The capital cost aspects of the environmental impact of new highways in association with the new design technique the Commercial Route Methodology (CRM)

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THE CAPITAL COST ASPECTS OF THE ENVIRONMENTAL IMPACT OF NEW
HIGHWAYS IN ASSOCIATION WITH THE NEW DESIGN TECHNIQUE THE
COMMERCIAL ROUTE METHODOLOGY (CRM).

BY

WILLIAM GRANT DUTCH. B.Sc., M.Sc.(Tech.),
D.I.C., C.Eng., M.I.C.E.

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DIRECTOR OF RESEARCH : DR.R.J.ALLWOOD
               B.Sc.Eng.(Hons.), Ph.D.,
               C.Eng., M.I.C.E.

SUPERVISOR : MR.F.R.SHAW
               B.Sc.Eng.(Hons.), F.Inst.C.E.S.,
               C.Eng., M.I.C.E., M.I.H.T.

© by WILLIAM GRANT DUTCH. 1989.
This study is dedicated to my father and mother of Rossie Island, Montrose, Scotland.
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ABSTRACT.


This work addresses the capital cost implications of environmental impact allied to new highways. Those environmental impact considerations which are capable of being evaluated in terms of capital cost are distinguished from those which are concealed and cannot be evaluated using monetary values.

The new design technique the Commercial Route Methodology (CRM) has been developed to evaluate in capital cost terms the concealed and unquantifiable impacts inter alia, visual intrusion, visual obstruction, effects on agriculture, ecological concern, heritage and conservation areas and aesthetic aspects.

The work studies the capital costs associated with environmental impact mitigation measures built into highway schemes located both internationally and in the United Kingdom. This approach identifies and analyses the capital cost of mitigation measures taken to ameliorate those implicit and identifiable environmental impacts - notably additional earthworks, noise barriers and insulation, landscaping and special treatments. In order to evaluate the cost of those impacts which are concealed and unquantifiable the Commercial Route Methodology was applied to a range of approved highway schemes of a Highway Authority - the Derbyshire County Council. In each case a Commercial Route was successfully derived and the hitherto unquantifiable aspects of environmental impact were evaluated. In this connection the application of CRM provided a figure of approximately 18 per cent which in Derbyshire represents a sum in excess of £4,000,000. Translated nationally this represents a sum of over £2,000,000,000 during the period 1976/77 - 1985/86.

The Commercial Route Methodology (CRM) is thus available for integration into the current highway design method to give a 'baseline' cost from which engineers, politicians, accountants and members of the public can assess and understand the capital cost of mitigating environmental impacts resulting from new highways - whilst providing additional data for public consultation and inquiry procedures, decision making and scheme ranking and appraisal.
CHAPTER 1

1.0 INTRODUCTION

1.0.1 Preamble

Currently highway design and construction programmes spend an increasing proportion of the associated capital budget on the mitigation of environmental factors in an attempt to reduce the impact of new highways. On analysis of scheme estimates and actual construction costs it was observed in this study and in current highway design practice that many facets of new highway schemes are environmentally related, typically noise attenuation and landscaping and planting arrangements. However, many of the environmental factors cannot at present be evaluated satisfactorily and it is the capital costs of these concealed or 'hidden' factors which the new method proposed in this thesis seeks to address – by the concept of the Commercial Route Methodology (CRM).

1.0.2 Financial Trends and Environmental Considerations

Since the oil crisis of 1973/74, capital funds for new highways have not been as freely available as they had been in earlier periods, particularly the 1960's, consequently the scrutiny of highways schemes in terms of economic justification has increased considerably over this period. The approach to this justification is typically through the application of cost benefit analysis techniques which balance the capital cost investments against the provision of routes capable of attracting traffic, i.e. by making the route a commercial proposition. During this same period the case for increased
consideration of the environmental impact of new highway works has been steadily developing into a major topic of concern. With the development of new political parties and groups such as, the Green Party and Friends of the Earth – it is now in 1989 of significant political interest. This interest is also recognised by the European Economic Community in its Directive to Member States requiring that all major new works (including new highways) have an Environmental Impact Assessment, and that this assessment be considered an integral part of the design programme.

1.0.3 Capital and the Environment – the Paradox

With the integration of environmental impact assessments into the design process and the increasing environmental awareness, commercial solutions to new routes cannot always be obtained. With the provision of funds either levelling out or declining it is necessary that every facet of the new scheme be accounted for and evaluated in capital cost terms. These figures must be produced to satisfy the public and its representatives who are usually Highway Authority Committee Members or Central Government Officers and politicians.

A paradox exists because the commercial aspects of capital funding and environmental considerations may often be at variance. A typical example of this latter arrangement is when a route may be made more expensive by increased construction costs in attempting to avoid an area of ecological interest.
1.0.4 Capital and the Environment and the New Design Technique -
The Commercial Route Methodology

Capital funding and the needs of the environment are addressed in this study by the use of a new design technique, the Commercial Route Methodology. The approach enables the professional highway engineer to evaluate the capital cost of the environmental impacts brought about by the construction of the new highway - particularly those impacts which are difficult or impossible to quantify.

The method is based on determining the capital cost of the route dictated by commercial pressures and which satisfy the bare minimum of planning and legal requirements.

1.0.5 Current Highway Design Methodology and Legislation

Professional highway engineers are aware of the paradox which exists between the environment and capital funds and will produce schemes with optimum solutions. This design approach incorporates framework and environmental assessment systems developed during the last fifteen years. The method enables various routes to be compared one with another for public consultation exercises and for public inquiries. The system within the framework is generally one of appraisal and ranking.

Although the more recent period of environmental concern dates from the mid-1970's the entire post second world war period has been punctuated with a variety of new Highway and Planning Acts and Government White Papers. This legislation has been aimed at allowing the public to channel grievances more
effectively, to enable engineers to acquire land beyond the road corridor for landscaping and to pay compensation in respect of certain environmental impacts. Legislation therefore has been drafted on the basis of a 'cause and effect' criteria of society's needs incurring public pressure and consequential legislation.

1.0.6 Cost Benefit Analysis and Hidden Environmental Impacts

The construction of a new highway will remove environmental impacts from one corridor to another - professional highway engineers therefore have to balance the many factors involved including economic and environmental considerations. Cost benefit analysis is applied to enable commercial decisions to be made on route selection - this methodology relies heavily on the application of numerical values to various benefits - most notably the lowest capital cost and the shortest journey times. As no monetary values are applied to environmental considerations there is some danger that these can be overlooked in any numerical analysis.

It is noted in examples of current highway design practice that the professional highway engineer can identify and quantify in monetary terms certain environmental impacts - notably noise and disruption due to construction, on the basis of compensation figures and the directly associated mitigation costs. Many impacts however cannot be evaluated in capital cost terms, inter alia, visual intrusion, visual obstruction, ecological interests and aesthetic considerations.
This study seeks to address the question of the evaluation in capital cost terms of not only those environmental impacts which are in fact identifiable but also those environmental impacts which are concealed or 'hidden'.

The current highway design process is examined and the Commercial Route Methodology (CRM) is developed and incorporated into that process in order that the capital cost of all environmental impacts may be tested and evaluated. The extent of the capital cost involved is put into perspective in terms of a typical County Highway's budget and the National Highways Programme. The Commercial Route Methodology (CRM) can also provide a datum against which several routes may be compared and thus be used for public consultation and public inquiry purposes for both the benefit of the engineer and members of the public.
CHAPTER 2

2.0 BACKGROUND TO THE HIGHWAY DESIGN PROCESS AND ITS RELATIONSHIP WITH ENVIRONMENTAL CONSIDERATIONS

2.1 HIGHWAY DESIGN IN PERSPECTIVE

The design of new highways has developed since the Second World War into a soundly based applied science as distinct from the essentially empirically based methods of the last century.

The scientific input has been rigorously pursued by highway engineers with such early examples as the analysis of the geometry and horizontal and vertical alignments, construction techniques and soil mechanics. These were developed from the well-researched and proven railway civil engineering systems.

Engineering developments of interest to Highway Engineers evolved out of the necessity to improve engine/vehicle technology which in turn increased average traffic speeds. For example the design speed of rural main roads in 1927 was 35 mph (56 kph) and is now in 1988 60 mph (96 kph) on single carriageway highways. This latter road category is currently typical of many inter-urban trunk and principal roads.

This increase of speed brought about a gradual decrease in the margin of safety and required engineers to design mitigation measures into new road layouts. The approach to mitigation was via the study and development of techniques such as overtaking sight distances, stopping
sight distances, and minimum and maximum radii - these were summarised in a modern form by the Ministry of Transport in Technical Memorandum No 780 published in 1961 (ref 1). An earlier document "Design of Roads in Built-Up Areas" (ref 2) published in 1946 by the Ministry of War and Transport did attempt to present a limited set of geometric guidelines.

Concomitant with vehicle development was the requirement for smoother, structurally sound and reliable road pavements. Basic to this consideration was the study of highway materials beginning typically with developments in soil mechanics and site investigation methods during the 1920s by Tergazi et al. (ref 3). The rapid interest in this science accelerated with research in many military related areas during the Second World War leading to important developments such as the California Bearing Ratio test (CBR) and soil stabilisation. Because most highway structures including pavements are founded on soils the materials lack the uniformity of other branches of engineering (in terms of consistency), when compared to the parallel developments in the uses of metals such as those prevalent in aeronautical engineering. The study of materials was a precursor to the concept of road pavement design - in which the structural engineering theories of lateral distribution of applied loads developed into flexible pavement theory. A rigid concrete pavement was considered to act like a structure (as in the form of beams and slabs) - bridging over localised areas of inadequate support. This technology culminated in 1965 with the introduction by the Transport and Road Research Laboratory of their 'Guide to Flexible and Rigid Pavements', (ref 4).
The foregoing developments are important examples of highway engineering technology which have been incorporated into design systems and continue to expand in tandem with the increase in road traffic - both in terms of personal travel and in freight. The total number of vehicles in use in 1965 was 9,439,000; in 1985 the number was 21,167,000 with a forecast of 26,725,000 for the year 2005. Freight transport (thousand million tonne kilometres) increased from 69 in 1965 to 102 in 1984 with a forecast of 124.9 by the year 2000 (ref 5).

2.2 COMERCIAL DEVELOPMENT OF TRANSPORATION PLANNING AND COMPUTER BASED TECHNIQUES

Traffic planning grew up mainly in the USA where even before the Second World War the technique had become a complex science. After the war traffic growth in the United States was the highest anywhere in the world and consequently accelerated all aspects of traffic planning. Since its conception, traffic planning (or traffic engineering) has been largely a numerical exercise based on statistics, queuing theory and other mathematical concepts. To expedite the complicated and extensive accumulation of traffic data, engineers experimented in the early 1960's with the use of computers. This computer development was also promoted by engineers involved with geometric design and surveying techniques. In the latter case computer technology allied to electronics to the introduction of Electronic Distance Measurement.

Electronic survey techniques in tandem with computer technology led to the development of computer uses with particular respect to the calculation of quantities for highway engineering purposes.
Activities in this field became intense during the mid 1960s when the work of many engineers was directed to the solution of geometric and volumetric equations - this expanded the development opportunities in all aspects of the application of computers to highway design. In this connection the expansion of computer use in the USA and the United Kingdom has been extensively outlined by L R Shureman for the American Society of Civil Engineers (ref 6) and Cotton and Petrie for the Institution of Highway Engineers (ref 7).

From these early developments the computer based analysis of highway engineering problems was made a commercial reality; currently these range from complex transportation modelling and three dimensional geometry (including the storage of mathematical ground models) to the finished contract plans processed through computer-aided design techniques.

2.3 HIGHWAY DESIGN AND THE ENVIRONMENT

It is of interest to consider at this stage the evolution of highway design as viewed retrospectively - from the 1930s Keynesian unemployment programme up to the military expediency of the Second World War. It is significant that the subject of the environment was only considered to have a minor role. The pattern of development of highway design being essentially numerical, in tandem with sciences such as physics and chemistry with only a nominal 'art' input by an architect or occasionally by a landscape architect. Some examples of early cases of improved road design in the UK were first presented to the Institution of Civil Engineers by G A Jelicoe in 1944 (ref 8).
This largely science based approach to highway engineering (and engineering in general) was summarised and put in its historical perspective in the early part of the twenty century by Lewis Mumford in his work 'Technics and Civilisation' (ref 9). Mumford addressed the question of technology and the environment and posited the view that technology had developed along the lines of three phases known respectively as Eotechnic, Paleotechnic and Neotechnic. The Eotechnic phase encompassed the earliest attempt by man to achieve minimal requirements for survival and in general had little or no effect on his environment. During medieval times this first phase frequently overlapped with the Paleotechnic which generally concerned itself with man's productions and associated labour intensive industries. The prime motive being the search for a concomitant combination of cheaper goods and higher profits to a commercial end. The Paleotechnic phase culminated in the well documented Industrial Revolution which Mumford considered a disastrous period in human and environmental terms ... "by its very nature it intensified the search for order. A sort of action and reaction - equal in opposite directions with no thought for human beings - the landscape could be left to the wolves."

The Neotechnic phase was envisaged as being equated to that of the present day - notably automation, stemming from the "cleaner" robotics technology. It had been hoped that the "drudge" jobs of the world would disappear and be replaced first by the electro-technology of the 1920s and secondly by the electronics of the present day. This technology was exemplified in art and architecture typically by the German architect Gropius and the related Bauhaus movement (ref 10).
Substantial overlaps occurred between the phases and was particularly apparent during the Paleotechnic phase. The earlier idealism of the Eotechnic phase survived in the great houses and estates in a variety of architectural and landscaping forms. Mumford suggested that these had a great civilising influence but did not extend to the public in general. The present time - the late 1980s - through to the year 2000 follows Mumford's Neotechnic phase which is often referred to as the Post-Industrial phase or Post-Industrial society and is outlined notably by K. Kumar in his work 'Prophecy and Progress' (ref 11). Kumar cites current examples at the interface between phases and are characterised by inter alia, environmental deterioration, overcrowding, depletion of resources, the costs of large scale organisations and rapid economic growth. The highway engineer must address himself to these problems if he is to perform his duty in a sympathetic and professional manner.

In terms of the interface between the environment and public works (such as highways) Mumford's hypothesis of overlapping phases pertains to today's scenario (ref 9). Much of the UK's industrial and residential landscape includes new highways and can be identified with Mumford's Paleotechnic and Neotechnic stages. Extensive areas of the landscape of Britain still has an Industrial Revolution profile and has not fully accommodated the latest thinking on environmental aspects of control and understanding. This philosophy including the associated socio-economic changes was presaged by such writers and artists as Lawrence (ref 12), Simmel (ref 13), Ruskin and Morris (ref 14).
However the period of the Industrial Revolution did provide a number of civil engineering examples designed and constructed with some inherent consideration and sympathy for the environment, notable examples being the Forth Bridge, the Menai Straits Bridge and sections of the Great Western Railway (ref 15). Holden in his paper (ref 16) sums up the dilemma facing the engineer when attempting an evaluation of aesthetic considerations - ... "it is of course a thing of the mind and is not easily propounded ..."

In considering the difficulties presented by Mumford's Paleotechnic period (much of which is still evident today), it is still possible to recognise that certain designs did attempt to be sympathetic to their surroundings or complemented their immediate environment in some way. It is this concern for surroundings - this "hidden" factor which translated to the present time is the factor to be explored in this work - in terms of its value measured as a capital cost.

2.4 THE IMPACT OF NEW HIGHWAYS ON THE ENVIRONMENT

2.4.1 The environment

The somewhat nebulous term 'the environment' can be considered at an early stage - from both the expectations of the design engineer and that of the general public. The British Road Federation (ref 17) considers ... "the environment is the physical surrounding in which we live and encompasses the whole human scene including our social and economic well-being, the natural and the built environment." This definition comes from a proponent of new roads ie the British Road
Federation - being the major representative of road haulers and civil engineering contractors engaged in the industrial and commercial aspects of highway engineering. The Oxford Illustrated Dictionary (ref 18) gives a definition of environment as ... "surroundings, surrounding objects, region, conditions or influences ...". Roget's International Thesaurus (ref 19) provides a list of key words which complement the Oxford's definition viz, surroundings, environments, settings, scene, background, atmosphere, climate, air, feel, quality, surrounding influence or condition.

In a paper presented to the American Society of Civil Engineers, Wilson et al (ref 20) described the environment as being split into two major categories of concern namely the physical environment and the social environment. The former being associated with the ecological aspects of the environment whilst the social environment concerned itself with the human side. These two broad categories will often overlap since the total environment is envisaged as being inter-connected and inter-dependent.

A landscape architect's view of the environment is described by Kelsey (ref 21) as "the external conditions and surroundings in which a plant or animal lives which influences its development and behaviour. Thus environment is concerned with soil, air, water and temperature. It is also concerned with noise, smell and pollution and therefore more quantifiable than the landscape. The landscape is part of the environment but only in as much as the view, be it squalid or beautiful, has a psychological effect on human beings".
The foregoing definitions of 'the environment' cover a wide variety of sources and backgrounds — however they all concur on a common use of keywords and related considerations inter alia, surroundings, quality, setting, ecological, physical and social concern.

2.4.2. New construction and its effect on the environment

Buchanan et al (ref 22) posits the view that new works and their effect on the environment "... as those aspects which are affected directly or indirectly by the presence of vehicles either moving or at rest". This interpretation is rather broad-based and may not describe the effect the 'bulk' of the new scheme may have on the landscape or environment — irrespective of the vehicles. Brant et al (Ref 23) provides an example in the M54 Motorway as having been designed to be effectively 'absorbed' into its surroundings.

This technique of 'absorbing' or 'blending' new works into their surroundings or environment requires skilful design measures by the highway engineer. Slaney (ref 24) considers that the growing use of computer aided design enables the engineer to devote more time "... to aesthetic and environmental considerations". Slaney further suggests that in order to service the foregoing considerations there would be an increased capital cost (or increased capital resources), but concludes that it remains difficult to estimate by how much the environmental treatment could increase the overall cost.
2.4.3. **New Highways - an analogy between traffic operations and commercial and industrial processes**

If it could be possible to carry road transport at some distance away from people then the social/environmental impact could be substantially reduced. There are many industrial processes which can be more offensive than traffic operation on new highways if they are carried out in the Main Street of a town or village or by the village green. Generally manufacturing activity is largely confined within factories or inside the perimeter fences of industrial plants or estates. Transportation on the ground must inevitably take place where people live and work - because the principal function is to move the people themselves and their goods.

Within the UK and Europe, it is virtually impossible to link industrial areas without traversing populated areas - it follows therefore that traffic as an industrial activity must to some degree impinge on people and their environment.

2.4.4. **Separation of traffic and the concept of commercial and environmental costs**

If major traffic flows could be concentrated on certain routes and if these routes could be made to go through uninhabited areas - then the environmental costs would be reduced to a 'minimum' (with perhaps some ecological costs). The idea of 'minimum' costs is a consideration because there would be minimal concern for environmental factors such as noise, vibration, visual intrusion, air pollution and so on. This is of
course a theoretical concept and would be analogous to constructing a road through a barren desert and would be a commercial proposition if the road construction costs could also be 'minimal'.

In the UK both uninhabited and barren desert regions are unknown - however there are areas where environmental costs could be at a minimum, for example on waste ground in a run down industrial area with no significant residential population. Areas which would represent a high environmental cost would be typically routes adjacent to residential areas with schools, woodlands, public parks and high grade farm land.

