ 20	£960.00
	Concrete culvert	
	6 * 0.35 * 20 * 2 = 84.0 Cu m	
	3 * 0.45 * 20 * 2 = 54.0 Cu m	
	= 138.0 Cu m * £ 85 per Cu m	£117,300.00
	Concrete channel	
	10 * 0.35 * 3.7 = 12.95 Cu m	
	10 * 0.45 * 1.50 * 2 = 13.50 Cu m	
	= 27.00 Cu m * £ 75 per Cu m	£20,250.00
	Brickwork and Copings	
	10 * 2 = 20 m * 0.50 * 80 say	
	20 * £ 25 per m	£1,500.00
	Fencing 40 * £ 100	£4,000.00
	Pumping	£3,000.00
	Miscellaneous items	£7,990.00
		£155,000.00
13	Stonehouse Brook to Sellyoak Park 1171m	
	Excavation and disposal	
	1171 * 7 * 1.84 = 15000 Cu m * £ 18 per Cu m	£270,000.00
	Waterproof membrane and stone protection	
	1171 * 11 = 12881 Sq m * £ 12 per Sq m	£154,572.00
	Gabions or concrete embankment protection	
	1171 * 2 = 2342 m * £ 75 per m	£175,650.00
	Brickwork walls and coping	
	1171 * 2 = 2342 m * 0.25 = 586 m * £ 80 per m	£46,880.00
	2342 * £ 14 per m	£32,788.00

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
	Cont	
13	Towpath / Cycleway surfacing	
	1171 m * 3 * £ 20 per Sq m	£70,260.00
	Diversion of services	£15,000.00
	Miscellaneous items	£19,740.00
		£850,000.00
14	Sellyoak Park to Harborne Lane Bridge 474m	
	Excavation and disposal	
	140 * 7 * 0.6 = 588 Cu m	
	215 * 7 * 1.05 = 1580 Cu m	
	119 * 10 * 1.25 = 1488 Cu m	
	98 * 23 * 1.4 = 3155 Cu m	
	= 6811 Cu m * £ 18 per Cu m	£122,598.00
	Waterproof membrane and protection	
	140 * 11 = 1540 Sq m	
	215 * 11 = 2365 Sq m	
	119 * 14 = 1666 Sq m	
	98 * 23 = 2254 Sq m	
	= 7825 Sq m * £ 12 per Sq m	£93,900.00
	Embankment protection (Gabions / concrete etc)	
	474 * 2 = 948 m * £ 75 per m	£71,100.00
	Brickwork walls and copings	
	474 * 2 = 948 * 0.25 = 237 Sq m * £ 80 per	£18,960.00
	948 * £ 14 per m	£13,272.00
	Towpath / Cyclepath	
	474 * 3 = 1422 Sq m * £20 per Sq m	£28,440.00
	Miscellaneous items	£1,730.00
	Weoley Park Bridge Being reinstated the summer of 1999	NIL
		£350,000.00
15	Harborne Lane Bridge 24m	
	Excavation and disposal	
	24 * 5 * 1.20 = 144 Sq m * £ 30 per Cu m	£7,200.00
	Lighting	£18,000.00
	Miscellaneous items	£19,800.00
		£45,000.00

LAPAL CANAL FEASIBILITY STUDY
COSTINGS

Ref	Costing Descriptions	Value £
	Cont	
16	Harborne Lane Bridge to Selly Oak Junction 331 m	
	Excavation and disposal (contaminated land)	
	180 * 10 * 2.70 = 4860 Cu m	
	45 * 4 * 2.20 = 396 Cu m	
	96 * 12 * 2.70 = 3110 Cu m	
	20 * 4 * 2.20 = 176 Cu m	
	= 8542 Cu m * £ 50 per Cu m	£427,100.00
	Waterproof membrane and protection	
	180 * 14 = 2520 Sq m	
	45 * 8 = 360 Sq m	
	96 * 16 = 1536 Sq m	
	20 * 8 = 160 Sq m	
	= 4576 Sq m * £ 12 per Sq m	£54,912.00
	Embankment protection (Gabions / concrete walls)	
	341 * 2 sides = 682 m * £ 95 per m	£64,798.00
	Brickwork walls and copings	
	341 * 2 = 682m * 0.25 = 1705 Sq m * £ 80 per Sq n	£13,640.00
	682 * £ 14	£9,548.00
	Refurbish Narrows brickwork	£6,000.00
	Towpath and cycleway	
	682 * 6 = 4092 * £ 20 per Sq m	£81,840.00
	Fencing 331 * 2 = 662m * £ 18 per m	£11,916.00
	Lighting	£12,000.00
	Diversion of services	£80,000.00
	Miscellaneous items	£58,246.00
		£820,000.00
17	Selly Oak Junction to the Worcester and Birmingham canal 10m	
	Excavation and disposal	
	10 * 10 * 2.5 = 250 Cu m * £ 50 per Cu m	£12,500.00
	Brick Bridge	£35,000.00
	Surfacing	£10,000.00
	Fencing	£5,000.00
	Miscellaneous items	£17,500.00
		£80,000.00