The aim of the highway engineer in constructing a new road is to transfer the problem of environmental costs from a potentially high cost area to an option containing lower environmental costs. When this is done it has the advantage of dealing with the main environmental costs at once or at least minimising those costs to the satisfaction of the greatest number of people (ref 25).

In order to minimise the effect of a new route on its environment mitigation measures will have to be undertaken in most cases, and it is these costs which this work seeks to address - either in isolation from each other or by an overall assessment of costs.
2.5 CURRENT HIGHWAY DESIGN METHODOLOGY

2.5.1 Outline of Methodology

The preparation and design of new highways is a long and multi-faceted process although mainly involving engineering disciplines does include professional input from Landscape Architects, Surveyors, Valuers, and the Legal Profession. A flow diagram of this methodology is shown in figs. 1 to 4, and illustrates the four main phases in the preparation of a major highway design through to construction. This system is in universal use in the United Kingdom and other parts of the western world and is also illustrated in outline by Williams for the Standing Committee on Trunk Road Appraisal (ref. 26).

The stages of the design shown in figs. 1 to 4 explains how the system operates in outline; the significance of each diagram is as follows:-

Fig. 1 describes how the design evolves from problem identification to public approval in the form of the Transport and Highways Committee approval for the preferred scheme. It is this stage which Williams (ref 27) refers to the procedure as a "sifting of options" or route selection, and includes the initial preliminary design stage. This particular stage includes the pre-estimate or budget capital cost estimate of a given scheme.

Concomitant with highway design are the preliminary traffic assessments, economics and environmental assessments (COBA and framework analysis). Prior to Committee approval the public consultation procedure is followed.
It is observed that the corridor for most highway proposals will have been considered many years ago, for example in Derbyshire many schemes were laid down in the 1951 Development Plan (ref 28).

Fig. 2 is the 'firming up' of the preferred route which while still at the preliminary design stage will now include site investigation, preliminary bridge design and a first landscape layout, noise surveys and closer and accurate land use examination. The capital cost can now be more closely monitored especially when considering different routes within a corridor. The use of the MOSS design system (ref. 29) enables engineers to quickly examine many different routes within a given corridor and this would include a calculation of capital cost changes between alternatives.

Fig. 3 illustrates the procedure from the planning application stage to the public inquiry and subsequent land acquisition - in association with compulsory purchase orders and side road orders.

The final diagram fig. 4 delineates detailed design elements all of which directly affect the final capital cost of the scheme, in particular the earthworks profile, the pavement design, drainage requirements, structural details, street lighting and statutory authorities works. The final activity shown in fig 4 outlines the tendering procedures through to the award of the tender and subsequent site management. However, the essential activities shown which are of interest from the capital cost view point are network numbers A00098 to A00123. Ultimately the final capital cost of the works will not be known until the scheme has been completed and any outstanding claims
have been agreed by the engineer to the contract as shown in activity A00131.

2.5.2 Highway engineering design standards - recommendations and guidelines

All new highways in England and Wales are designed and built to standards set down by the Department of Transport, similar standards are used in Scotland and Northern Ireland and these are supplemented by the respective Development Agencies.

The design process can be split conveniently into several areas notably (a) Geometry, (b) Site Investigation, (c) Earthworks, (d) Pavement Design, (e) Drainage Design, (f) Structures, (g) Specifications, (h) Measurement.

These parts of the design process are coordinated by the highway engineer in his role as Project Manager on a major scheme.

(a) **Geometry** is controlled by the recently produced 'Highway Link Design' (ref 30) in tandem with 'Layout of Roads in Rural Areas'. (Ref 31). Further guidance in connection with junctions and roundabouts is available in the 'Layout of Major/Minor Junctions' (ref 32) and the 'Geometric Design of Roundabouts'. (ref 33).

(b) **Site Investigation** is summarised typically in the 'Specification for Site Investigation Contracts'. (ref 34). This publication refers to many British Standard publications which can be used as necessary. Site Investigation at its preliminary level can be carried out as a 'desk top' study.
The geology of an area can be studied via information provided by the Institute of Geological Sciences. Local information can be obtained from the mineral sections of a County Planning Department and Historical Records held by the County Records Office. In mining areas the records kept by British Coal (either deep mining or open cast) usually contain essential input to any study or design.

(c) **Earthworks** - design is a synthesis of geometry and site Investigation recommendations. A major element in earthworks design is economics; this may relate for example to the number and spacing of structures or the availability and proximity of suitable fill to form embankments. Mass-haul diagrams and analysis can be usefully employed as outlined by O'Flaherty (ref 35). Software programs have been developed which enable this process to be speeded up and provide for a higher degree of accuracy. As the Earthworks design is progressed the landscaping considerations can be developed and presented as an integral part of the final design.

(d) **Pavement Design** - is a function of a number of elements viz, ground conditions, drainage, geometrical alignment, disposition of traffic and traffic predictions. In this connection pavement policy will depend whether the pavement is located on embankment, at grade or in cutting and the proximity of suitable plant and materials. The premier publication and design guide is the Department of Transports 'Road Note 29' and its derivatives (ref 36).

(e) **Drainage Design** is typically a function of geometric layout, rainfall intensities, the width of carriageways,
geographical location, verges and embankments. An important and useful publication is 'Road Note 35' (ref 37).

(f) **Structures** are invariably designed by Specialist bridge engineers who liaise throughout the design phase with the highway engineer in his capacity as Project Manager. The principle considerations relative to overall design are typically structural integrity, economics and aesthetics. Structural considerations are an extensive subject and typical Standards are BD 14/82: Loads for highway bridges (ref 38) and BD 24/84: Design of concrete bridges. (ref 39).

(g) **Specification** - the Department of Transport's 'Specification for Road and Bridge works' (ref 40) is the controlling document for accuracy, consistency and integrity of all new highway works.

(h) **Measurement** - the Department of Transport's 'Standard Method of Measurement' (ref 41) ensures that all new works are measured in a consistent manner and in harmony with the Department of Transport's specifications and objectives.

The foregoing design areas whilst not exhaustive largely represent the highway design process which leads the engineer to an appropriate solution for a new road design in respect to its form, extent and capital cost. It is from this synthesis of applied sciences, legal and management techniques that the capital cost can be evaluated in a consistent manner, such that options can be compared - from the budget estimate through to the final pre-tender works estimate and eventually (on receipt of the final account) to the final capital cost.
2.5.3 Landscaping, aesthetics and other environmental and commercial considerations in the highway design process

This aspect of new highway design is an inherent element of the design process. Referring to the design network in chapter 2.5.2, landscape considerations are included in fig. 1, Route Assessment and Public Consultation viz initial appreciation of alternative routes, preliminary design, consultation with other Departments and Public Authorities; and in fig. 2, Surveys and Preliminary Design viz, landscape requirements, noise survey, off-site earthworks for landscaping and environmental purposes. Fig. 4 Detailed Design - includes detailed landscaping and layout and quantities. As part of the design network, bridge designs must be submitted in the case of motorways and trunk roads for consideration by the Fine Arts Commission - this is largely for aesthetic consideration.

Because of constraints on design time professional engineers designing a new highway will require to adopt a commercial approach in terms of the number of alternative routes and options to be studied. This approach is also outlined by Williams (ref 27) where the case for a practical and economic approach is recommended for this stage of the design. From this premise the engineer tends to disregard routes which are going to be contentious (usually for environmental reasons), unless no viable alternatives are reasonably available to him.
2.5.4 Background to the landscaping element of highway design

At a philosophical level Kelsey (ref 21) regards man's effect on the landscape as being measured in terms of a datum - "the absolute baseline". This datum is the measure of a landscape which after being effected by new works, on completion must be found to be no worse than its state before works commenced. Kelsey points out that no other source has found any method of measuring 'landscape' other than by weighting systems.

It may not be entirely clearly recorded when landscape first received 'after treatment' but there was a proposal to form a Landscape Advisory Group in 1929, however, it was not until 1956 when a Standing Committee was formed to advise the Minister of Transport. This Committee did not have a brief to consider capital costs but was charged to consider options on various routes and the effect of new highway proposals on the landscape and the rest of the environment (ref 42).

Prior to the formation of the Standing Committee, the Council for the Preservation of Rural England in 1954 prepared an advice note 'The Landscape Treatment of Roads' (ref 43). This publication used the term 'fitted' highway at a time when travelling fast by motor car was relatively novel. This consideration led to the concept of sweeping lines and sinuous curves lending themselves to following land forms more closely. The concept of a three-dimensional approach had been recognised in a paper published in 1949 by Spencer (ref 44) when a method for overcoming malalignments was proposed (either real or imagined) by the co-ordination of the horizontal and vertical tangent points. It has been recognised by engineers from that time that the co-ordination of tangents was an ideal and was not always a commercial proposition.
In 1967 the publication 'Roads in the Landscape' (ref 42) acknowledged the need for landscape treatment ('after treatment') in the form of planting and earthworks. Throughout this period a great deal of highway design time was employed in the fitting of new roads into their surroundings and their environment. This trend was reinforced by the Report of the Urban Motorways Committee in 1972, 'Development and Compensation - Putting People First' (ref 45). This publication outlined a need for the greater consideration of amenity and of the environment when designing and building new roads.

2.5.5 Landscaping and highway layout

The project engineer for a new highway approaches the design and preparation of the scheme with the premise that the landscape and the environment 'left behind after construction albeit changed will be no worse than how he found it'. (ref 21). This concept need not be a negative or neutral state; it can even allow for a bridge in a highway to increase the 'drama' and impact of a landscape - for example the Forth Bridge, (ref 46) and the M6 in Cumbria (ref 47). This latter consideration adds to the responsibilities of the engineer - already concerned with financial accountability, efficiency of design, the integrity of design and the construction, earthworks, pavements and structures.

The application of standards outline in 2.5.2 and in particular item (a) Geometry, provides for the 'shape' of the final new highway at its interface with its surroundings, the landscape and the environment. The appearance of the new highway at any given location is dictated by
the geometry (horizontal and vertical alignment) and in this connection the current standards TD9/81 'Highway Link Design' (ref. 30) and 'The Layout of Roads in Rural Areas' (ref. 31) are the premier publications which effect the 'fit' of the new road with its surroundings.

Currently there is some possibility of a paradox between the above documents whereby the older publication (ref. 31) subscribes to a sinuous alignment to match ground contours and the current Links Design Approach (ref. 30) allows the greater use of straight sections. A selection of recommended radii for horizontal curve design for use with straight sections (ref. 30) are shown in fig. 5. Fig. 6 illustrates an example on the A3 trunk road at Petersfield contrasting the more sinuous alignment of the dual-carriageway with the single carriageway straights and curves (ref. 48).

Landscape Architects have had a mixed reaction to Link Design (HLD) for example Watson (ref. 49) suggests that HLD assists design because of its greater flexibility - and can even be useful in reducing land acquisition by a judicious use of straights and smaller curves. He concedes that the coordination of tangents points is not practical. In so far as phased tangents makes for a higher degree of aesthetic quality Watson suggests that the 'distant' view must be subordinate to economics - particularly in land-use economy.

The flexibility of the Highway Link system (ref. 30) is demonstrated by the success of the improved A3 in Hampshire over some 22 kilometres (ref. 50). The improved alignment has a variety of single and dual-carriageways where he feels the integration of
HORIZONTAL CURVE DESIGN

FIGURE 5

EFFECT OF GEOMETRIC CONSTRAINTS ON ALTERNATIVE STANDARDS AT PETERSFIELD.

FIGURE 6
the new road with the landscape has been met in full. Kelsey (ref. 51) disputes these views and feels society must pay a price for the poorer alignments and appearance - he considers the engineer concerns himself too much with rules and formulae, .... "standards are inferior - they tend to establish precedents and they can be anti-pathetic to thinking". This view is supported by the Landscape Advisory Committee (ref. 52) who came to the conclusion on Highway Link Design .... "most disturbing consequences must arise from the recommendations which places over-riding importance on the need for adequate overtaking - "highway design we are informed will now concentrate upon the provision of straight sections joined by small curves ....... it cannot fail to be inferior in landscape terms when compared with the flowing alignment". Kelsey (ref. 51) suggests that adhering to the standards leads automatically to numerically preferred solutions which cannot be altered without the imposition of a numerical penalty - usually expressed in additional capital cost.
CHAPTER 3

3.0 HIGHWAY DESIGN, THE ENVIRONMENT AND HIGHWAY LEGISLATION

3.1 THE DEVELOPMENT OF LEGISLATION UP TO 1959

Legislation has developed considerably since the end of the Second World War relative to the size and growth of heavy goods vehicles and also with the growth in numbers of private motor cars. The first major road legislation to be enacted after the war was the Trunk Road Act 1947 - this involved the addition of a major portion of county principal road networks to the then Ministry of Transport. This Act enabled engineers to incorporate for the first time a large central reserve for use for reasons other than basic engineering purposes - whilst it did not at the time use the term 'environmental' it did allow this concession for certain property considerations.

In the same year the Town and Country Planning Act 1947 was enacted which had the effect of requiring Planning Authorities to prepare development plans showing the intended land use - including the approximate location of future highways to enable land to be reserved and protected from development. The development plans had to be kept up to date and be available for revision every five years (ref 53).

The Special Roads Act 1949 was of major significance in that it was initiated to construct motorways. This consequential step was promoted to facilitate the movement of long distance motor traffic and connect many of the main centres of the population. At that time the environmental
considerations of the new road were not mentioned or considered of prime importance in the overall reckoning, the main considerations during the period of development being one of economics.

There followed a number of Acts which were brought about by the need to acknowledge the growth of traffic including the Transport Act 1953. From the highway construction point of view the 1959 Highways Act (ref 54) was important because it rationalised a number of older Acts and simplified the procedures for the acquisition of land for new works.

3.1.1 **New legislation effecting the climate for highway design**

Following the 1959 Highways Act the first significant change in legislation was the 1971 Highways Act (ref 55) which introduced a number of minor but useful changes - allowing some deviation from the 1959 Act which stated that the law on land acquisition (in connection with compulsory purchase orders for principal roads) was almost wholly limited to land acquired for the construction of a highway. In 1973 the Land Compensation Act (ref 56) allowed the Highway Authority to acquire land compulsorily if necessary, for the purpose of "mitigating any adverse effect which the existence or use of a highway construction has or will have on the surroundings of the highway". The Act also gave the necessary power to carry out works on the land acquired to permit elements such as screens, mounds or planting. These variations on the 1959 Act were constituted mainly for the purpose of mitigating adverse effects a new road might have on its surroundings. In addition it enabled the Highway Authority to develop such land so as to improve the surroundings of a highway for the specific purpose of acting as a barrier against traffic noise or otherwise mitigating the adverse effects of a new highway.
3.2 THE REPORT OF THE URBAN MOTORWAYS COMMITTEE 1972

This report (ref 57) was published to coincide with a Government White Paper which set out proposals for a full scale review of the compensation code. The report contents was also in accordance with the provisions of the Land Compensation Act 1973 whilst the earlier 1968 Town and Country Planning Act and 1971 Town and Country Planning Act were precursors to these developments (the White Paper). The review now required the engineer to address his design considerations to policies which involved the problems of the environment within a corridor. The essential information implied in the White Paper was such that a completely new approach was required to the planning and design of new highways. There was much more emphasis placed on comprehensive planning and on environmental values - the improved compensation was seen as essentially secondary to preventative measures. In addition the Report recognised that construction projects such as new motorways and highways benefited the community as a whole, but could also bear unreasonably hard on those most directly exposed to their more adverse effects - unless steps were taken to mitigate or remove potential harm. The Urban Motorways Committee whilst addressing the needs of the urban based schemes stressed that similar works in other area types would require the same approach and attention. On this particular aspect they emphasised (with the support of National Government) that the cost of measures to mitigate harmful aspects in areas adjoining the scheme should be treated as part of the new works.

It could be misleading to imply that the approach to road planning by the Urban Motorways Committee was 'new' in the sense that it had never been proposed before. In essence much of the 'new' approach has already been
incorporated (within certain practical constraints) into several earlier motorway and principal road schemes. Many examples such as the M1 in Leicestershire (ref 58) and the M6 in Cumbria (ref 47) illustrate how considerable efforts had been made towards environmentally "acceptable" new highway designs.

The foregoing legislation has not only assisted the engineer to promote and expedite new works but has attempted to fulfill the needs of the public — particularly those effected by new works. Government policy since the end of World War II had increasingly aimed at preparing legislation which moved forward in tandem with its own policy and with public opinion with respect to all aspects of transportation and its impact on the environment.
CHAPTER 4

4. NATIONAL AND LOCAL OBJECTIVES FOR NEW ROADS AND ASSOCIATED FUNDING AND COMMERCIAL CONSIDERATIONS

4.1 OUTLINE OF NATIONAL GOVERNMENT'S OBJECTIVES

The present Government's objectives for the National Trunk Road Network is as set out recently for use by highway engineers and the public in 'National Roads, England 1985' (ref 59). The main objectives are as follows:

(a) To aid economic recovery and development by reducing transport costs;
(b) To improve the environment by removing through traffic (especially lorries) from unsuitable roads in towns and villages;
(c) To enhance road safety;
(d) To preserve the existing investment (including infrastructure);

The Government's objectives for major local authority roads which act as feeders to the National network are set out in a White Paper 'Policy for roads in England: 1983' (ref 60). The principal objectives are to:

(e) Encourage the provision and maintenance of primary routes which complement trunk roads in quality and capacity;
(f) To provide relief for communities suffering from heavy through traffic by providing by-passes and relief roads;
(g) Provide for the movement of buses which have a major function in meeting transport needs;
(h) Continue to improve road safety.

4.2 POLICY BACKGROUND: THE COUNTY COUNCIL'S ROAD IMPROVEMENT POLICIES -

LOCAL OBJECTIVES

The Highway Authority's (The County Council) overall policy for road improvements is defined in the County Structure Plan (ref 61) in the following terms:-

a) The structural road network for the Structure Plan area will comprise the motorways and other trunk roads, the principal roads and those other roads which provide links with the main centres of population and industry or provide for the distribution of traffic within the main urban areas;

b) The County Council will normally confine comprehensive road improvements to the principal roads of the County; and will determine the priority for such improvements by reference to safety and environmental conditions, the volume of traffic, the nature of traffic, functions and importance by reference to safety and environmental conditions, all with consideration to the structural network and the location policies of the Structure Plan for residential and industrial development.

c) Improvement to other roads in the structural network which are the responsibility of the County Council will normally be limited to the removal of particular local hazards and environmental conflicts. In considering the need for minor improvements to roads which do not form part of the structural network account will be taken of the need for
adequate access, road safety and environmental impact. Other local objectives and further aims are contained in the Transport Policies and Programme (ref 62);

d) An efficient highway network, free of delays and congestion and of the additional journey costs incurred;

e) The reduction of congestion which delays public transport thereby increasing operating costs leading to a loss in reliability in services;

f) To construct road improvements to help the impact of heavy flows of traffic (particularly lorries) on people living, working and shopping alongside busy routes;

g) It is recognised that a significant contribution can be made in the reduction of accidents by removing conflict between moving vehicles and between vehicles and pedestrians and cyclists.

4.3 POLICY FOR CAPITAL EXPENDITURE AND ROAD FUNDING

The Government's current objectives for Local Transport expenditure is as set out in 'Public Expenditure Plans 1986/87 to 1990/91' (ref 63) and are as follows:-

a) To enable Local Highway Authorities to develop and improve their role, by new construction and traffic management in order to meet the needs of road users, particularly commercial and industrial traffic and so reduce costly delays and accidents;

b) To enable Local Highway Authorities to improve safety and amenities for all road users including cyclists and pedestrians and to reduce the environmental impact of road schemes by good design;
c) To preserve the local road system by adequate maintenance;

d) To promote convenient and reasonably priced public transport at lower cost to the taxpayer by encouraging competition and thereby more efficient operations;

e) To enable provision by Authorities at their discretion for transport concessions for elderly and disabled people, and for children and young people in full-time education;

f) To provide for sufficient investment in transport trading services - public transport, parking, ports and airports - to meet customer demand and reduce unit costs. Within the context of its Public Expenditure Plans the Government's objectives for capital expenditure on Local Authority roads is as set out in 'Policy for Roads in England: 1983' (ref 60).
4.4 PROVISION OF FUNDS FOR NEW ROADS

"The major transportation problem facing the County is the overall inadequacy of the cash being made available for all expenditure in Derbyshire, both capital and revenue". (ref 64). All new roads constructed by a County Council (The Highway Authority) is financed out of capital expenditure, whilst general maintenance is set against revenue expenditure – this is normally obtained through the County budget which in part is obtained through the Central Government's allocation of the rate support grant.

This budget is in the form of a block allocation of finance set against all aspects of local authority expenditure, inter alia, education, social services and libraries.

There is a distinguishing feature in the financing of roadworks, both maintenance and new works, which is the transport supplementary grant mentioned above (TSG). The amount of the TSG can vary annually and depends on the Transport Policies Programme (TPP) submitted by the County Council each year. The TSG also varies in part – depending on the extent of the rate support grant (RSG).

Central government set targets for annual expenditure both capital and revenue and will impose penalties on spending above the government approved targets. The penalty is implemented by reduction in the rate support grant.
Capital expenditure is the main source of concern to the highway engineer engaged in the design and construction of new works, if capital is in short supply - the new highway programme must obviously suffer in some way, usually by a deferment in the original programme. Whilst capital is raised by loans from a variety of sources, eg bonds and the city - the interest is paid back from the revenue account. However as the time scale for servicing these repayments are over a long period of years, capital payments have less effect on the annual rate when compared with direct revenue expenditure. For this reason in part the accounting technique of 'capitalising maintenance' has evolved and an example is shown in Table I (from TPP 13) (ref 62). The sum of £2,500,000 for this purpose would normally be used for new works, however as funds for maintenance are also short - a balance has to be found in the account such that the eventual result is to cut funds for the five year programme of new works by some 30 per cent over the period 1986/87 to 1991/92.

An emerging trend from the forgoing is the growing importance of capital consuming elements such as environmental mitigation measures as indicated in the policy objectives document and the continuing reduction or levelling out in funds for new works.

Funds being considered here are capital funds raised either by the County Council through the transport supplementary grant and/or the rate support grant.

It is therefore all the more important that capital expenditure must be accounted for against every consideration and of engineering elements. In this particular work the cost of the mitigation of environmental impact
for new works is considered highly relevant in terms of capital expenditure.

The decline and levelling out in capital funding is illustrated in figs 7-9 which illustrates both local and national trends. As funds become scarcer the 'value for money' concept applies to all engineering works and in this respect highways are no exception. All the elements making up the highway must consume capital and environmental mitigation measures represents a significant user of capital funds.
Graph showing Capital Expenditure on New Roads 1978/79 to 1987/88.

SOURCE: Derbyshire County Council Treasurers Department.

KEY:
- County Roads
- Trunk Roads
- T.S.G

FIGURE 7
Road Expenditure at Constant 1980/81 prices (England and Wales).


Source: Figures 8 and 9.
(a) British Road Statistics 1987: British Road Federation.
CHAPTER 5

5.0 ENVIRONMENTAL FACTORS AND ROAD INVESTMENT APPRAISAL
AND ASSOCIATED COMMERCIAL FACTORS

5.1 BACKGROUND TO COST BENEFIT ANALYSIS (COBA)

The subject of road investment appraisal follows on from the previous chapter on funding and the associated capital expenditure element. This chapter explores capital funding relative to government involvement and interest in the mitigation of environmental impact created by the construction of new highways. Any involvement in the design and preparation of new works requires an economic assessment or an investment appraisal (ref. fig 1); this enables a scheme to be tested on an economic basis. This applies to proposed new roads in a system analogous with that of cost benefit justification commonly used for commercial developments. In the case of public roads - the then Ministry of Transport during the 1960's developed techniques for comparing the expected benefits from alternative road investment projects (ref. 65).

The original approach to the basic measurement of economic benefit was to 'weigh' the cost of the new construction against various benefits including those obtained from the reduction in accident rates, the reduction in vehicle operating costs and travelling times. In addition some allowance was made for changes in road maintenance costs. The Ministry of Transport and its successor, the Department of Transport, developed the current road appraisal system known as Coba (Cost Benefit Analysis), (ref. 66). This system first published in 1971 is referred to
as 'full cost benefit analysis'. The main development associated with Coba has been the measurement of the effects of highway investment over a whole network of roads which may be under consideration and in addition an extension of the time period over which costs and benefits are estimated.

The earlier techniques of investment appraisal took the first operating year rate of return as the measure of operating benefits (ref. 65), this is in contrast to current practice which is to calculate benefits over a period of 30 years which attempts to allow for a build up of traffic over the longer period of time. (ref. 66).

5.2 DIFFICULTIES ASSOCIATED WITH COST BENEFIT ANALYSIS

An important factor in economic analysis is the accurate forecast of traffic - this can be particularly difficult in an urbanised locality, but in any location there are obvious uncertainties about what might happen over periods as long as 30 years. For example, government regional economic policy could change and the development of different forms of transport for the availability of fuel could effect the future of traffic flows. A further major problem in applying road investment appraisal techniques is that of calculating a rate of return on the investment required to construct the road and this involves putting money values on those benefits which are measured (ref 66). The most important benefit to result from new road construction is usually the shortened journey times and a feature of Coba is that of putting a monetary value on time savings, but not however, directly attempting to put any monetary value on environmental considerations. The time element in the appraisal for transport and road investment has been the subject of intensive
research and of subsequent literature. Journey time which is numerically important to all evaluations has the effect of swamping the inclusion of environmental factors which might otherwise be worthy of consideration (ref. 67). An example of an applied Coba print-out is shown in Appendix A.

5.3 FINANCIAL TRENDS

The engineer engaged in the design, promotion and construction of new highways must operate within the guidelines of a scheme programme laid down by the client. In the case of the County Council (the Highways Authority) guidelines are laid down in the policies outlined in chapter 4 and in the Transport Policies and Programme (TPP) which is published annually. The funding described in chapter 4 is largely dependent on the Authority being able to service the loans required to pay off the capital debt which accrued against the scheme. Central government may offer 50% of the estimated capital cost of an approved scheme and almost without exception recent TPP's are made up of schemes in this category.

Table 1 (Table 1 from TPP 13) (ref. 62) illustrates how the capital expenditure for new work is insufficient to cover the cost of an on-going programme of major works. For example financial year 1986/87 shows £550,000 out of a total of £6,634,000 committed to new schemes. This issue must clearly be one of political decision and applies an accountancy approach to counter the development of a deficiency in funds by capitalising salaries, maintenance, land in advance and so on. The outcome is to slow the new works programme down and to cause scheme "slippage" by lack of capital resources to service the previously agreed programme of works. Table 2 (ref 68) illustrates this problem with
respect to negative adjustments concerning the transport supplementary grant settlement for Derbyshire County Council 1987/88.

In considering the programme from a road investment/ranking point of view, cost benefit analysis has been applied to scheme ranking throughout but has had little effect on maintaining the programme. Prior to the use of Coba the Government and Highway Authorities used the Economic Rate of Return Approach for grant purposes which required a first year rate of return typically in the range of 10 per cent to 20 per cent (ref. 69). Many of the pre-1975 (Local Government re-organisation) schemes now completed were on this basis, for example in Derbyshire the Pleasley bypass and Hasland bypass. After 1975 the capital programme was considerably delayed and this is illustrated in Table 3.

From Table 3 it is observed that the four major schemes programmed in TPP 13 were accepted as early as TPP 5, i.e. 8 years previously. On a local scale much of the new roads programme has slipped, mainly through capital problems (ref. 70). Nationally, capital is also a problem in this respect but so are the environmental pressure groups (ref. 71 and 72). Over the complete period shown in table 3 the average delay is six years.

Much of the United Kingdom motorway programmes were established largely on the basis of cost benefit analysis where the preferred route provided the best rate of return. In many cases environmental groups lobbied successfully to remove the best 'economic' route to another location. In the case of the M40 a small area of heath land containing a unique species of insect was saved, the road being diverted considerably at extra cost to avoid this Special Site of Scientific Interest (SSSI) (ref. 73). This compromise cost the tax payer a sum of money which could
be said to be set against certain environmental considerations - in this case the habitat of a unique insect life and an interesting and important moorland feature.
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<thead>
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<td>Commitments</td>
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<td>550</td>
<td>1205</td>
<td>2322</td>
<td>2334</td>
<td>2682</td>
<td>2270</td>
<td>5650</td>
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<tr>
<td>Minor Highway Schemes (£0.1-£1m) (from table 3)</td>
<td>790**</td>
<td>256**</td>
<td>395**</td>
<td>355</td>
<td>500</td>
<td>315</td>
<td>675</td>
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<tr>
<td>Minor Improvement and Accident Remedial Measures (&lt; £0.1m)</td>
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<td>900</td>
<td>700</td>
<td>700</td>
<td>700</td>
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<td>Land in Advance</td>
<td>150</td>
<td>484</td>
<td>345</td>
<td>345</td>
<td>340</td>
<td>355</td>
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<td>s188 and Private Street Works</td>
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<td>600</td>
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<td>7159</td>
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<td>Total Highways and Transport</td>
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<td>6464</td>
<td>7307</td>
<td>7279</td>
<td>7742</td>
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</table>

(All figures at £'000 Nov 1985 prices excludes expenditure on Vehicles, plant and machinery)

* includes only expenditure required to complete schemes started or under construction during 1991/92 (ie not new starts post 1992)

** includes expenditure on 'emergency schemes'

* * *
### TABLE 2

Transport Supplementary Grant (DCC) 1987/88

<table>
<thead>
<tr>
<th>ROAD NO.</th>
<th>SCHEME</th>
<th>START YEAR</th>
<th>TOTAL COST £</th>
<th>ACCEPTED £</th>
<th>ESTIMATED OUT-TURN £</th>
<th>ACCEPTED £</th>
<th>BUDGET £</th>
<th>ESTIMATED £</th>
<th>PROPOSED £</th>
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<td>A610</td>
<td>Langley Mill By-Pass</td>
<td>80/81</td>
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<td>10</td>
<td>110</td>
<td>0</td>
<td>22</td>
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<td>Ripley By-Pass</td>
<td>83/84</td>
<td>3105</td>
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<td>19</td>
<td>20</td>
<td>107</td>
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<td>Tapton By-Pass (I &amp; II)</td>
<td>86/87</td>
<td>5505</td>
<td>1200</td>
<td>250</td>
<td>1930</td>
<td>889</td>
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<td>Buxton Inner Relief Road</td>
<td>86/87</td>
<td>1470</td>
<td>870</td>
<td>70</td>
<td>710</td>
<td>595</td>
<td>770</td>
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<td>A6007</td>
<td>Ilkeston Inner Relief Road</td>
<td>89/90</td>
<td>8165</td>
<td>0</td>
<td>250</td>
<td>1400</td>
<td>105</td>
<td>195</td>
<td>195</td>
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<td>A514</td>
<td>Swarkestone Causeway</td>
<td>/-</td>
<td>245</td>
<td>1500</td>
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<td>110</td>
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**Adjustment for 85/86**
-1400  
-1300

**Total Roads Minor Works Satisfying Criteria**

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<td>833</td>
<td>932</td>
<td>152</td>
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**Total estimated expenditure in 87/88 proposed for acceptance for TSG**
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<td>A619 Pleasley By-Pass</td>
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<td>S</td>
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<td>D</td>
<td>C</td>
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</tr>
</tbody>
</table>

**TABLE 3**

**DERBYSHIRE COUNTY COUNCIL: DELAYS ON PLANNED SCHEME STARTING DATES**

(1975 - 1979)

(Principal Road Major Schemes >£0.50M)

**KEY**

S First Planned Start Date
D Delay
C Construction Started
6.0 ENVIRONMENTAL CONSIDERATIONS

6.1 EARLY DEVELOPMENT

Problems regarding the environment and new construction became apparent in the early 1960s and was recognised in the Clough Williams-Ellis booklet 'Roads in the Landscape' (ref. 42) writing for the then Ministry of Transport. Further contributions on this subject were provided by Buchanan (ref. 74) and Hoskins (ref. 75) - both writers drew attention to many aspects of environmental impact concerning new highways.

At that time the engineer was under considerable pressure to develop a pragmatic approach to formulating new routes because of such typical requirements as the provision of rates of return in the range 10% - 20% (ref 69). This approach was not necessarily in sympathy with all environmental needs, although within a given corridor the professional judgement of engineers minimised the risks to property and in most cases the fabric of the landscape. Public opinion in the late 1960s and the early 1970s arguably led to the publication of the report by the Urban Motorways Committee in 1972 (ref. 57) - which argued that social as well as private costs should be taken into account in the cost of new work. These should include the effects of traffic noise, severance of communities, construction disturbance and visual intrusion. The report was followed up by supporting legislation notably the Land Compensation Act 1973 (ref 56).
In the mid-1970s there was a spate of innovative and experimental approaches to the evaluation of environmental factors and environmental impacts. Many highway authorities and engineering consultants engaged in highway design attempted evaluation projects. Rouse (ref 76) studied a number of systems using a points method of evaluation of environmental benefits or dis-benefits. Research during this period reached a peak in March 1976 with the publication of the Jefferson report 'Route Location With Regard to Environmental Issues' (ref. 77).

This report also coincided with the Department of Transport's decision to set up the Standing Advisory Committee on Trunk Road Assessment (SACTRA) chaired by Sir George Leitch. The subject of environmental appraisal and associated impacts became a subject of much greater depth and scrutiny.
6.2 THE LEITCH REPORTS ON ENVIRONMENTAL CONSIDERATIONS

In 1976 the Secretary of State for Transport set up the review body 'The Standing Committee on Trunk Road Assessment' - and it was from this body that the first official reports on environmental considerations were brought to public notice.

The request was based on the Government's desire to seek independent advice on the preparation of new road schemes following the publication in April 1976 of its 'Transport Policy, Consultation Document' (ref 78). The assessment was introduced so as to comment on and recommend any changes in the Department of Transport's appraisal of road schemes and was to comprise many factors including environmental considerations. Leitch began his report (ref 79) by examining procedures used throughout the world, for convenience he started with an examination of the current methodology in the United Kingdom - beginning with the work carried out by Jefferson of the then South West Road Construction Unit.

Jefferson's terms of reference had been to prepare the 'Draft Guidance to Road Construction Units on the Location of Major Inter-Urban Road Schemes with regard to Noise and other Environmental Issues' (ref 77). The various factors which Jefferson took into account were land-take, noise, vibration, air pollution, visual effects, severance and accidents. Essentially this work studied each factor in isolation; for example the review proposed in the case of land-take, an index system as shown in Table 4.
MAFF classification of agricultural land
and Department of Transport Productivity Index

For each scheme the area of agricultural land take is multiplied by its index and the products summed.

On the evaluation of other factors Jefferson concluded that land-take, noise costs (compensation) and accident costs (with reservations on values of safety) could all be evaluated in terms of capital cost and hence included in the cost benefit analysis. Vibration and air pollution were considered as being insignificant.

The unquantifiable elements were visual effects, comprising three factors viz: landscape attractiveness, intrusion of the road on the landscape and the intrusion of the road on properties. Jefferson considered that the Landscape Advisory Committee (set up in 1956) was the best judge of these

Table 4

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<th>MAFF Classification</th>
<th>Productivity Index</th>
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<td>1</td>
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factors and that subjective judgement should be used in these latter cases and also extended to agricultural and community severance.

Leitch investigated points of special relevance to his review by looking at current practices in the USA, France and the Federal Republic of Germany (ref 80). He noted similarities between the British and the German practice, the French assuming an assessment system based rather more on qualitative judgement but less vigorous than the British system.

An important observation on the American system is the requirement (since 1969) for Highway Agencies to prepare Environmental Impact Statements (EIS). These are required for 'major actions' which are defined as any action likely to precipitate significant foreseeable alterations in land use, planned growth, travel patterns and so on. In this connection highways such as new freeways or highways providing substantially improved access are examples of 'major actions' (ref 81).

6.3 CRITICISMS OF CURRENT EVALUATION PROCEDURES

Many organisations and interested groups were invited to comment via Leitch on the evaluation techniques for new roads. The first group represented objectors whose views were promoted by, inter alia, Professor Self of the London School of Economics, Doctor Adams of Friends of the Earth, Cambridge Conservation Society, the Midland Motorway Action Committee and The Royal Town Planning Institute. The theme of their criticism was "a serious objection to the present method of cost benefit analysis is that it is unintelligible and obscure to most people, including those who have a special interest in the decisions ...." (ref 82).
The Oxford University Transport Study Unit concluded that their critique confirmed the public's suspicion of the methods used to evaluate road projects .... "cost benefit analysis in the way it is embodied in COBA does not seem applicable to the average road scheme. It simply clothes it in a aura of scientific precision ....". (ref 83).

Leitch summarised the input from the above bodies and organisations and recommended that as a starting point the techniques laid down by Jefferson (ref 77) would be the most appropriate. With regard to economic evaluation, Leitch and his Committee agreed that the current methods of scheme appraisal based on COBA were sound up to a point; he believed however that the total assessment was unbalanced and that a shift of emphasis in the whole approach should be adopted. This view was taken up on the basis that the appraisal system was seen to be out of balance - being dominated by those factors which were susceptible to valuation in money terms.

His final recommendation was to approach the environmental valuation on the basis of a comprehensive framework system - relying on judgement. The framework would embrace all the factors involved in scheme assessments (economic and environmental) and should be applied to all stages of the design procedure (ref 84).

6.4 THE FRAMEWORK APPROACH

The Standing Advisory Committee on Trunk Road Assessment (SACTRA) under the Chairmanship of Sir George Leitch reported back in October 1979 (ref 85) on his recommendations with regard to the use of frameworks. These
recommendations were made after the methods had been applied to several examples of new highway schemes. The Department of Transport adopted the method in 1980. The main characteristics of frameworks (ref 86) are as follows:

(a) No effects which are relevant or might reasonably be thought to be relevant should be excluded.

(b) The preliminary stages of design should contain a convenient check list to ensure that the Engineer has covered all the effects - initially only in outline and at later stages the details can then be filled in.

(c) Certain impacts should be quantified, for example the cost of noise insulation or the estimated increase in noise level. However, where uncertainty is associated with the calculation of some impacts, a verbal description would be more suitable.

An example of a framework presentation is shown in Appendix B.