GERARD PAKES CONSULTANTS
CHARTERED CIVIL ENGINEERS

TUNNEL PRICING SYSTEM
Soft Ground Tunnels

PROJECT: Lapal Tunnel Refurbishment
CLIENT: Lapal Canal Trust
DATE: Jun-99

DRIVE SHAFTS
DETAILS

			β-distribution variables		
			Expected	High	Low
Length	3824.0	m			
Diameter	5.5	m			
Progress	73	m/wk	72	108	40
Shifts/wk	10	nr			
Time	53	week	53	35	96

MACHINE DETAILS

			β-distribution variables		
			Expected	High	Low
Installed power	275	HP			
Cost	766667	£	750000	1200000	400000
Write off	3824	m	3824	3824	3824
Residual	1	£	1	1	1
Hire Rate	200.49	£/m	196.13	313.81	104.60

LPM SUMMARY

	£
Labour	3041659
Tunnelling Machines	766666
Plant	845842
Plant Consumables	164950
Materials	5339791
Sub-Contract	1097744

ESTIMATED TOTAL COST = £ 11,256,652

ESTIMATED RATE PER METRE = £ 2,944

Add:

1. Drive Shaft in contaminated ground: 1.000 000
2. Tunnel furniture 3824 @ £120/m 500 000
3. Site Overheads 75 wks @ £42500 3 200 000
4. Contingencies 10% 1500 000

£17 5m

GERARD PAKES CONSULTANTS
CHARTERED CIVIL ENGINEERS

TUNNEL PRICING SYSTEM
Soft Ground Tunnels

PROJECT: Lapal Tunnel Refurbishment
CLIENT: Lapal Canal Trust
DATE: Jun-99

Item	Cost Post	Unit Rate (£)	Quant	Unit	Rate (£)	Cost per Week (£)	Total (£)
1	**LABOUR**						
1.1	Tunnel Foreman	220	1	shift	220	2200	115772
1.2	Leading Miners	220	3	shift	660	6600	347317
1.3	Miners	200	2	shift	400	4000	210495
1.4	Miners labourers	170	5	shift	850	8500	447303
1.5	Loco Drivers	160	5	shift	800	8000	420991
1.6	Pit Bottom Men	190	3	shift	570	5700	299956
1.7	Machine Drivers	300	1	shift	300	3000	157872
1.8	Tunnel Fitters	300	2	shift	600	6000	315743
1.9	Tunnel Electricians	300	1	shift	300	3000	157872
1.10	Pit Top Men	180	3	shift	540	5400	284169
1.11	Crane Drivers	200	1	shift	200	2000	105248
1.12	Surface Labour	68	5	shift	340	3400	178921
1.13	Others						
	TOTAL Labour		32			57800	**3041659**
2	**PLANT**						
2.1	Tunnelling Machines	200.49	3824	m	766666		766666
2.2	Tunnelling Shields	0	0	week	0		0
2.3	Face Conveyors	0	0	week	0		0
2.4	Locos	575	5	week	2875		151294
2.5	Skips + Bogies	25	30	week	750		39468
2.6	Bogie flats	15	10	week	150		7894
2.7	Manriders	30	5	week	60		3157
2.8	Track	3.6	382	10m/wk	1377		36222
2.9	150mm Air Pipe	1.2	382	10m/wk	459		12074
2.10	75mm Water pipe	0.5	382	10m/wk	191		5031
2.11	100mm Pump main	0.75	382	10m/wk	287		7546
2.12	Cabling	2.5	382	10m/wk	956		25154
2.13	Lighting	1.8	382	10m/wk	688		18111
2.14	Ventilation Ducting	1.2	382	10m/wk	459		12074
2.15	Booster Fans	125	5	week	625		32890
2.16	Grout Mixers	80	3	week	240		12630
2.17	Grout Pumps	125	3	week	375		19734
2.18	Grout Hoses & pipes	75	3	week	225		11840
2.19	Transformers/Swichgear	150	5	week	750		39468
2.20	Small Tools	995	2	week	1990		104721
2.21	Other underground plant	0	1	week	0		0
2.22	Hoists	0	1	week	0		0
2.23	Man hoists	400	1	week	400		21050
2.24	Cranes	900	3	week	2700		142084
2.25	Compressors	236	5	week	1180		62096
2.26	Air Receivers	40	5	week	200		10525