6.5 THE MANUAL OF ENVIRONMENTAL APPRAISAL (THE MANUAL)

Following the publication of the Leitch Reports in 1977 and 1979 the Department of Transport published the advice note 'The Preparation of Frameworks for Trunk Road Appraisal' (ref 87). This was followed in the same year by 'Frameworks for Trunk Work Appraisal' (ref 88). These publications were introduced as an interim measure to ensure that the 'post-Leitch' report stage would be approached in a consistent manner. This procedure was to be immediately adopted by the Department of Transport cognizant in the knowledge that not all factors could be considered in monetary terms.
The Manual of Environmental Appraisal (ref 89) was published by the Department of Transport in October 1983. This manual incorporated the information held in those earlier standards outlined above and is intended as a guide for highway engineers and planners in respect of framework preparation. Detailed advice is given on the assessment of particular environmental impacts, inter alia, noise, visual impact, air pollution, conservation. Commenting on the Manual on its release to the public, Mrs Linda Chalker the Parliamentary Under Secretary for Transport said in the introduction to the manual, "New roads can have a major impact on the environment. They relieve hard pressed communities along the existing roads from the noise and congestion caused by heavy through traffic, but they also bring some disturbance to the areas in which they pass. Both the gains and losses to the environment need to be assessed properly and the potential for limiting any adverse effects explored, along with the costs of traffic benefits of each new road" (ref 90).

6.5.1 The basic framework layout (ref 91)

The frameworks for public inquiry purposes should contain a minimum of 3 columns:-

(1) The Department's preferred route.
(2) "Do Nothing Route".
(3) Comment column.

Where a "Do Nothing" forecast might be considered an unfair basis of comparison, the term "Do Minimum" would be used if appropriate. The routes chosen by objectors may also need separate columns so that a comparison of
their environmental or other consequences compared with the preferred route. There is a need for the presentation of all the data in the framework to be consistent from scheme to scheme and to this end it is advised that information should be presented in the following 6 appraisal groups:

1. The effects on travellers;
2. The effects on occupiers of property;
3. The effects on users of facilities;
4. The effects on policies for conserving and enhancing the area;
5. The effects on policies for development and transport;
6. Financial effects.

The framework therefore considers each appraisal group against any impact germane to the appropriate group listed above or against a combination of groups.

6.5.2 The environmental impacts (ref 92)

(a) Traffic noise

The scale adopted by the Department of Transport to assess traffic noise is L10 (18-hours) (dBA). This is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the 18 hours between 6.00 am and midnight. In concerning itself with frameworks the Department of Transport has recommended two approximate methods to help the general public compare proposed changes in their environment. The first deals solely with the effects of traffic flow changes and the second concentrates on the distance
between the observer and the road. These concerns are covered by the statutory provisions—the Noise Insulation Regulations 1975 (ref 93).

(b) Visual Impact

The Standing Committee for Trunk Road Assessment (ref 94) distinguished between two types of visual impact viz, (i) obstruction (ii) intrusion:

(i) Obstruction

For this impact to appear in a framework there must be a view, there must be observers and some part of the new scheme must appreciably cut off the view from the observers. Where the engineer requires an appraisal it is recommended that visual obstruction should be expressed in the framework on a 3 point scale ie, slight, moderate or high.

(ii) Visual Intrusion

The appraisal of this impact is a function of how the highway (and its structures) changes the visual quality of the area through which it runs. This quality is as perceived by the people who live in or visit the area. Leitch recommends that visual intrusion should be left unquantified and ranked in the framework on a before and after basis or simply high and low intrusion. This impact is very much the professional province of the landscape architect who would normally ensure consistency of appraisal of the detailed effects of route options in visual terms.
Fig 10 illustrates an example of visual intrusion, using a photo-montage system.

Fig 11 is an extract from a working drawing showing landscaping and other mitigation details.

(c) Air Pollution

The Standing Committee for Trunk Road Appraisal recommended that this impact should be included in any assessment where the engineer considered it to be a particular problem, otherwise it should be excluded. The report emphasises that the increase or decrease in pollution of the air by exhaust emissions should not normally be represented as an impact unless it brings substantial relief to a heavily polluted area or is a specific problem such as a tunnel portal. Where existing air pollution is recognised as a problem the improvement due to the proposed road should be noted in framework.

(d) Community Severance

Community Severance is defined as the separation of residents from facilities and services they use within their community. Severance may result from the difficulty of crossing heavily trafficked roads or from a physical barrier formed by highway features such as cuttings embankments or from the legal prohibition of access for pedestrians. The Transport and Road Research Laboratory recommended that this type of severance (ref 95) could only be described on a 4 point scale viz, none, slight, moderate or severe.
Example of Visual Impact: Ringwood Park and lake at Brimington as it exists shown above and with the proposed By-pass embankment below using a photo-montage technique.
PROPOSED FOOTPATH/CYCLEWAY
Screen planting between footpath/cycle track and the road.

Retain existing trees along riverside.

BLUE BANK POOLS S.S.S.I...
The pools fed by percolating water support a rich diversity of flora and fauna (Aquatic) and old meadows and canal towpath botanical interest and entomological interest. Minimum disturbance to this area required. Detailed consultations with D.N.T & N.C.C. required.

KEY
Tree and Shrub planting...
Areas for planting beyond proposed present boundary...

Landscape plan (1:2500 Scale).
Extract for plan showing landscaping and other mitigation details.

FIGURE: 11.
(e) Effects on agriculture

The 2 main effects dealt with in the Manual of Environmental Appraisal in this particular section are (i) land-take and (ii) severance.

(i) Land-take

There is a statutory duty required of the Engineer under the Highways Act 1980 (ref 96) to give "due consideration to the requirements of local and national planning, including the requirements of agriculture".

The Ministry of Agriculture and Fisheries and Food (MAFF) has classified land into 5 main categories (ref 97). There is a recommendation from the Department of Transport to avoid grades 1 to 3A of farm land wherever practicable.

(ii) Severance

Even if minimal land-take is involved in the severance of a farm the effect on its economics and operational structure can be similar to those caused by substantial land-take. The design engineer can help to redress damage to the farm structure by boundary adjustments and land exchanges; these measures however may not always succeed and careful discussion with affected occupiers and owners is recommended by the Department of Transport.
(f) Heritage and Conservation Areas

This section relates mainly with those buildings, structures, works or areas that are protected by statutory protection. While an unprotected landscape may not necessarily be of great merit in the national context it may have great local significance and every attempt should be made to harmonise the road into the landscape with the minimum physical and aesthetic impact. The Manual provides a number of descriptions for the various heritage and conservation areas and for convenience group to make 3 broad types:-

(i) Man-made structures or groups of structures. This section is made up of ancient monuments, listed buildings, building preservation notices, conservation areas and other historic sites which together form the physical record of the national heritage.

(ii) Areas of land form, vegetation or wildlife habitat, which like (a) above cannot be replaced. This section is made up of inter alia National Parks, Areas of Outstanding National Beauty (AONB), Heritage Coasts, International Nature Reserves, Sites of Special Scientific Interest (SSSI).

(iii) Other land forms, buildings or habitat which have historic, scientific or amenity values whose loss would be serious. Items under this heading typically are Common land, town and village greens, public open spaces and church lands. The Department of Transport recommends that all or any relevant site should be identified and the line of a new road checked and re-surveyed before a public inquiry.
Leitch recommends that the impact on any of the above Heritage and Conservation sites should be assessed on the basis of three types:-

(i) Direct physical impact - for example demolition, land-take, vibration, etc;

(ii) Indirect physical impact - for example alterations to water table levels, atmospheric and ground water pollution, etc;

(iii) Aesthetic degradation typically where additional noise or visual intrusion detracts from the setting or enjoyment of the area, or enhancement - where such problems are reduced.

(g) Ecological factors

As with other impacts the engineer has to assess whether there is a case for a consideration to be made in this area - commencing with an initial appraisal. The main purpose of this should be to take a preliminary look at the ecological area surrounding each route - in order to discover whether there are ecologically sensitive areas which may be affected by a proposed new highway. Reference may be made to any sites in the area such as sites of special scientific interest, local nature reserves as outlined in the previous paragraph (f). Where a significant impact on an area is thought likely, consideration should be given to a full appraisal including a desk top study to bring together all the factors affecting the threatened site. It should also include a description of the expected impacts from the construction and operation of each route, together with an appraisal of their ecological significance.
(h) Disruption due to construction

This impact is defined as the temporary nuisance and annoyance to people in the area, which can occur between the start of the pre-construction works (such as soil surveys, side road diversions and fencing), and the main works itself through to the end of the maintenance period (including the removal of temporary works).

For framework purposes each route is considered in the light of appraisal groups 1, 2 and 3, in tandem with the number of properties within 100 metre bands on either side of the site. This will indicate the comparative effects on a community. The Land Compensation Act 1973 (ref 56) entitles the Highway Authority to compensate persons suffering 'injurious affection' and the Noise Insulation Regulations 1975 (ref 93) allows for noise insulation to be provided as appropriate.

(i) Pedestrians and cyclists

The two main aspects considered in this section are the effects on amenity and on journey time. The Manual defines amenity as the "relative pleasantness of a journey". It is therefore concerned with the changes in the degree and duration of people's exposure to fear, noise, dirt and air pollution. Changes in journey time if extensive can lead to community severance.

For assessment purposes the general pattern of cyclists and pedestrian movement should be studied. The manual supported by the Transport and Road Research Laboratory (ref 98) suggests that several main factors are
involved when changes of amenity are considered typically, traffic flow, traffic composition, pavement width and separation from traffic. A general description can be given of the likely effects in the remarks column.

(j) **View from the road**

The Manual defines this impact as the extent to which drivers are exposed to the different types of scenery through which a route passes. Four different types of landscape are distinguished for this purpose:

(i) Industrial and commercial;
(ii) Residential;
(iii) Agricultural, woodland or moorland;
(iv) 'Scenic' landscape above the national average of visual quality.

The Manual recognises that 'view from the road' is of limited usefulness and it is recommended that objective descriptions be given using professional advice.

(k) **Driver stress**

The Leitch Committee recommended that this impact be included in assessments whilst recognising the difficulty of establishing degrees of stress.
7.0 THE EVALUATION OF ENVIRONMENTAL IMPACT IN TERMS
OF CAPITAL COST AND COMMERCIAL CONSIDERATIONS

7.1 THE APPROACH TO CAPITAL COST VALUES

The problem of assessing environmental impact considerations was addressed in chapter 6. The typical approach to assessment is one of judgement and the subsequent use of frameworks. The capital cost value of each of the environmental impacts could not in general be calculated and hence made available for evaluation. In the case of the Manual of Environmental Appraisal (ref 89), most impacts were described as unquantifiable, assessments therefore were recommended to be made typically on the basis of degree, for example, good, bad or no difference.

In order to evaluate the capital cost considerations of environmental impacts, each individual impact must be judged from a civil engineering viewpoint to ascertain whether a capital cost evaluation can be made. This approach is based on the application of engineering costs, data and standards to mitigation measures adopted by the engineer in an attempt to ameliorate the impact of a new highway on its surroundings or environment. For a consistent approach to capital costs, measurement and evaluations will be based on the 'Standard Method of Measurement' (ref 41) and by the use of current methods of highway design as described in chapter 2.
7.2 THE CAPITAL COST CONSIDERATIONS OF ENVIRONMENTAL IMPACTS LISTED IN THE MANUAL OF ENVIRONMENTAL APPRAISAL.

(a) Traffic noise

This impact, which carries statutory obligation, can be costed typically by measuring the volume of earthworks in respect of earth embankments or bunds used for noise mitigation. The former is often associated with the total landscape aspect of the proposed scheme whereby the engineer or landscape architect can integrate the noise bunds with additional land­take, earthworks and a planting programme.

Noise is also mitigated by the use of insulation in the affected properties in accordance with 'Noise Insulation Regulations, 1975' (ref 93). An estimate for a three bedroomed house with double glazing and ventilating units in the "lived in" rooms is typically £1,000 (ref 99).

(b) Visual impact

Visual impact is distinguished in two ways viz;

(i) obstruction

(ii) intrusion
(i) **Obstruction**

SACTRA advise "... by obstruction we mean blocking the view by a road structure - for example, a 10 metre high embankment ...". This impact cannot be evaluated and SACTRA recommends a subjective approach and also to apply a grading system such as good, bad or no difference. A monetary value may be applied on the basis of injurious affection using the Land Compensation Act 1973 (ref 56) - which allows for a relatively small capital sum to be paid to an aggrieved householder. The compensation is usually calculated by the District Valuer or the County Estates Officer.

(ii) **Intrusion**

Intrusion cannot be numerically valued and hence cannot be costed at the present time. SACTRA recommends using a grading system as with obstruction outlined above. Intrusion may be ameliorated to some extent by landscaping and planting schemes and may be measured and costed and integrated into the final civil engineering works.

(c) **Air pollution**

There is no method of costing this impact at the present time nor are there any statutory obligations due in part to difficulties connected with the measurement of air pollution. An approach discussed in the Manual is for the Highway Authority to purchase any property exposed to a predicted pollution value of 4.0 ppm; the value of the property can then
be set against the capital cost of this impact. Williams (ref 100) considers that this impact "... cannot adequately be treated by using the C.O. level ...".

(d) Community severance

There are no known methods of costing this impact - although there are examples where structures over a road separating a community could be evaluated. The "hurt" felt by a community cannot at this time be measured. There is no statutory obligation to prevent severance, however local objectives recommend that the Highway Authority makes every attempt to improve safety and amenities for all road users and in this respect must incur capital costs.

(e) Effects on agriculture

No practical system is in existence to enable this impact to be evaluated although an attempt was made in the 1970's when the HOPS program was made available (ref 101). This program optimised the horizontal and vertical alignments of a new road scheme and included the effect on agriculture (include capital costs) as one of its objectives. Another approach to obtaining the capital cost of the effect on agriculture is to summarise the cost of bridges or underpasses used in the highway design layout to assist agricultural frontagers as with community severance.
(f) **Heritage and conservation areas**

These are avoided by highway designers, in part because no capital cost can be practically apportioned and because many heritage and conservation areas do have statutory protection and in addition local objectives (outlined in chapter 4.2) contain the recommendation to avoid such areas of interest.

(g) **Ecological impacts**

No practical method exists to evaluate this impact - although avoidance of such zones is obviously desirable. There are no statutory requirements at the present time. A paper by Bixby (ref 102) outlined a method for evaluating the economic value of the Otmoor landscape (which includes the ecology) - however, this method has not been adopted by the Department of Transport.

(h) **Disruption due to construction**

In a typical capital cost profile for any scheme, this impact can be valued and built into the estimate or tender price. This is a measure of the inconvenience caused by the obstruction on any person adjacent to the proposed works. An aggrieved householder can request the District Valuer to estimate any damage he considers to be a consequence of the works, for example the replacement of carpets or the installation of noise insulation. Payment would be made on the basis of the Land Compensation Act 1973 (ref 56) and the Noise Insulation Regulations 1975 (93). This payment is a capital sum which can be evaluated.
(i) **Pedestrians and cyclists**

In this instance the Local Objectives typically outlined in the County Council's Transport Policies and Programme (outlined in chapter 4.2) request the special considerations be made and measures taken to incorporate appropriate facilities such as road crossings or a footbridge. These can be costed and included in the works estimate; however, the inconvenience and psychological factors involving pedestrians and cyclists cannot be evaluated.

(j) **View from the road**

This impact is at the present time entirely subjective and cannot be evaluated. Williams (ref 103) suggests that this impact could in certain types of schemes be omitted from any assessment.

(k) **Driver stress**

This impact is also highly subjective and cannot be evaluated. Some work has been done in the field of ergonomics but otherwise is represented only in the sphere of psychological studies. Williams (ref 104) when referring to urban roads considers that driving is highly stressful but cannot take the matter any further.
7.2.1 **Summary of the capital cost considerations of each environmental impact listed in chapter 7.2**

An examination of the impacts outlined in this chapter indicates that only two of the eleven impacts can be realistically evaluated in terms of capital cost. Typically those impacts such as driver stress and view from the road are unlikely to be quantified in this way, whilst others such as traffic noise can have some costs apportioned to it. Table 5 illustrates how each of the impacts can be costed either totally or partially, or are un-quantifiable. Their relationship with statutory provisions and local or national objectives are also included.

To summarise, the two impacts which can be 'totally' costed are traffic noise and disruption due to construction because it is noted that the valuation elements representing capital cost relate to the compensation made available by Statutory provisions.

Certain impacts appear to have the ability to be partially costed, notably visual impact, air pollution, community severance, pedestrian and cyclists—because to a degree they may be mitigated by landscaping or by further investment in accommodation works. However there remains no known point within this group whereby the degree of quantifiable environmental impacts can be totally evaluated.

The remaining impacts viz heritage and conservation areas, ecological, view from the road and driver stress have no means of evaluation in capital cost terms at this time.
<table>
<thead>
<tr>
<th>Consideration</th>
<th>Ability to be Evaluated</th>
<th>Ability to be Evaluated</th>
<th>Unquantifiable As Capital Costs</th>
<th>Covered by Statutory Provisions</th>
<th>Covered by local and National Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Noise</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Visual Impact</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Air Pollution</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Community Severance</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Heritage and Conservation Areas</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ecological Impact</td>
<td>✓</td>
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<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Disruption Due to Construction</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pedestrians and cyclists</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>View from the Road</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Driver Stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

**TABLE 5**

*Environmental Impacts Capable of Being Costed*
7.3 THE CAPITAL COST OF ENVIRONMENTAL IMPACTS AS CONSIDERED BY OTHER SOURCES

7.3.1 United Kingdom Published sources

In his paper "Working with the Environment", Poyser (ref 105) examined the problem of designing and constructing a new highway through a conservation area. Poyser's sympathetic design was achieved typically by utilising high grade materials and special finishes.

Out of a total construction cost of £727,500 a sum of £22,500 was identified for environmental consideration including landscaping and slabbing. No allowance was made in this sum for potential environmental improvements such as granite setts, ornamental walling and cast-iron railings.

Ramsey (ref 106) of the University of Strathclyde was critical of Poyser's paper because he considered ... "The general tone appears to be one of pride that environmental considerations had been accommodated, but it seems that this was achieved only after objections had been received from various amenity bodies ..." Poyser replied that ... "He (the engineer) is limited by extremely tight cash budgets and the financial input is just not available. The public on the other hand want the environmental improvements - but on the other - is very critical of wasting money on supposedly frivolous fringe items" (ref 107).
Philips (ref 108) suggests that seven or eight times more money should be spent on planting schemes and initial maintenance along motorways than is currently the case; he posits the view that the reason for poor highway design in the United Kingdom stems from ... "the utterly inadequate level of investment ..."

In the field of aesthetics (eg visual impact/view from the road), Ashworth (ref 109) describes how the harmonisation of vertical and horizontal tangent points can effect the cost of a project. He outlines the example of the M1 motorway in Northamptonshire where fully phased tangents would have increased the volume of earthworks by 40 per cent. Another large scale project—the proposed West Midlands Rapid Transit System (a linear development similar to a highway) is of considerable interest in view of its high estimated capital cost—some £420,000,000 for 151 kilometres. From this sum the developers have made an allowance of 9 per cent of the total cost towards achieving high environmental standards—by using special finishes, planting and pavings. This figure represents a sum of £37,800,000. (Ref 110).

Brant et al writing on the M54 Design and Construction (ref 111) indicates a figure of 4 per cent of the works cost for environmental considerations to be a reasonable percentage to allocate against the works estimate. In the event this figure proved to be a good pre-estimate. The measures costed entailed environmental treatment such as noise bunds, additional landscaping, planting, lowering sections of the motorway (into cuttings) and the provision of off-site earth mounding. The 4 per
cent represented an approximate capital sum of £500,000.

In his paper the "Economy and the Environment", Sabey (ref 112) outlined Leicestershire County Council's road building programme. He noted that the capital value of the works had expanded from £3,000,000 in 1979 to a maximum of circa £16,000,000 in 1986. Sabey emphasised that the programme had been achieved by a 'soft approach' and explained that this meant paying particular regard to environmental issues, landscaping and design. He argued that this approach to design had made the new road proposals publicly acceptable and had by implication expedited his County's programme.

Watts (ref 113) discussing environmental impact in connection with the M25 in Kent, states that mitigation was executed by retaining all earthworks from cuttings on site (500,000 m³). This material was used to construct noise bunds and landscape areas. Several of these facilities enabled re-contouring to take place around the site and thus enabling much of the land to be returned to agriculture.

Bridle et al (ref 114) examined the evaluation of new highways with particular regard to the groupings identified in the Leitch Report (ref chap 6.2). The paper looked at various methods of reducing subjective judgements to a mode which might be more publicly acceptable and understandable, for example by allocating money values capital to individual environmental impacts. The paper was
summarised by recommending further research into methods of evaluation aimed at providing an overall assessment of the combined effects of Leitch's environmental impacts.

7.3.2 International published sources

Examples of mitigation measures involving capital costs at Groningen and Overbosch in the Netherlands were described by Nije (ref 115). Measures such as 'depressed' road construction (road in cutting or with earth mounds) and terraced acoustic walls including gardens were made an integral part of the highway design. Nije found that the 'depressed' road had cost less to build than either at-grade or elevated options.

In the USA, Yamanaka (ref 116) in his paper to the American Society of Civil Engineers outlined the social and environmental impacts associated with the Edens Reconstruction Project (Inter-State Freeway). The State Project Engineer mitigated environmental impact by using the capital sum $3,300,000 saved from the original tender and advantage was taken of re-cycling surplus unsuitable soil and other materials. Emphasis was placed on landscaping with the proviso that it must be provided at a reasonable cost with regard to the total value of the project - a capital sum of circa $150,000,000.

The State Highway Authority in Colorado carried out the Inter-State highway improvement located at the Glenwood Canyon. Considerable importance was placed on minimising environmental impact by the
construction of terraces, viaducts and re-vegetation. Trapani and Beal (ref 117) describes the design and construction of this scheme and examines the mitigation measures - two examples are shown in Figs 12 and 13. The authors further outline how the scheme total capital cost was increased as a result of environmental concern.

Hassan and Martin (ref 118) examined environmental protection costs in Saskatchewan, Canada in particular the 14.5 kilometre extension to Highway No 13 constructed at a total cost of $1,000,000. The capital cost of implementing environmental mitigation measures is as shown in table 6.

<table>
<thead>
<tr>
<th>Capital Cost of each Measure</th>
<th>Percentage Mitigation of Total Scheme Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>E I Assessment</td>
<td>28,000</td>
</tr>
<tr>
<td>Archeological Programme</td>
<td>77,000</td>
</tr>
<tr>
<td>Wild Life Monitoring</td>
<td>30,000</td>
</tr>
<tr>
<td>Sideslope flattening (earthworks)</td>
<td>16,000</td>
</tr>
<tr>
<td>Re-vegetation</td>
<td>3,000</td>
</tr>
<tr>
<td>Borrow Pit Restoration</td>
<td>4,000</td>
</tr>
<tr>
<td>Other Environmental Works</td>
<td>40,000</td>
</tr>
<tr>
<td>Total for Mitigation Measures</td>
<td>198,000</td>
</tr>
</tbody>
</table>

Table 6

Please note that the figures above exclude EIA (Environmental Impact Assessment). The total capital costs of environmental mitigation measures, Highway 13, Saskatchewan, Canada (1979 prices) are as shown in the table above.
DISTURBED AREA WITH CANTILEVER AND RETAINING WALL

DISTURBED AREA WITH RETAINING WALL

DISTURBED AREA WITH FILL SLOPE

USE OF RETAINING WALLS

FIGURE 12

SMALL EXPOSED WALL HEIGHT

PLANTINGS TO SCREEN SMALLER, MORE HUMAN SCALE STRUCTURAL ELEMENTS

PREFERRED UPHILL CUT TREATMENT

FIGURE 13
The Department of Highways and Transport responsible for roads in Canada has estimated that for budgeting purposes the total cost of implementing environmental protection is of the order of £2000/km (1983 Costs) for implementing the Environmental Impact Analysis, and £1000/km (1983 Costs) for mitigation measures. These figures the authors suggest are applicable to all road types in Canada (ref 119).

Weck et al (ref 120) outlines the environmental process in connection with the design of the Trenton Complex, New Jersey which involved the creation of a $3,000,000 wetland. Various combinations of structures and earth embankments were used for environmental purposes.

Green (ref 121) discusses the approach by engineers in overcoming objections to the design and construction of the Inter-State Highway No 78 through the Watchung Reservation. Although total environmental costs cannot be calculated - much of the scheme costs were directly related to the reduction of 'wildlife' severance by constructing a 'wildlife' bridge at a cost of $4,000,000. To reduce noise in the park section, sound barriers were introduced at a cost of $15,000,000. The concrete walls were constructed in special finishes, textures and colours to provide a more sympathetic interface with the surroundings.
### Capital Costs of Environmental Mitigation Measures

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Mitigation Measure</th>
<th>Mitigation Cost £</th>
<th>Scheme Total Cost £</th>
<th>% Mitigation of Total Cost %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halifax Town Centre Distributer</td>
<td>Special Materials, Landscaping</td>
<td>22,500</td>
<td>727,500</td>
<td>3%</td>
</tr>
<tr>
<td>M1 Motorway Northamptonshire (Earthworks)</td>
<td>Phasing horizontal and vertical tangent points</td>
<td>-</td>
<td>-</td>
<td>+ 40% increase in earthworks</td>
</tr>
<tr>
<td>West Midlands R.T. System</td>
<td>Comprehensive coverage</td>
<td>37,800,000</td>
<td>420,000,000</td>
<td>9%</td>
</tr>
<tr>
<td>M54 Motorway Telford</td>
<td>Landscaping, earthworks, noise mounds</td>
<td>560,000</td>
<td>13,000,000</td>
<td>4%</td>
</tr>
<tr>
<td>Leicester District Distributer and L.C.C. Programme</td>
<td>Landscaping</td>
<td>-</td>
<td>-</td>
<td>Indicated and increase in costs</td>
</tr>
<tr>
<td>M25 Swanley - Sevenoaks Kent</td>
<td>Landscaping, Additional Land-Take Amenity Bunds</td>
<td>Not given</td>
<td>Not given</td>
<td>Indicated increased earthworks costs</td>
</tr>
</tbody>
</table>

**TABLE 7**

United Kingdom Published Sources
### Capital Costs of Environmental Mitigation Measures

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Mitigation Measure</th>
<th>Cost</th>
<th>Total Cost</th>
<th>% Mitigation of Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groningen and Overbosch Netherlands</td>
<td>Acoustic Walls, depressed road, Landscaping</td>
<td>Not given</td>
<td>Not given</td>
<td>No costs but preferred depressed road on cost grounds</td>
</tr>
<tr>
<td>Edens Project Chicago USA</td>
<td>Revegetation, Re-cycling, Landscaping</td>
<td>3,300,000</td>
<td>150,000,000</td>
<td>2.2% (indicate that Mitigation Costs 'reasonable')</td>
</tr>
<tr>
<td>Glenwood Canyon Project, Colorado, USA</td>
<td>Revegetation, Planting, Landscaping, Earthworks, Structures</td>
<td>Not given</td>
<td>300,000,000</td>
<td>No costs available</td>
</tr>
<tr>
<td>Highway 13 Saskatchewan, Canada</td>
<td></td>
<td>170,000</td>
<td>1,000,000</td>
<td>17%</td>
</tr>
<tr>
<td>Department of Highways Saskatchewan, Canada</td>
<td>General Mitigation Measures</td>
<td>1000/km</td>
<td>-</td>
<td>Varies $1000/km budget figure for all schemes</td>
</tr>
<tr>
<td>Crosswicks Creek, New Jersey, USA</td>
<td>Woodlands Creation</td>
<td>3,000,000</td>
<td>17,000,000</td>
<td>17% +</td>
</tr>
<tr>
<td>Inter State 78, California, USA</td>
<td>Earthworks Sound Barriers Structures</td>
<td>19,000,000</td>
<td>111,000,000</td>
<td>17% +</td>
</tr>
</tbody>
</table>

**TABLE 8**

International Published Sources
7.5 THE CAPITAL COST OF ENVIRONMENTAL IMPACT MITIGATION MEASURES
IN RESPECT OF RECENTLY CONSTRUCTED OR PLANNED HIGHWAY SCHEMES

7.5.1 The Approach to Costing

Chapters 7.3 and 7.4 illustrate how environmental impact mitigation measures have been valued in terms of capital cost. These costs were obtained from United Kingdom and International sources typically from published papers in the Proceedings of the Institution of Civil Engineers, the Institution of Highway and Transportation Engineers and the American Society of Engineers.

The mitigation measures listed in Tables 7 and 8 cover the following elements, viz;

Landscaping,
Special materials,
Aesthetic considerations,
Noise mounds,
Re-vegetation,
Planting,
Noise insulation,
Special structural finishes,
Acoustic walls and fences,
Off-site earthworks and planting.

A synthesis of these measures was obtained and contained in a letter circulated to Highway Authorities and Consultants acting for the
Department of Transport requesting details of schemes including costs of environmental mitigation measures and associated mitigation engineering details. (Request letter in Appendix C).

The Authorities contacted were located in the Midlands of England to provide a degree of consistency for the purposes of comparison with Derbyshire County Council highway schemes.

7.5.2 Environmental mitigation costs and details built into schemes located in the Midlands of England

Summary in table 9.

7.5.3 Environmental mitigation costs and details built into schemes located in Derbyshire and designed and/or constructed by the Derbyshire County Council

Summary in table 10.
7.6 A REVIEW OF THE CAPITAL COSTS DATA ASSOCIATED WITH
ENVIRONMENTAL IMPACT MITIGATION MEASURES

Tables 7, 8, 9 and 10 summarise details of environmental mitigation measures taken by Highway Authorities or Consulting Engineers in respect of new highway schemes located in the United Kingdom and abroad.

7.6.1 United Kingdom published sources (Table 7)

Table 7 illustrates capital costs associated with United Kingdom projects which were the subject of published papers. The 3 schemes fully priced up show environmental mitigation capital costs (as a proportion of total scheme cost) in the range 3 per cent to 9 per cent.

The example of the M1 motorway earthworks in Northamptonshire has no supporting costs - but can show an increase in earthworks of 40 per cent. Similarly Leicestershire County Council has no specific details but implies that the roads programme was aided by taking a pro-environmental approach - whilst suggesting that it does increase capital costs.

7.6.2 International published sources (Table 8)

The American examples are well documented with a useful degree of detail for use by practicing engineers - however whilst an increase in costs due to mitigation measures is acknowledged, no breakdown of individual costs is provided.
The Dutch example is given in some detail and illustrates the cheapest approach is via the depression of the highway, however no specific costing information is provided. The Canadian example does give a detailed account of mitigation costs and confirms that these costs are 17 per cent of the total scheme costs. This example from Saskatchewan also provided a figure of $1000/kilometre in connection with budgeting for environmental mitigation measures.

7.6.3 Schemes in the Midlands of England (Table 9)

These schemes listed in Table 9 are those Authorities and Consulting Engineers responsible for inter-urban schemes designed and constructed in the Midlands. The environmental mitigation costs fall into a range 1.77 per cent to 11.1 per cent of total costs.

7.6.4 Schemes in Derbyshire (Table 10)

These schemes which have been designed and constructed by Derbyshire County Council provide sufficient detail to identify the costs of environmental mitigation measures. These are in the range of 0.26 per cent to 19.23 per cent of total scheme costs.
<table>
<thead>
<tr>
<th>Scheme</th>
<th>Year</th>
<th>Total Value</th>
<th>Rural Semi</th>
<th>Planting &amp; Rural</th>
<th>Screen</th>
<th>Fencing</th>
<th>Noise Insulation</th>
<th>Extra Earthworks &amp; Land</th>
<th>Structural</th>
<th>Total Environ. Cost</th>
<th>Environmental Mitigation as Percentage of Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A47 Uppingham By-Pass</td>
<td>1981</td>
<td>1,100,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>57,670</td>
<td>-</td>
<td>64,600</td>
<td>122,270</td>
<td>11.1</td>
</tr>
<tr>
<td>A38 Alrewas By-Pass</td>
<td>1985</td>
<td>4,000,000</td>
<td></td>
<td></td>
<td>13,500</td>
<td>-</td>
<td>25,500</td>
<td>10,000</td>
<td>-</td>
<td>65,000</td>
<td>1.62</td>
</tr>
<tr>
<td>A38 Burton-on-Trent By-Pass</td>
<td>1985</td>
<td>4,000,000</td>
<td>15,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40,000</td>
<td>165,000</td>
<td>4.12</td>
</tr>
<tr>
<td>Tamworth/Bole Brick Junction</td>
<td>1984</td>
<td>2,000,000</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>65,000</td>
<td>-</td>
<td>-</td>
<td>95,000</td>
<td>4.75</td>
</tr>
<tr>
<td>Southern Loop</td>
<td>1985</td>
<td>2,000,000</td>
<td></td>
<td>30,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>90,000</td>
<td>1.77</td>
</tr>
<tr>
<td>Eastern Link</td>
<td>1985</td>
<td>1,005,000</td>
<td></td>
<td>39,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>39,000</td>
<td>2.98</td>
</tr>
<tr>
<td>A6 Chapel By-Pass</td>
<td>1984</td>
<td>17,000,000</td>
<td>147,000</td>
<td></td>
<td>-</td>
<td>45,000</td>
<td>12,000</td>
<td>100,000</td>
<td>304,000</td>
<td>5.5</td>
<td>6.5</td>
</tr>
<tr>
<td>M42 Polesworth (M)</td>
<td>1984</td>
<td>10,920,000</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10,920,000</td>
<td>5.5</td>
</tr>
<tr>
<td>M42 Polesworth (S)</td>
<td>1985</td>
<td>8,350,000</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8,350,000</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Table 9

Environmental Mitigation Costs and Details Built into Schemes Located in the Midlands of England.
<table>
<thead>
<tr>
<th>Scheme</th>
<th>Year</th>
<th>Total Value</th>
<th>Rural</th>
<th>Semi Rural</th>
<th>Planting &amp; Landscaping</th>
<th>Screen Fencing</th>
<th>Noise Insulation</th>
<th>Extra Earth-Works &amp; Land</th>
<th>Structural</th>
<th>Total Environ. Cost</th>
<th>Environmental Mitigation as Percentage of Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A624 Hayfield Relief Road</td>
<td>1977</td>
<td>730,000</td>
<td>✓</td>
<td></td>
<td>10,000</td>
<td>-</td>
<td>10,000</td>
<td>1,300</td>
<td>4,210</td>
<td>25,000</td>
<td>3.5</td>
</tr>
<tr>
<td>A6020 Ashford Relief Road</td>
<td>1978</td>
<td>510,000</td>
<td>✓</td>
<td></td>
<td>10,000</td>
<td>-</td>
<td>-</td>
<td>12,200</td>
<td>75,900</td>
<td>98,100</td>
<td>19.23</td>
</tr>
<tr>
<td>A610 Langley Mill By-Pass</td>
<td>1982</td>
<td>2,000,000</td>
<td>✓</td>
<td></td>
<td>11,000</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16,000</td>
<td>0.8</td>
</tr>
<tr>
<td>A610 Ripley By-Pass</td>
<td>1983</td>
<td>2,100,000</td>
<td>✓</td>
<td></td>
<td>14,000</td>
<td>2,430</td>
<td>-</td>
<td>1,220</td>
<td>-</td>
<td>17,650</td>
<td>0.8</td>
</tr>
<tr>
<td>A6175 North Wingfield Diversion</td>
<td>1985</td>
<td>510,000</td>
<td>✓</td>
<td></td>
<td>4,000</td>
<td>-</td>
<td>1,000</td>
<td>-</td>
<td>1,500</td>
<td>6,500</td>
<td>1.3</td>
</tr>
<tr>
<td>A5002 Spring Gardens Buxton Inner Relief Road</td>
<td>1986</td>
<td>1,100,000</td>
<td>✓</td>
<td></td>
<td>3,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>22,000</td>
<td>2.3</td>
</tr>
<tr>
<td>A607 Ilkeston Inner Relief Road (Est)</td>
<td>1987</td>
<td>6,500,000</td>
<td>✓</td>
<td></td>
<td>67,000</td>
<td>60,000</td>
<td>6,000</td>
<td>3,650</td>
<td>-</td>
<td>136,650</td>
<td>2.1</td>
</tr>
<tr>
<td>A617 Hasland By-Pass</td>
<td>1976</td>
<td>2,260,000</td>
<td>✓</td>
<td></td>
<td>10,000</td>
<td>5,000</td>
<td>2,500</td>
<td>10,500</td>
<td>7,000</td>
<td>34,000</td>
<td>1.5</td>
</tr>
<tr>
<td>A619 Brimington By-Pass (Est)</td>
<td>1987</td>
<td>7,125,000</td>
<td>✓</td>
<td></td>
<td>23,000</td>
<td>28,000</td>
<td>-</td>
<td>145,000</td>
<td>-</td>
<td>197,000</td>
<td>2.8</td>
</tr>
<tr>
<td>A619 Staveley By-Pass (Est)</td>
<td>1976</td>
<td>7,000,000</td>
<td>✓</td>
<td></td>
<td>18,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18,000</td>
<td>0.26</td>
</tr>
<tr>
<td>A617 Glapwell By-Pass (Est)</td>
<td>1973</td>
<td>715,000</td>
<td>✓</td>
<td></td>
<td>2,000</td>
<td>1,000</td>
<td>2,000</td>
<td>3,000</td>
<td>-</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>A617 Pleasley By-Pass</td>
<td>1975</td>
<td>723,850</td>
<td>✓</td>
<td></td>
<td>2,500</td>
<td>3,000</td>
<td>3,000</td>
<td>17,500</td>
<td>25,500</td>
<td>3.53</td>
<td></td>
</tr>
</tbody>
</table>

Table 10

Environmental Mitigation Costs and Details Built into Schemes Located in Derbyshire and Designed by Derbyshire County Council
An inspection of tables 7 to 10 reveals that Highway Authorities in the United Kingdom and Internationally do invest capital in environmental mitigation measures in new highway schemes.

The capital cost input to schemes to service these measures are observed to be in the range 0.26 per cent to 19.23 per cent of the final scheme costs.

This range of percentage costs would appear to have no particular significance or pattern. For example the United Kingdom schemes in Table 7 and the English Midlands schemes in table 9 - range respectively 3 per cent to 9 per cent and 1.7 per cent to 11.1 per cent. The schemes listed in table 7 are all inter-urban (or linear schemes) except for the Halifax Town Centre Distributor which is an urban project. This scheme which provides the lowest percentage of mitigation costs is also the lowest scheme capital cost. With respect to the inter-urban aspects of tables 7 and 9 a reasonable comparison might be made, viz: M54 Telford motorway and the M42 motorway, ie 4 per cent and 5.5 per cent respectively.