GERARD PAKES CONSULTANTS CHARTERED CIVIL ENGINEERS				TUNNEL PRICING SYSTEM Soft Ground Tunnels			
Item	Cost Post	Unit Rate (£)	Quant	Unit	Rate (£)	Cost per Week (£)	Total (£)
2.27	Pipework & controls	40	5	week	200		10525
2.28	Generators	180	incl	week	0		0
2.29	Transformers/Switchgear	180	1	week	180		9472
2.30	Surface fans	75	2	week	150		7894
2.31	Loaders	390	1	week	390		20523
2.32	Slurry Seperation plant	incl	0	week	0		0
2.33	Other Surface plant	850	1	week	425		22365
	TOTAL plant (excl machines)				18282		**845842**
3	**PLANT CONSUMABLES**						
3.1	Electrical Power	16722.973	0.0785	kWh/wk	1313		69082
3.2	Gas oil	2000	0.26	lit/wk	520		27364
3.3	Lubrication Materials	5000	1	sum	95		5000
3.4	Spares	19167	1	sum	364		19167
3.5	Filters	7500	1	sum	143		7500
3.6	Hydraulic Oil	500	1	lit/wk	250		13156
3.7	Other Consumables	450	1	week	450		23681
	TOTAL plant cons.				3135		**164950**
4	**MATERIALS**						
4.1	Segments	1126.56	3824	m			4307948
4.2	Gaskets	4.2	90820	lm			381444
4.3	Bolts	3.1	114720	nr			355632
4.4	Grout	73.5	3514	m			258274
4.5	Void filler	5000	1	sum			5000
4.6	Packings	6.5	191	nr			1243
4.7	Temporary Materials	25000	1	sum			25000
4.8	Segment Transport	3	1750				5250
	TOTAL materials						**5339791**
5	**SUB-CONTRACT**						
5.1	Spoil Disposal	10.5	104547	m			1097744
5.2	Caulking	3.9	0	m			0
	TOTAL Sub-contract						**1097744**

LPM SUMMARY

		β-distribution variables		
	£	Expected	High	Low
Labour	3041659	3069822	2046548	5525680
Tunnelling Machines	766666	749999	1199999	399999
Plant	845842	853674	569116	1536613
Plant Consumables	164950	184633	158089	284840
Materials	5339791	5334541	5334541	5334541
Sub-Contract	1097744	1097744	1097744	1097744
ESTIMATED TOTAL COST	**11,256,652**	**11,290,413**	**10,406,037**	**14,179,417**
ESTIMATED RATE PER METRE	**2,944**	**2,953**	**2,721**	**3,708**

GERARD PAKES CONSULTANTS
CHARTERED CIVIL ENGINEERS

TUNNEL PRICING SYSTEM
Soft Ground Tunnels

PROJECT: Lapal Tunnel Refurbishment
CLIENT: Lapal Canal Trust
DATE: Jun-99

DRIVE SHAFTS

DETAILS

			β-distribution variables		
			Expected	High	Low
Length	3824.0	m			
Diameter	4.5	m			
Progress	73	m/wk	72	108	40
Shifts/wk	10	nr			
Time	53	week	53	35	96

MACHINE DETAILS

			β-distribution variables		
			Expected	High	Low
Installed power	230	HP			
Cost	658333	£	650000	950000	400000
Write off	3824	m	3824	3824	3824
Residual	1	£	1	1	1
Hire Rate	172.16	£/m	169.98	248.43	104.60

LPM SUMMARY

	£
Labour	3041659
Tunnelling Machines	658332
Plant	845842
Plant Consumables	150937
Materials	4479328
Sub-Contract	757163

ESTIMATED TOTAL COST = £ 9,933,261

ESTIMATED RATE PER METRE = £ 2,598

Additions

1. Drive shaft in contaminated ground		850,000
2. Tunnel furniture	3824 @ £100/m	400 000
3. Site overheads	75 wks @ £37.000	2750 000
4. Contingencies	10%	1400 000

GERARD PAKES CONSULTANTS
CHARTERED CIVIL ENGINEERS

TUNNEL PRICING SYSTEM
Soft Ground Tunnels

PROJECT: Lapal Tunnel Refurbishment
CLIENT: Lapal Canal Trust
DATE: Jun-99

Item	Cost Post	Unit Rate (£)	Quant	Unit	Rate (£)	Cost per Week (£)	Total (£)
1	**LABOUR**						
1.1	Tunnel Foreman	220	1	shift	220	2200	115772
1.2	Leading Miners	220	3	shift	660	6600	347317
1.3	Miners	200	2	shift	400	4000	210495
1.4	Miners labourers	170	5	shift	850	8500	447303
1.5	Loco Drivers	160	5	shift	800	8000	420991
1.6	Pit Bottom Men	190	3	shift	570	5700	299956
1.7	Machine Drivers	300	1	shift	300	3000	157872
1.8	Tunnel Fitters	300	2	shift	600	6000	315743
1.9	Tunnel Electricians	300	1	shift	300	3000	157872
1.10	Pit Top Men	180	3	shift	540	5400	284169
1.11	Crane Drivers	200	1	shift	200	2000	105248
1.12	Surface Labour	68	5	shift	340	3400	178921
1.13	Others						
	TOTAL Labour		32			57800	**3041659**
2	**PLANT**						
2.1	Tunnelling Machines	172.16	3824	m	658332		658332
2.2	Tunnelling Shields	0	0	week	0		0
2.3	Face Conveyors	0	0	week	0		0
2.4	Locos	575	5	week	2875		151294
2.5	Skips + Bogies	25	30	week	750		39468
2.6	Bogie flats	15	10	week	150		7894
2.7	Manriders	30	5	week	60		3157
2.8	Track	3.6	382	10m/wk	1377		36222
2.9	150mm Air Pipe	1.2	382	10m/wk	459		12074
2.10	75mm Water pipe	0.5	382	10m/wk	191		5031
2.11	100mm Pump main	0.75	382	10m/wk	287		7546
2.12	Cabling	2.5	382	10m/wk	956		25154
2.13	Lighting	1.8	382	10m/wk	688		18111
2.14	Ventilation Ducting	1.2	382	10m/wk	459		12074
2.15	Booster Fans	125	5	week	625		32890
2.16	Grout Mixers	80	3	week	240		12630
2.17	Grout Pumps	125	3	week	375		19734
2.18	Grout Hoses & pipes	75	3	week	225		11840
2.19	Transformers/Swichgear	150	5	week	750		39468
2.20	Small Tools	995	2	week	1990		104721
2.21	Other underground plant	0	1	week	0		0
2.22	Hoists	0	1	week	0		0
2.23	Man hoists	400	1	week	400		21050
2.24	Cranes	900	3	week	2700		142084
2.25	Compressors	236	5	week	1180		62096
2.26	Air Receivers	40	5	week	200		10525

GERARD PAKES CONSULTANTS CHARTERED CIVIL ENGINEERS				TUNNEL PRICING SYSTEM Soft Ground Tunnels			
Item	Cost Post	Unit Rate (£)	Quant	Unit	Rate (£)	Cost per Week (£)	Total (£)
2.27	Pipework & controls	40	5	week	200		10525
2.28	Generators	180	incl	week	0		0
2.29	Transformers/Switchgear	180	1	week	180		9472
2.30	Surface fans	75	2	week	150		7894
2.31	Loaders	390	1	week	390		20523
2.32	Slurry Seperation plant	incl	0	week	0		0
2.33	Other Surface plant	850	1	week	425		22365
	TOTAL plant (excl machines)				18282		**845842**
3	**PLANT CONSUMABLES**						
3.1	Electrical Power	13986.486	0.0785	kWh/wk	1098		57778
3.2	Gas oil	2000	0.26	lit/wk	520		27364
3.3	Lubrication Materials	5000	1	sum	95		5000
3.4	Spares	16458	1	sum	313		16458
3.5	Filters	7500	1	sum	143		7500
3.6	Hydraulic Oil	500	1	lit/wk	250		13156
3.7	Other Consumables	450	1	week	450		23681
	TOTAL plant cons.				2868		**150937**
4	**MATERIALS**						
4.1	Segments	926.28	3824	m			3542091
4.2	Gaskets	4.2	78807	lm			330987
4.3	Bolts	3.1	114720	nr			355632
4.4	Grout	73.5	2913	m			214125
4.5	Void filler	5000	1	sum			5000
4.6	Packings	6.5	191	nr			1243
4.7	Temporary Materials	25000	1	sum			25000
4.8	Segment Transport	3	1750				5250
	TOTAL materials						**4479328**
5	**SUB-CONTRACT**						
5.1	Spoil Disposal	10.5	72111	m			757163
5.2	Caulking	3.9	0	m			0
	TOTAL Sub-contract						**757163**

LPM SUMMARY

		β-distribution variables		
	£	Expected	High	Low
Labour	3041659	3069822	2046548	5525680
Tunnelling Machines	658332	649999	949999	399999
Plant	845842	853674	569116	1536613
Plant Consumables	150937	168224	137983	264303
Materials	4479328	4474078	4474078	4474078
Sub-Contract	757163	757163	757163	757163
ESTIMATED TOTAL COST	**9,933,261**	**9,972,960**	**8,934,886**	**12,957,836**
ESTIMATED RATE PER METRE	**2,598**	**2,608**	**2,337**	**3,389**