However a paradox exists in respect of table 9 where the Chapel-en-le-Frith bypass designed to motorway standards and recently constructed in the Peak District National Park surprisingly has only 1.78 per cent of scheme costs allocated to environmental mitigation measures.
The highest figures are 17 per cent against Route 13 Saskatchewan (Table 8) and 19.23 per cent against the A6020 Ashford Relief Road (Table 10). There is no similarity however between the schemes in that Route 13 (rough construction) is essentially set in Canadian forested terrain and Ashford Relief Road is close to a scenic village in the Peak District National Park.

Tables 9 and 10 contain further examples of anomalies, viz: Hayfield Relief Road at 3.5 per cent and Uppingham bypass at 11.1 per cent, both schemes are located in conservation areas and of high scenic quality.
THE LIMITATIONS OF THE CAPITAL COSTS DATA ASSOCIATED WITH ENVIRONMENTAL IMPACT MITIGATION MEASURES AND THE COMMERCIAL ELEMENT

The data is that which is as listed in Tables 7, 8, 9 and 10 inclusive (chapters 7.3.1, 7.3.2, 7.4.1, 7.4.2). The range of percentage mitigation costs extends from a minimum of 0.26 per cent to a maximum of 19.23 per cent. In terms of total scheme value and concomitant environmental protection costs, no definite trend can be established which could be deemed useful as a design tool. However it is significant to note that every scheme does in fact have a capital input in respect of environmental impact mitigation.

In schemes costing over £15,000,000 a figure of approximately 6 per cent for mitigation costs could be inferred to represent certain inter-urban all purpose dual-carriageways and motorways. However within this classification the lower figure of 1.78 per cent (Chapel-en-le-Frith Bypass) suggests caution in attempting to draw too many conclusions. This is also apparent in International examples - if the figure of $1000/km (1983 value) was applied to United Kingdom schemes the value would be (by analysis and inspection) generally far too low. On the basis of the data it appears unrealistic to compare schemes from different types of terrain.
7.9 AN INTERPRETATION OF ALL UNITED KINGDOM AND INTERNATIONAL DATA OUTLINED IN CHAPTERS 7.3 AND 7.8 WITH PARTICULAR RESPECT TO THIS METHOD OF OBTAINING THE COSTS OF ENVIRONMENTAL MITIGATION MEASURES

The data review (chapter 7.6), the data examination (chapter 7.7) and the associated limitations (chapter 7.8) indicate that no trend can be deduced - such that useful information can be applied to either budgeting or pre-estimate exercises required within the Highway Design Network (chapter 2.5). It was noted that capital costs were invariably allocated for environmental mitigation measures.

No guidance can be given for a scheme in any particular circumstance from the commencement of route location through to detailed design - it being a matter of working through the various design stages in the appropriate detail required by Highway Design Methodology (chapter 2.5). It is noted that final scheme details including environmental mitigation measures cannot be resolved until all interested parties have been consulted, viz: effected householders, land owners, committee members, Statutory Authorities, civic societies and so on.

The replies to the request letter (Appendix C) were generally helpful with costs or percentage costs attached to each mitigation measure. The percentage of environmental mitigation costs was generally less than 5 per cent (for 66 per cent of United Kingdom schemes including Derbyshire). This low percentage was viewed with some scepticism by many engineers because the innate professional judgement was that a higher
value should be given to a new highway relieving a 'hard pressed' community from the progressive pressure of environmental impacts. For example the A6 Trunk Road Chapel-en-le-Frith By-pass has a value of 1.78 per cent of total costs against environmental impact mitigation and considered by the design consultants as rather low and unrepresentative of the new environmental position. The current preferred route for the Brimington bypass has an environmental value of 2.8 per cent - this figure was considered rather low by the objectors to the original southern route (ref 135).

The County Engineer and Planning Officer for Devon County Council felt unable to reply in detail to the data request letter - he suggested that planting costs for new highway schemes came in the range of 1.5 per cent to 5 per cent of overall scheme costs. However he was not prepared to discuss possible costs of other environmental matters such as aesthetics, noise, community severance, visual obstruction and so on. These elements he explained were part of the integral design process and not capable of individual itemisation and costing (reference Appendix D).

This problem highlighted by the County Engineer of Devon and supplemented by examples in Derbyshire, (0.8 per cent for Ripley bypass and Langley Mill bypass and 0.26 per cent for the proposed Staveley bypass suggest that much of the total cost of environmental mitigation is "hidden" or concealed in terms of the integral design capital costs concerning the new highway which includes elements such as the vertical and horizontal alignments and associated landscaping, bridges, and other structures.
The capital cost considerations of each impact listed in the Manual of Environmental Appraisal (Chapter 7.2) outlines how many of the environmental elements cannot be valued in terms of capital costs. It is apparent that the current methodologies cannot put capital values on environmental impacts such as a change of view, landscapes, landscape changes, community severance and so on. The data in Tables 7-10 inclusive with chapters 6.0 to 6.5.2 inclusive and 7.0 to 7.9 inclusive illustrates the problem of isolating elements of environmental impacts and subsequent costing to form a total capital cost. It is these unquantifiable environmental impacts which are considered to be concealed in terms of capital costs.

In connection with concealed costs, the Ministry of Transport's publication in 1967 "Roads in the Landscape" (ref 58) stated that, "... Justly to reconcile the claims of utility and amenity will always be difficult, for though you can reckon the cost of a motorway at so much a mile, who can evaluate the view. Nevertheless when for instance it was a question of either disrupting Charnwood Forest by the M1 motorway or making a half mile detour at extra cost the Minister of the day chose the latter civilised alternative with the country's general approval ...." 

This considered statement by Clough William-Ellis provides an indication that the extra length of the M1 motorway in the Charnwood Forest, Leicestershire might be the way ahead to form the basis of an approach to
incorporate all the environmental factors in one capital cost. This approach will form a hypothesis for an addition to the Highway Design Methodology such that the environmental mitigation costs could be isolated and identified as a single sum of capital funds. This is the factor which Bridle et al. suggested that further research should be made into the overall assessment of environmental impacts (ref 122).

In all the schemes outlined in chapters 7.4 and 7.5 there is no doubt that the data obtained cannot possibly represent all environmental impacts and so when added together into one whole value of capital cost does not represent the total environmental impact costs. This is the point the Devon County Engineer made in his letter (Appendix D), that the environmental issues were "not seen by him in isolation but were an integral part of the design process."

The environmental aspects of design and aesthetic issues in particular are summed up by Holden (ref 16) in his lecture to the Institution of Civil Engineers "... it is of course a thing of the mind and is not easily propounded ..."
8.0 A HYPOTHESIS FOR A COMMERCIAL ROUTE METHODOLOGY TO
ESTABLISH THE OVERALL CAPITAL COST OF ENVIRONMENTAL
MITIGATION MEASURES

8.1 A REVIEW OF FACTORS LEADING TO A HYPOTHESIS

The Manual of Environmental Appraisal (ref 89) outlines how out of the Leitch Reports (ref 79, ref 85) the various environmental factors could be identified and considered. Several factors were shown to have the ability to be evaluated - such as traffic noise and construction disturbance; however most of the factors could not be evaluated in capital cost terms. Chapter 7 illustrated how various environmental factors can be represented by capital costs using British and International data. The results provided a range of environmental mitigation costs and illustrate how each scheme had an element of mitigation integral to it - but with no consistency in terms of scheme type, terrain, landscape or as a percentage of overall costs. A major consideration was found in the approach involved in treating each environmental impact in turn and summating into a "final" total - this total still does not appear to represent the total environmental capital cost of a scheme because of the unquantifiable environmental factors and the related concealed capital costs. This consideration is supported by Clough Williams-Ellis (ref.58) Holden (ref. 16) and Bridle et al (ref.122).
8.2 FACTORS ESSENTIAL FOR INCLUSION IN A DESIGN METHOD

HYPOTHESIS - ENVIRONMENTAL AND COMMERCIAL

Bridle et al (ref. 122) recommended that further research should be pursued - including the overall assessment of the combined effect of environmental impacts. Whilst he did not confine his work to the capital cost element of highway investment he was prepared to consider the commercial concept of "trading one thing against another" backed up by monetary values. The spirit of this paper is in harmony with the current views of the Treasury and by the County Council in respect of value for money and in the full understanding of how capital funds are spent on behalf of the taxpayer and the ratepayer. (ref 123).

The Manual of Environmental Appraisal's groups and environmental impacts are now well documented and will be included in an overall approach. This position is also supported by Statutory provisions particularly with certain impacts such as Listed Buildings and construction noise as outlined in chapters 6 and 7.

Local and national objectives are also factors integral to the highway design preparation - either because of legal considerations, as in the case of the TPP (Transport Policies Programme) or advisory as in certain local objectives outlined in chapter 4.
8.3 THE CURRENT HIGHWAY DESIGN METHODOLOGY AND ASSOCIATED CAPITAL COSTS AFFECTING A HYPOTHESIS

The current highway design methodology outlined in chapter 2.5 requires calculations to identify capital costs at various stages of the design. These are inter alia, pre-estimates, preliminary design, detailed design - including earthworks, pavement design, structures and traffic control; a consistent measurement approach is adopted by the use of standard documents, these are typically the Standard Method of Measurement (ref. 41) Specification for Road and Bridgeworks (ref. 40) and Road Note 29 (ref. 36) and its derivatives. For public roads the use of these documents and all Department of Transport publications are a statutory requirement.

The preliminary design stage includes the examination of various alternative routes on an iterative basis containing sufficient engineering and cost details to form a recommendation for a preferred route. All alternative routes have to fulfil the local and national objectives as described in chapter 4. The premier objective usually is the removal of through traffic from the affected area which may range in extent from a small village to a conurbation.

The iterative method of route selection must also fulfil those legal requirements set down in the local and national objectives notably the avoidance of listed buildings and the need for economy both in design and construction. Local knowledge is an important factor and the design engineer has to take into account any related issues.
- this is particularly important so that social and environmentally sensitive areas (politically sensitive) can be avoided (ref. 124). Examples of such areas are junior schools, church yards, playing fields, housing estates and so on.

At all stages of scheme preparation, Williams (ref. 124) recommends that the selection of the preferred route must be on a practical basis and hence economic - from a design preparation and construction viewpoint. On this premise the engineer should keep design and preparation costs down by avoiding contentious routes or corridors assuming viable alternatives are reasonably available. This approach accords with the Local and National Objectives outlined in chapters 4.

8.4 A SYNTHESIS OF FACTORS IN THE DEVELOPMENT OF THE HYPOTHESIS

Clough Williams-Ellis' view (ref. 58) that the M1 motorway would have cost more by avoiding Charnwood Forest provides an initial basis for the hypothesis. The fact that the M1 was re-routed around the forest at extra cost is in accord with the view that the longer route had cost more than the shorter but "less civilised" alternative. The difference in cost between the two routes reflected that sum which the public was prepared to pay (via the tax payer) to protect an area of high natural beauty.

Williams (ref. 124) recommends avoiding contentious routes many of which might prove to be cheaper - through being shorter or simpler
from an engineering viewpoint. The schemes outlined in Tables 7, 8, 9 and 10 (ref. chapter 7) could have been cheaper (in capital cost terms) if the environmental mitigation measures had been omitted. Provided that the legal requirements concerning environmental impacts were met, these schemes could have been constructed for a smaller capital cost than the existing and accepted scheme. This consideration would also be applicable for routes crossing politically sensitive areas, and provided that the statutory provisions and local and national objectives had been met - cost savings would have to be found to justify pursuing this particular route or corridor.

A current example of a politically and environmentally sensitive scheme is the M40 motorway proposal to the north of Oxford and in particular through the area known as Otmoor. Fig 14 on the following page illustrates this motorway proposal in outline. (ref. 125).

These proposals show the Department of Transport's preferred route - a line through part of the Otmoor Site of Special Scientific Interest (SSSI) and other sensitive areas, saving £2,400,000 at 1984 prices against the alternative route to the east preferred by the principal objectors.

This consideration with regard to weighing the balance between commercial and environmental factors was defined by the Department of Transport as follows:-

"The basic position is that we have a capital cost and an operating cost advantage to the published proposals (when
compared to the eastern alternative) to weigh against a landscape and possibly to some extent a natural conservation argument." (ref. 126).

The Inspector at the Public Inquiry reported (ref. 127) on viewing Otmoor ... "I accept the area is rather unique ... it would have a serious effect on other aspects of the moor particularly near Fencott and Murcott (part of Oxford's green belt)". The M40 motorway extension report on the same inquiry ... "in an area where there are extremely important historical landscapes, ancient forests, SSSI's and rare species of flora and fauna which need conservation then the landscape situation in my view becomes of paramount importance in the choice of route". (ref. 127).

The Department of Transport and the Department of the Environment agreed to reconsider the Otmoor route (following the report of the Public Inquiry) and decided to fully reconsider the development of the eastern route. Bixby (ref. 72) outlined a case for the environment in respect of the alternative route cognizant of the extra £2,400,000 in extra capital costs. The original route preferred by the Department of Transport was shorter and cheaper and was therefore financially more attractive than the eastern alternative - this route is said to be a better COMMERCIAL proposition. These routes are shown in fig. 14.
Fig. 14.

M40 Oxfordshire showing DTP preferred route with eastern alternative.
8.5 **THE COMMERCIAL ROUTE HYPOTHESIS**

The intention of this hypothesis as developed in chapters 8.1 to 8.4 is that it can be added to and included in the Highway Design Methodology outline in chapter 2. Consequently the hypothesis must conform to all the standards laid down by the Department of Transport in respect of all engineering considerations. The Commercial Route therefore must be consistent in all engineering respects with a Preferred Route or any alternative studies by the highway engineer except in such measure it will not avoid sensitive areas. By aligning the Commercial Route through a sensitive area the effect on a given environment is maximised - by comparison with a preferred or other route options where the environmental impact is usually minimised. The legality of any route must also be maintained and in this aspect of design the Commercial Route must concur in every respect. The respective legal aspects are outlined in chapter 6.5.2 and the capital cost elements of each environmental impact are as in chapter 7. Table 5 summarises the quantifiable and unquantifiable impacts in tandem with statutory provisions and local and national objectives.

The environmental impacts containing statutory provisions must be allowed for in estimating the capital cost of the Commercial Route and in this respect the route must be aligned to avoid those elements of heritage and conversation areas which are so protected eg listed buildings. Fig 15 on the following page illustrates an example of an abstract by pass containing the Commercial Route, the Preferred Route and various other alternative routes.
ABSTRACT BYPASS.
SHOWING PREFERRED AND OTHER ALTERNATIVE ROUTES, AND THE COMMERCIAL ROUTE.
It should be noted that not all heritage and conservation areas are protected by statutory provision and in this respect many sites of ecological interest are placed in this category.
8.6 EQUATION FOR COMMERCIAL ROUTE HYPOTHESIS AND SUMMARY OF
ESSENTIAL CAPITAL COST ELEMENTS INTEGRAL TO THE COMMERCIAL
ROUTE AND THE PREFERRED ROUTE

8.6.1 The Preferred Route capital cost (P) will involve an
appropriate works cost, viz. Wp.

Wp will include all the capital costs necessary to satisfy
engineering, legal and public satisfaction criteria. The following
environmental impacts will be taken into full consideration and
incorporated into the final design:-

Heritage and conservation areas, (HC)
(It will be assumed that the route will be engineered to avoid listed
buildings, monuments and archeological sites, from within the HC
category and therefore Wp will be assumed to include the appropriate
costs. It is also noted that certain Heritage and Conservation
areas are not statutorily protected ref. chapter 6).

Visual (VI)
(Intrusion and Obstruction)
Community Severance (CS)
Ecological impact (EI)
Pedestrian and cyclist considerations (PC)
View from the road (V)
Driver stress (S)
Additionally the final capital cost will include:

Noise insulation costs (N)
Agricultural compensation (AC)
Disruption due to construction (IA)
(Injurious affection payments)

The appropriate works cost (Wp) therefore assumes that the (hidden) impacts HC, VI, CS, EI, PC, V and S are an integral part of the final cost.

ie, Wp includes (HC + VI + CS + EI + PC + V + S)p.

Whereas traffic noise (N), agricultural compensation (AC), disruption due to construction (IA) are added on to the final capital cost. \((P)\).

Therefore the final capital cost of the preferred route \((P)\) is as follows:

\[ P = Wp + (N + AC + IA)p \]

8.6.2 The Commercial Route capital cost \((C)\) will involve the appropriate works cost \((Wc)\) minimal to construct the road at the lowest capital cost consistent with legality.

The environmental impact which must be accounted for in the works cost \((Wc)\) must be those elements of heritage and conservation areas which may be affected.
ie, $W_c$ includes the listed buildings, monuments and archeological sites element of heritage and conservation areas as for the Preferred Route and as in chapter 8.6.1, ie. these sites will be avoided in the alignment of the Commercial Route, however Heritage and Conservation areas not protected by Statutory Provisions will be available for consideration.

ie $W_c$ includes HC (as defined above).

Whereas noise ($N$) agricultural compensation ($AC$) and disruption due to construction ($IA$) (Injurious Affection) are added to the final capital cost ($C$).

Therefore the final capital cost of the Commercial Route ($C$) is as follows:

$$C = W_c + (N + AC + IA)c.$$
Summary of essential differences in capital costs between the Preferred and Commercial Routes

The difference in capital cost between the routes is a sum of money equivalent to a value of the unquantifiable environmental impacts viz:

Heritage and conservation (HC) + visual impact (VI) + community severance (CS) + ecological impact (EI) + pedestrian and cyclist consideration (PC) + view from the road (V) + driver stress (S).

The listed building ancient monument and archeological element of heritage and conservation areas which are avoided in both Preferred and Commercial routes so that this selective impact is included in the respective works capital costs, ie $W_p$ and $W_c$.

So that in summary:

Preferred route capital cost $P = W_p + (N + AC + IA)_p$

Commercial route capital cost $C = W_c + (N + AC + IA)_c$
8.6.4 Capital cost of unquantifiable (hidden) environmental impacts (E)

Therefore if preferred route capital cost is (P)

\[ P = W_p + (N + AC + IA)p \]

and Commercial route capital cost is (C)

\[ C = W_c + (N + AC + IA)c \]

Therefore the Hidden Capital Costs (E) = P - C

and E as a percentage of P = E%

In practice the total works cost (or estimate) of the Preferred Route less the total works cost of the Commercial Route is a capital sum equivalent to an amount of cash the public are prepared to pay to protect a particular environment effected by the construction of a new highway.

8.6.5 Inclusion of Commercial Route Methodology into the highway design network

The equations developed in chapters 8.6.1 to 8.6.4 illustrates how the sum of the whole capital cost of the unquantifiable (hidden) environmental impacts are estimated.

This methodology in tandem with the sifting of options which is
integral to route selection (ref Chapter 8.1 to 8.5) may be shown in flow diagram form.

The salient features of the Commercial Route Methodology are combined in Figures 16 and 29 to illustrate how the methodology may be incorporated into the current highway design process.
COMMERCIAL ROUTE INCORPORATED INTO DESIGN NETWORK
(EXTRACT FROM FIGURE 1)

DERBYSHIRE COUNTY COUNCIL

ERIC HOOK, C.Eng., M.IC, M.H.T.
County Surveyor.

FIGURE 16

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CHAPTER 9

9.0 APPLICATION OF COMMERCIAL ROUTE HYPOTHESIS TO A TEST EXAMPLE (NO 1)

9.1 BACKGROUND TO TEST EXAMPLE

The test example is the A619 Brimington Bypass proposal - a scheme located to the north east of Chesterfield forming part of the principal road from Chesterfield to the M1 Motorway at Junction 30.

The scheme is in the 5 year programme based on the Transport Policies and Programme 14 (TPP14) and is scheduled to commence construction in 1991 (ref 128). The proposal to bypass Brimington village has a long history, however the first design consideration occurred when it was incorporated into the County Development Plan of 1951 (ref 129). In 1968 preliminary design works commenced and the basic solution to the Brimington bypass was based on a corridor to the north and south of the village. The former was routed largely through zones of industrial and derelict land coupled with some lower grade agricultural land whilst the latter ran through and closer to park land, recreational and residential areas. In 1972 the County Council (the Highway Authority) submitted a planning application for the bypass based on a route through the southern corridor. The difference in cost between the northern and southern route was estimated at £478,317.00 (September 1973 costs). (ref 130).

The Preferred Route outlined in the above planning application was opposed by a number of groups and in particular many local residents represented
by the pre-1974 Local Authorities. In 1972 consultants were appointed by Chesterfield Rural District Council supported by Chesterfield Borough Council and Staveley Urban District Council. The brief to the consultants (Husband and Partners) was to act for the various Councils in opposing the Derbyshire County Council's preferred route - primarily on environmental and amenity grounds. The thrust of the opposition's argument was to place the proposed Bypass to the North of the Village on a route less detrimental to the local environment. In February 1974 the projected Public Inquiry into the proposals was postponed at the request of the County Council. It was agreed that the consultant's work should continue and be presented in report form (ref 131). The County Council initiated a counter report analysing the content of the consultant's report. (ref 132). The outcome of the analysis was agreement with the objectors that the route to the north of the village would be likely to reduce environmental impact rather more than the route to the South, whilst noting that the route to the North was also more expensive.

The County Council's case maintained that to attract a grant, the higher economic rate of return provided by the southern route was the only way to place the scheme in the Firm Programme. The statement continued ...... "In the future with the total revision of transport grant, grant rules are less likely to be a deterrent to reasonable interpretation of the new policies, but clearly limitations on financial resources will remain". (ref 133).
9.1.1 **A Summary of the County Council's and objectors' proposals with respect to the test example**

The County Council carried out an exercise (ref 133) examining the environmental considerations of each corridor and concluded that the alternative route to the North proposed by the principal objectors was indeed more satisfactory than the preferred route as far as environmental considerations were concerned. However, when the capital cost had been analysed for each scheme the southern corridor was less expensive and consequently remained the County Council's preferred route. The report continued that if environmental factors could be "weighted" in some way in a route selection procedure it could well be reflected in the proposed structure plan for the Brimington/Staveley area. As no creditable methods of selection were available the County Council concluded that route selection would have to take place by a public participation exercise.

9.1.2 **Public consultations**

Following new financial restrictions the County Council decided in October 1978 that it would be financially unrealistic to pursue a single comprehensive improvement for the whole of the A619 route from Chesterfield to the M1 but instead decided to consider the effectiveness of a series of more limited and separate improvements including the test case - the A619 Brimington bypass. The public consultation was held on May 1980 at various venues in the district. Members of the public were provided with a coloured map and a questionnaire showing all the alternative routes with capital costs, traffic flows, existing conditions,
environmental factors, land take, farm land, effect on pedestrians, schools and noise. Other considerations included pedestrianisation systems for the village centre, canal and nature sites, canal tow paths and footpaths (ref 134).

Figure 17 illustrates the alternative routes studied including the original preferred route submitted by the County Council in its planning application of 1972. During the public consultation exercise members of the public attending the exhibitions were asked to answer a questionnaire, first they were asked to consider the main problems along the route. The second asked their preferences for each route, the third related to how their choice was influenced, the fourth asked for general comments on the proposals and the fifth asked where they lived.

An analysis of questionnaires showed that a majority of people considered the industrial northern corridor to be preferable to the recreational and residential southern corridor. The grounds for the preferences were invariably environmental (ref 135).

9.1.3 Analysis of decision making process leading to the current Preferred Route

(a) Pre-1980 Public Consultation Route

From inspection of figure 18 the following observations may be made:

Southern Corridor

1) The pre-1980 preferred route and its derivatives were located to the south of the village.
ii) The routes were closer to residential property.

iii) The routes were located in zones of open land including gardens, park land, farm land and were generally closer to the village centre.

iv) The southern corridor affected more properties.

Northern Corridor

i) No domestic properties were affected.

ii) The least area of residential land and farm land was affected.

iii) A larger area of derelict and open-casted coal board land was affected.

iv) A larger area of industrial land was affected.

b) Route location aspects

The northern corridor followed a natural valley containing existing railways in tandem with the river and canal; the eastern end of this corridor being considerably affected by old and current mine workings, much of the area being in made ground. This latter consideration had been considered a major engineering problem and contributed significantly to early decision making. The southern route whilst shorter and crossing generally undulating ground had no particularly difficult geological conditions.

Southern

The route was closer to the village and included a higher value of property demolition in its capital cost. It was noted that the southern route attracted a higher economic rate of return using cost benefit analysis (refs 135 and 136).
(c) **Relative capital costs**

Referring to figure 18 the capital costs of the preferred routes north and south are as follows:

Northern Route I, £7,125,000.00  
Southern Route I, £6,900,000.00

The capital costs (ref 135) rank in order of cost (1988 values) of all the route options as shown below in Table 11.

<table>
<thead>
<tr>
<th>Route</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern I</td>
<td>£6,900,000</td>
</tr>
<tr>
<td>Northern II</td>
<td>£7,050,000</td>
</tr>
<tr>
<td>Southern II</td>
<td>£7,100,000</td>
</tr>
<tr>
<td>Northern I</td>
<td>£7,125,000</td>
</tr>
<tr>
<td>Northern III</td>
<td>£7,200,000</td>
</tr>
<tr>
<td>Southern III</td>
<td>£7,250,000</td>
</tr>
</tbody>
</table>

*Table 11*
(d) Route Ratification

The Public Consultation Exercise in 1980 was followed by the decision of the Highways and Transport Committee to approve the northern corridor and in particular northern route I. The estimate for northern route I at 1988 prices is £7,125,000, i.e., \[ \text{The Works Cost of Preferred Route (P) = £7,125,000.} \]

Prior to this consultation the preferred route had been in the southern corridor and in particular on southern route I. It should be noted from Table 11 that the cheaper route was not chosen by the public — in fact the public’s choice was the northern corridor which was perceived to have the least environmental impact. It appeared that the public preferred the route/corridor which was furthest from residential areas and which affected a substantial area of community recreational land and Grade 3A farm land and associated severance (ref 135).

9.2 THE CURRENT POSITION WITH THE TEST EXAMPLE — THE A619 BRIMINGTON BYPASS

Figure 18 illustrates the current Preferred Route (northern) and for comparison the pre-1980 Preferred Route (southern). The routes were selected by Public Consultation and by route location/highway design methods outlined in chapter 2. The capital cost was built up on this basis and in particular by means of the Standard Method of Measurement (ref 41) outlined in chapter 2.5. The current preferred route was chosen (in addition to its engineering parameters) by the local population — and in particular by their desire to consider the environmental factors
ALTERNATIVE ROUTES STUDIED AT PUBLIC CONSULTATION STAGE.
TITLE:
THE CURRENT PREFERRED ROUTE & THE
ORIGINAL PRE-1980 PREFERRED ROUTE

KEY
- RESIDENTIAL / URBAN AREAS
- HEAVY INDUSTRY
- PARK LAND
- CREMATORIUM
The current preferred route (Preferred route prior to 1980)
outlined in chapter 6. The planning application was submitted to and approved by the Highway and Transport Committee in 1984. The capital costs of mitigating environmental impacts are outlined in chapter's 6 and 7, and the design requirements for these impacts are considered an inherent part of the Highway Design Process - as outlined in Chapter 2.5. All schemes in table 11 include mitigation costs. It is noted in table 10 that a sum of £196,000 representing 2.8 per cent of the Brimington bypass estimate was allocated to specific environmental mitigation measures.

The difference in capital costs between the current preferred route and the cheapest of the alternatives offered to the public are as shown in table 11. This extra capital sum indicates that the public are prepared in part to provide funds for an improved environment and that the money be allocated to environmental mitigation measures on the basis of the public consultation (ref 135).

A summary of the foregoing is as follows:-

The current preferred route is seen as the most advantageous from an environmental and amenity point of view by members of the public, particularly the residents of the village of Brimington and that they are prepared to sanction their Highway Authority (the County Council) to spend an extra £225,000 for this purpose.
9.3 TEST APPLICATION OF COMMERCIAL ROUTE HYPOTHESIS TO A TEST EXAMPLE (NO 1) – A619 BRIMINGTON BYPASS

Figure 18 shows the current Preferred Route and the pre-1980 Preferred Route, whilst Figure 17 shows a range of alternative routes presented to the public for consultation purposes. The application of the Commercial Route Hypothesis is now applied, commencing with an iterative approach to route selection consistent with a common design speed (ref. chapter 2.5) cognizant of local and national objectives (ref. chapter 4). Figure 19 illustrates every option studied by the scheme design engineers and in addition includes a number of shorter/cheaper routes and "concept" straight line routes.

9.3.1 Synthesis of Local and National Objectives in respect of test example

The Commercial Route Hypothesis requires that it be the cheapest legal route option available irrespective of the environmental impacts which may be created. The legal requirements in connection with the environment must be respected in tandem with Local and National objectives. In order to establish the latter (as described in chapter 4) a table of scheme objectives will be synthesised to produce a convenient listing of the pertinent points relative to a particular scheme. For this example – the Brimington bypass - the scheme objectives are consolidated and shown in table 12.
DIAGRAM SHOWING ALL ROUTES CONSIDERED INCLUDING DISCARDED OPTIONS.

FIGURE: 19.

KEY
- RESIDENTIAL / URBAN AREAS
- HEAVY INDUSTRY
- PARK LAND
- CREMATORIUM

Scale 1:10,000
The rejected route (approved route prior to 1980)

Diagram showing all considered including options.
<table>
<thead>
<tr>
<th>SCHEME OBJECTIVES</th>
<th>NATIONAL OBJECTIVES</th>
<th>LOCAL OBJECTIVES</th>
<th>EXPENDITURE REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Aid economic recovery by reducing travel costs for business and commercial traffic.</td>
<td>Ch 4.1: a, c</td>
<td>Ch 4.2: a, d</td>
<td>Ch 4.3: a</td>
</tr>
<tr>
<td>(b) Improve safety.</td>
<td>Ch 4.1: c, h</td>
<td>Ch 4.2: b, c, g</td>
<td>Ch 4.3: b</td>
</tr>
<tr>
<td>(c) To provide relief for communities suffering from heavy traffic by providing bypasses which continue to form strategic links to motorways.</td>
<td>Ch 4.1: b, f</td>
<td>Ch 4.2: b, f</td>
<td>Ch 4.3: a, b</td>
</tr>
<tr>
<td>(d) Provide for movement of radial through traffic at acceptable speeds with traffic capacity in balance with through routes in adjacent areas.</td>
<td>Ch 4.1: b, e, g</td>
<td>Ch 4.2: b, d, e</td>
<td>Ch 4.3: a</td>
</tr>
<tr>
<td>(e) Conserve and improve the environment.</td>
<td>Ch 4.1: b, f</td>
<td>Ch 4.2: b, c</td>
<td>Ch 4.3: b</td>
</tr>
</tbody>
</table>

**TABLE 12**

Consolidated Scheme Objectives
From table 11 the engineer proceeds with a sifting of route options (ref 124) cognizant of the objectives (a) to (d) from Table 12. However scheme objective., (e) in the case of the Commercial Route is ignored except for the legal requirements set out in chapters 4 and 6.5.2. The sifting of options begins with the existing road and variations to the existing road.

9.3.2 Improvement To Existing Road

This option is shown in figure 19 where the improvements to the existing road can be obtained by a series of minor and connected improvements. However, it is impossible to obtain a consistent 85 kph (50 mph) design speed to satisfy the economic through-route criteria. The land take for full design speed criteria would require most of the village centre (including listed buildings) - which are in part a major aspect of the bypass requirement. This option is therefore discarded at an early stage.

9.3.3 The shortest distance between ends of scheme ('Concept Routes')

The two possible straight line options ('Concept Routes') are as shown on figure 19, but against local and national objectives these must be disregarded because of the magnitude of the cost, some six times the normal rate. Much of the village would have to be demolished to permit such a scheme and therefore mitigates against the principles of economics, society and engineering.
9.3.4 Sifting of the remaining options

Having examined and discarded the road improvement approach and the 'concept route', the next step is to proceed in an iterative manner and examine a series of route options emanating from the village centre. This is accomplished by working out from the centre (from the existing A619 principal road) and out towards the outskirts of the village. Figure 19 illustrates the possible options close to village centre open to the designer. As the test case has a number of routes north and south of the village already well established, the remaining possibility is to search for a Commercial option. To be Commercial the option must be cheaper and also must be consistent with the equation from chapter 8.6.4 i.e.,

\[
\text{Commercial Route Capital Cost (C)} = W_c + (N + AC + IA)c
\]

9.3.5 The Commercial Route - the test example

Figures 17, 18 and 19 illustrate all the legal alternative routes (and the unacceptable and impossible 'concept' routes). The legal route alternatives do to some degree improve the village centre environment but also cause to varying degrees a dis-benefit to the particular environment it passes through. The Commercial Route has to be the cheapest and must remain consistent on engineering and design terms, e.g., geometry and design speed (chapter 2.5). It must remain legal, for example it must not impinge on listed buildings (chapter 6.5.2). The cheapest must by inspection of the village layout and adjacent terrain be aligned through gaps in residential areas close to the main A619 principal road but bypassing the village.
All Routes Considered In Test Examples (including discarded routes) omitting urban detail
Test example No1 - Brimington Bypass

\textbf{FIGURE: 20}\textsuperscript{-}
The map illustrates the commercial route, the current preferred route, and the pre-1980 preferred route. The map is titled "Diagram Illustrating the Commercial Route, the Current Preferred Route and the Pre-1980 Preferred Route." The key to the map indicates different areas such as residential/urban areas, heavy industry, park land, and crematorium.
Diagram Illustrating Commercial Route, The Preferred Route and Pre-1980 Preferred Route.
centre. Thus the cheapest route so obtained has the greatest environmental
dis-benefit (ref item (e), table 12) consistent with legality. This route
will provide the best commercial return by having the lowest capital cost.
Figure 20 illustrates how the Commercial Route is aligned through the area
relative to every option studied for the preliminary design. For clarity
the listed buildings and heritage areas have been shown whilst most of the
remaining village and land-form details have been removed.

The iterative approach to design (the sifting of options, ref 124) is
illustrated by the range of alternatives around the village as in figure 19.
Each legal alternative seeks the acceptable gaps in the urban fabric
around the village.
These gaps are typically parkland, public parks, recreational areas,
farmland and in some cases domestic properties around the urban fringe of
most routes.

9.3.6. The value of the unquantifiable (hidden) environmental impacts
on the test example

The Capital cost of the Preferred Route (P) (from table 11) is £7,125,000.
The Capital cost of the Commercial Route (C) is £5,424,900.

THE CAPITAL COST OF THE UNQUANTIFIABLE (HIDDEN) ENVIRONMENTAL IMPACTS = E
(ref chapter 8.6.4)

and \( E = P - C \)

therefore \( E = £7,125,000 - £5,424,900 \)

dependent \( E = £1,700,100 \) (1988 prices)
The unquantifiable environmental elements in respect of the Brimington bypass are valued in capital cost terms at £1,700,100.

Figure 21 illustrates the Commercial Route appropriate to the test case at Brimington. The current Preferred Route and the pre-1980 Preferred Route are shown for the purposes of clarification.

The history of the design sequence outlined in chapters 9.1 and 9.2 does convey how the engineers have attempted to avoid the difficult environmental problem closer into the village centre. Albeit the pre-1980 route proved unsuccessful it nevertheless avoided the worst of the problems but clearly (in view of the results of the public consultations exercise) not enough. The closer proximity of the pre-1980 route to private housing, parks and other recreational areas created a catalyst from which public opposition became intense.

9.3.7 Comparison of environmental impact between the Preferred Route and the Commercial Route (Brimington bypass)

The comparisons are made in tables 13 and 14.

The premier feature to emerge from table 13 is that the Commercial Route has a greater effect on woodland and recreational areas, a higher number of properties to be demolished and a higher number affected by dirt and noise. A higher number of roads and footpaths are severed but there is a decrease in the area of agricultural land required.

The Preferred Route does require a much higher area of vacant and derelict land and is worse with regard to the effect on agriculture.
The environmental impacts—visual intrusion, visual obstruction, pollution, community severance, disruption due to construction, heritage and conservation areas, effects on pedestrians and cyclists and driver stress are worse in respect of the Commercial Route.
<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACT</th>
<th>CURRENT PREFERRED ROUTE</th>
<th>PRE-1980 PREFERRED ROUTE</th>
<th>THE COMMERCIAL ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties Demolished (No.)</td>
<td>1</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Agricultural land (Ha)</td>
<td>27.7</td>
<td>43.7</td>
<td>24.0</td>
</tr>
<tr>
<td>Woodland &amp; Recreational Land (Ha)</td>
<td>1.1</td>
<td>6.5</td>
<td>13.0 (Parkland)</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>0.8</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Heritage &amp; Conservation Areas (Ha)</td>
<td>0.10</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Derelict, Vacant &amp; Industrial Land (Ha)</td>
<td>18.6</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Properties affected by noise and dirt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(in distances from road)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50m</td>
<td>28</td>
<td>76</td>
<td>198</td>
</tr>
<tr>
<td>20m</td>
<td>0</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Roads affected</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Public Footpaths affected</td>
<td>5</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

TABLE 13

Test Scheme No. 1 - A619 Brimington Bypass (Measured Values)
<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACT</th>
<th>CURRENT PREFERRED ROUTE</th>
<th>PRE-1980 PREFERRED ROUTE</th>
<th>THE COMMERCIAL ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Intrusion</td>
<td>low</td>
<td>moderate</td>
<td>high</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>low</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Pollution</td>
<td>low</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Community Severance</td>
<td>low</td>
<td>moderate</td>
<td>high</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>moderate</td>
<td>moderate</td>
<td>low</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>moderate</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Heritage &amp; Conservation Areas</td>
<td>moderate</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>low</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>low</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>View from the Road</td>
<td>moderate</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Drive Stress</td>
<td>low</td>
<td>low</td>
<td>moderate</td>
</tr>
</tbody>
</table>

**TABLE 14**

Test Scheme No. 1 - A619 Brimington Bypass (Judgemental Values)
CHAPTER 10

10.0 TEST APPLICATION OF COMMERCIAL ROUTE METHODOLOGY TO A FURTHER SIX TEST SCHEMES

10.1 LIST OF SIX FURTHER TEST SCHEMES

(No 2) A610 Ripley bypass

(No 3) A610 Langley Mill bypass

(No 4) A617 Pleasley bypass

(No 5) A6175 Hasland bypass

(No 6) A617 Glapwell bypass

(No 7) A6020 Ashford diversion

10.2 TEST SCHEME NO 2 - RIPLEY BYPASS (ref. 137)

(a) Current Position

The scheme was completed in 1984 at a cost of £2,089,631. The scheme first appeared in the County Council's 5 year programme in 1976.

The route was chosen to avoid the maximum number of private dwellings and consequent disruption. The route largely crosses parkland and
farmland commencing at the A38 Junction with the A610 to the north of Ripley close to the Headquarters of the Derbyshire Constabulary and terminating east of the town near the recreation ground. The only alternatives to the Preferred Route were small deviations within the existing narrow corridor. It should be noted however that in 1966 there was a route examined closer to the town centre on the line of a disused railway.

(b) The Commercial Route

This route took advantage of the latter disused railway between the A38 Junction and the A61 (about the mid-point of the scheme). The remainder of this route followed the existing bridle road through to the recreation ground at the eastern end of the town.

The Commercial Route was located much closer to the town centre and as a consequence caused greater community severance. This route also affected an area of church land close to the A61 Principal Road.

The Capital Cost of the unquantifiable environmental impacts = £

\[ E = P - C \]

\[ ' ' E = £2,089,631 - £1,602,500 \]

\[ ' ' E = £487,131 \quad (1983 \text{ prices}) \]

(c) Comparison of environmental impact between the Preferred Route and the Commercial Route

The comparisons are made in tables 15 and 16.
The premier measured environmental impacts to emerge from the tables are that the Commercial Route has a greater effect on residential property, derelict and vacant land and creates greater severance of roads and footpaths.

The Preferred Route affects woodland and recreational land to a greater degree and is significantly higher in respect of agricultural land.

With regard to the Commercial Route the following environmental impacts (Judgemental) are all graded higher, viz: visual intrusion, visual obstruction, community severance, disruption due to construction, pedestrians and cyclists and driver stress.
FIGURE 22
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme length (km)</td>
<td>2.0</td>
<td>1.55</td>
</tr>
<tr>
<td>Properties demolished (No.)</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Agricultural land (Ha)</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Woodland and Recreational (Ha)</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Derelict, Vacant and Residential (Ha)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Heritage &amp; Conservation Area (Ha)</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In distance from road)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20m</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>50m</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>Roads affected (No.)</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Public Footpaths affected (No.)</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

**TABLE 15**

Test Scheme No. 2 - A610 Ripley Bypass (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Impact</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Pollution</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Heritage &amp; Conservation</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>Low</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**TABLE 16**

Test Scheme No. 2 - A610 Ripley Bypass (Judgemental Values)
(a) **Current position**

The scheme was completed in 1983 at a cost of £1,669,567, and the scheme first appeared in the 5 year programme in 1976.

The scheme commenced at the junction of the terminal roundabout with the A610/A608 Principal Road junction and diverted around the northern fringe of the built-up area to the western end at A610, Cromford Road. This route was constructed largely over agricultural land and derelict land.

(b) **The Commercial Route**

This route took advantage of the shorter distance between the A608 Junction and the railway bridge on A610 Cromford Road. This was the original preferred scheme in 1967 which involved the upgrading of the main road from the railway westwards. The existing service road would be utilised with limited access to the new road. A church and a cemetery would be affected off Upper Dunstead Road.

The capital cost of the unquantifiable environmental impacts = E.

\[
E = P - C
\]

\[.\]. \hspace{1cm} E = 1,669,567 - £1,298,285

\[.\]. \hspace{1cm} E = £371,282 \hspace{0.5cm} (1982 prices)
(c) **Comparison of environmental impact between the Preferred Route and the Commercial Route**

The comparisons are made in tables 17 and 18.

The premier measured features to emerge from the tables are that the Commercial Route has a greater effect on residential areas/property, woodland and recreational land (including the church and cemetery).

The Preferred Route affects a significantly higher area of agricultural land and a little more derelict, vacant and industrial land.

In respect of the Commercial Route the following environmental impacts (judgemental) are all graded higher viz: visual intrusion and obstruction, pollution, disruption due to construction, pedestrians, cyclists and driver stress.
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme Length (km)</td>
<td>2.5</td>
<td>2.25</td>
</tr>
<tr>
<td>Properties Demolished (No.)</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Agricultural Land (Ha)</td>
<td>57</td>
<td>0.25</td>
</tr>
<tr>
<td>Woodland &amp; Recreational Land (Ha)</td>
<td>0</td>
<td>5.50</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>0.25</td>
<td>3</td>
</tr>
<tr>
<td>Heritage &amp; Conservation (Ha)</td>
<td>0</td>
<td>0.40</td>
</tr>
<tr>
<td>Derelict Vacant and Industrial (Ha)</td>
<td>67.75</td>
<td>56.75</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In distance from the road)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20m</td>
<td>1</td>
<td>62</td>
</tr>
<tr>
<td>50m</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Roads affected (No.)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Public Footpaths affected (No.)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**TABLE 17**

Test Scheme No. 3 - Langley Mill Bypass (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Intrusion</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Pollution</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Heritage &amp; Conservation Areas</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**TABLE 18**

Test Scheme No. 3 - Langley Mill Bypass (Judgemental Values)
(a) **Current position**

The scheme was completed in 1976 at a cost of £723,781. The planning and design stage was executed before the introduction of the Transport Policies and Programme in 1974. The scheme consisted typically of a roundabout located on vacant derelict and industrial land to the north of the village centre with connections to the A619 west and east, Rotherham Road, Common Lane and Chesterfield Road.

The Common Lane link to the north east takes advantage of a disused railway line to avoid a church and churchyard.

(b) **The Commercial Route**

This route placed the roundabout again on the vacant derelict industrial land in a similar position to the preferred - but used shorter side road connections in tandem with the utilisation of existing roads. The scheme affected the village churchyard.

The capital cost of the unquantifiable environmental impact = $E$.

\[ E = P - C \]

\[ \therefore E = £723,851 - £603,429 \]

\[ \therefore £ = £120,422 \quad (1975 \text{ prices}) \]
(c) **Comparison of environmental impact between the Preferred Route and the Commercial Route (Pleasley bypass)**

The comparisons are made in tables 19 and 20.

The premier measured features are the greater land-take in respect of agricultural, vacant and derelict and industrial land by the Preferred Route.

The Commercial Route requires a greater area of woodland and recreational land particularly in the vicinity of the village churchyard and the school playing fields.

In respect of judgemental values, the environmental impacts on both routes are similar.
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme length</td>
<td>1200m D2 lane</td>
<td>1200m D2 lane</td>
</tr>
<tr>
<td></td>
<td>1100m S2 lane</td>
<td>400m S2 lane</td>
</tr>
<tr>
<td>Properties Demolished</td>
<td>(No.) 7</td>
<td>(No.) 7</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>(Ha) 16</td>
<td>(Ha) 2</td>
</tr>
<tr>
<td>Woodland &amp; Recreational land</td>
<td>(Ha) 6</td>
<td>(Ha) 9</td>
</tr>
<tr>
<td>Residential</td>
<td>(Ha) 5</td>
<td>(Ha) 5</td>
</tr>
<tr>
<td>Heritage &amp; Conservation</td>
<td>(Ha) 0</td>
<td>(Ha) 0.40</td>
</tr>
<tr>
<td>Derelict Vacant and Industrial</td>
<td>(Ha) 14</td>
<td>(Ha) 10</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt</td>
<td>(No.)</td>
<td>(No.)</td>
</tr>
<tr>
<td>(In distance from road)</td>
<td>20m 19</td>
<td>20m 19</td>
</tr>
<tr>
<td></td>
<td>50m 32</td>
<td>50m 32</td>
</tr>
<tr>
<td>Roads affected</td>
<td>(No.) 6</td>
<td>(No.) 6</td>
</tr>
<tr>
<td>Public Footpaths affected</td>
<td>(No.) 7</td>
<td>(No.) 7</td>
</tr>
</tbody>
</table>

**TABLE 19**

Test Scheme No. 4 - A617 Pleasley Bypass (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Intrusion</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pollution</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Heritage &amp; Conservation Areas</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**TABLE 20**

Test Scheme No. 4 – A617 Pleasley Bypass (Judgemental Values)
10.5 TEST SCHEME NO 5 - A6175 HASLAND BYPASS (ref. 140)

(a) Current position

The scheme was completed in 1977 at a cost of £2,206,000 and although much of the scheme preparation was prior to 1974 the detailed design took place after Local Government re-organisation.

Each end of the route was fixed, at the west end near Horn's Bridge at the junction with A61 Trunk road and at the east end with the existing A619 Heath bypass.

This route utilised a disused railway line running approximately east-west for some 50 per cent of the scheme length.

(b) The Commercial Route

This route took an alignment through the same breaks in the urban fabric as the preferred route and hence could not be aligned in a commercial sense to any greater effect. In this latter respect the disused railway line was particularly useful.

Shorter routes could be found by aligning the Commercial Route in the direction of the existing Mansfield road and the concomitant 'ribbon' development. This course of action however was discarded because of high capital costs and with due regard to the Local and National Objectives, (ref. chapter 9.3.1. and table 12 (c)) 'provide relief for
communities suffering from heavy through traffic'. However in respect of table 12 (e); the scheme objective, 'conserve and improve the environment' will be disregarded in the case of the Commercial Route, (ref chapter 8).

In this latter context the environmental impact 'Community severance' is mitigated by the provision of two overbridges in respect of the Preferred Route. The Commercial Route does not have any bridges.

The capital cost of the unquantifiable environmental impacts = $E$

\[ E = P - C \]

\[ \therefore \quad E = £2,206,000 - £2,096,000 \]

\[ \therefore \quad E = £110,000 \] (1977 costs)

(c) Comparison of environmental impact between the Preferred Route and the Commercial Route

The comparisons are as shown in tables 21 and 22.

As both routes are on the same alignment no specific comparison can be made in respect of the engineering decisions. However the Commercial Route dispenses with the overbridges - and in this respect community severance must be increased.
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme length (km)</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Properties demolished (No.)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Agricultural land (Ha)</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Woodland &amp; Recreational land (Ha)</td>
<td>4 (Allotments)</td>
<td>4 (Allotments)</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Derelict, vacant &amp; Industrial land (Ha)</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Heritage &amp; Conservation (Ha)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In distance from road) 20m</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>50m</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>Severance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roads affected (No.)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Public Footpaths affected (No.)</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

**TABLE 21**

Test Scheme No. 5 - A6175 Hasland Bypass (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Impact</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pollution</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Moderate</td>
<td>high</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Heritage &amp; Conservation</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>low</td>
<td>low</td>
</tr>
</tbody>
</table>

**TABLE 22**

Test Scheme No. 5 - A6175 Hasland Bypass (Judgemental Values)
(a) **Current position**

This scheme has not progressed beyond committee approval stage in 1973/74 but remains an approved scheme of the County Council. The road corridor is protected from further development to allow construction when funds permit.

Whilst the scheme would largely avoid the residential areas it would have a considerable effect on agriculture and inflict agriculture severance, notably on the fringe of Hardwick Park - an area of historical and ecological interest.

(b) **The Commercial Route**

The route is aligned to the north of the village on a shorter corridor, shorter than the Preferred Route - from the west end at the former colliery entrance via the sports ground and connecting back to the A617 Mansfield Road east of the village.

The capital cost of the unquantifiable environmental impacts = $E$

\[
E = P - C
\]

\[
\therefore E = £715,000 - £605,000
\]

\[
\therefore E = £105,000 \quad (1973 \text{ prices})
\]
(c) Comparison of environmental impact between the Preferred Route and the Commercial Route

The comparisons are as shown in tables 23 and 24.

The premier features are the increased agricultural and recreational land-take by the Preferred Route.

The Commercial Route requires a greater number of properties to be demolished and a greater area of residential, derelict vacant and industrial land.

In terms of noise and nuisance (dirt) the Commercial Route is significantly worse, however the Preferred Route affects a greater number of roads and footpaths.

With regard to the environmental impacts and the respective judgemental values, it was noted that Heritage and Conservation, visual obstruction and disruption due to construction were all affected to a higher degree on the Commercial Route.
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme length (km)</td>
<td>3.75</td>
<td>3.05</td>
</tr>
<tr>
<td>Properties demolished (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural land (Ha)</td>
<td>44</td>
<td>38</td>
</tr>
<tr>
<td>Woodland &amp; Recreational land (Ha)</td>
<td>22</td>
<td>8 (7.0 sports ground)</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Derelict, Vacant &amp; Industrial Land (Ha)</td>
<td>8.5</td>
<td>15</td>
</tr>
<tr>
<td>Heritage &amp; Conservation (Ha)</td>
<td>0</td>
<td>0.2 (Chapel grounds)</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In distance from road)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20m</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>50m</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Roads affected (No.)</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Public footpaths affected (No.)</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

TABLE 23

Test Scheme No. 6 - A617 Glapwell Bypass (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Intrusion</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pollution</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Heritage &amp; Conservation</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pedestrians &amp; Cyclists</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

**TABLE 24**

Test Scheme No. 6 - A617 Glapwell Bypass (Judgemental Values)
10.7 TEST SCHEME NO 7 - A6020 ASHFORD DIVERSION (ref. 142)

(a) **Current position**

Construction commenced on this scheme in 1978 and was opened to traffic in 1979. The scheme was promoted jointly by Derbyshire County Council and the Peak Park Planning Board as part of an environmental improvement in respect of the village and in part as an improved heavy lorry route to serve local quarry traffic.

At Local Government reorganisation the scheme was included in the list of schemes in the under £500,000 category ie not in the 5 year programme.

Features of the works were the use of natural stone as a skin on the reinforced concrete structures, 1:6 batters to the earthworks for landscaping and agricultural purposes and an extensive tree and shrub planting programme.

(b) **The Commercial Route**

This route took the same alignment as the Preferred Route from the junction with the A6 to the north bank of the River Wye. It was known at the design stage that the position for the bridge crossings provided the cheapest structures at these points. North of the river the road crosses Mill Lane on a 65 Kph (40 mph) reverse curve. (lowest acceptable for roads in rural areas).
The junction with Church Street (the village junction) is approximately at the same position as the Preferred Route but closer to the Village Hall and to private housing.

The capital cost of the unquantifiable environmental impacts = $E$

\[ E = P - C \]

\[ \therefore \quad E = £510,000 - £378,000 \]

\[ \therefore \quad E = £132,000 \] (1978 prices)

(c) **Comparison of environmental impact between the Preferred Route and the Commercial Route**

The comparisons are as shown in tables 25 and 26.

Both routes are on similar alignments for approximately half the scheme length – deviating only at the 'village' northern end. The Commercial Route is marginally shorter and has no environmental mitigation elements such as stone walls, special earthworks or planting schemes.
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme length (km)</td>
<td>0.4</td>
<td>0.44</td>
</tr>
<tr>
<td>Properties demolished (No.)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agricultural land (Ha)</td>
<td>11.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Woodland and recreational land (Ha)</td>
<td>6 (3.0 sports grounds)</td>
<td>1.5 (sports ground)</td>
</tr>
<tr>
<td>Residential</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Derelict, Vacant &amp; Industrial (Ha)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heritage &amp; Conservation (Ha)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Properties affected by Noise and Dirt (No.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In distance from road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20m</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>50m</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Roads affected (No.)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Public Footpaths affected (No.)</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**TABLE 25**

Test Scheme No. 7 - A6020 Ashford Diversion (Measured Values)
<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Preferred Route</th>
<th>Commercial Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Intrusion</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pollution</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Community Severance</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Agricultural Severance</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Heritage &amp; Conservation</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pedestrians &amp; Cyclists</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>View from the Road</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

**TABLE 26**

*Test Scheme No. 7 - A6020 Ashford Diversion (Judgemental Values)*
10.8 SUMMARY OF ENVIRONMENTAL IMPACT
MEASURED VALUES

<table>
<thead>
<tr>
<th>SCHEME</th>
<th>PROPERTIES TO BE DEMOLISHED (NO)</th>
<th>WOODLAND AND RECREATIONAL (Ha)</th>
<th>RESIDENTIAL GARDENS ETC (Ha)</th>
<th>AGRICULTURAL (Ha)</th>
<th>DERELICT VACANT AND INDUSTRIAL (Ha)</th>
<th>HERITAGE AND CONSERVATION (Ha)</th>
<th>PROPERTIES AFFECTED WITHIN:</th>
<th>AFFECTED ROADS PUBLIC FOOTPATHS (NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>C</td>
<td>P</td>
<td>C</td>
<td>P</td>
<td>C</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>A619, Brimington Bypass (Table 13)</td>
<td>1</td>
<td>13</td>
<td>1.1</td>
<td>13.0</td>
<td>0.8</td>
<td>6</td>
<td>27.7</td>
<td>24.0</td>
</tr>
<tr>
<td>A610, Ripley Bypass (Table 15)</td>
<td>2</td>
<td>13</td>
<td>11</td>
<td>6</td>
<td>1</td>
<td>10.6</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>A610, Langley Mill Bypass (Table 17)</td>
<td>2</td>
<td>9</td>
<td>0</td>
<td>5.5</td>
<td>0</td>
<td>4.5</td>
<td>57</td>
<td>0.25</td>
</tr>
<tr>
<td>A617, Pleasley Bypass (Table 19)</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>A6175, Hasland Bypass (Table 21)</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>A617, Glapwell Bypass (Table 23)</td>
<td>1</td>
<td>2</td>
<td>22</td>
<td>8</td>
<td>0.5</td>
<td>1</td>
<td>44</td>
<td>38</td>
</tr>
<tr>
<td>A6020, Ashford Diversion (Table 25)</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>11.5</td>
<td>6.5</td>
</tr>
<tr>
<td>TOTALS:</td>
<td>21.0</td>
<td>46.0</td>
<td>54.1</td>
<td>47.0</td>
<td>11.3</td>
<td>29.1</td>
<td>197.2</td>
<td>96.75</td>
</tr>
</tbody>
</table>

P = Preferred Route
C = Commercial Route

TABLE 27
SUMMARY OF ENVIRONMENTAL IMPACT MEASURED VALUES

SUR/1586
## 10.9 SUMMARY OF NET EFFECTS OF ENVIRONMENTAL IMPACTS

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>IMPACT OF COMMERCIAL ROUTE</th>
<th>IMPACT OF PREFERRED ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties to be demolished (No)</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>Woodland and Recreational (Ha)</td>
<td>-</td>
<td>15.1</td>
</tr>
<tr>
<td>Residential (Ha)</td>
<td>17.8</td>
<td>-</td>
</tr>
<tr>
<td>Agricultural (Ha)</td>
<td>-</td>
<td>100.45</td>
</tr>
<tr>
<td>Derelict, vacant &amp; Industrial (Ha)</td>
<td>-</td>
<td>23.60</td>
</tr>
<tr>
<td>Heritage and Conservation (Ha)</td>
<td>4.8</td>
<td>-</td>
</tr>
<tr>
<td>Properties within 20m (No)</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Properties within 50m (No)</td>
<td>98</td>
<td>-</td>
</tr>
<tr>
<td>Roads affected (No)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Public footpaths affected (No)</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

**TABLE 28**

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### 10.10 COMPARISON OF JUDGEMENTAL ENVIRONMENTAL IMPACTS

<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACT (JUDGEMENTAL)</th>
<th>A619 BRIMINGTON</th>
<th>A610 RIPLEY</th>
<th>A610 LANGLEY MILL</th>
<th>A619 PLEASLEY</th>
<th>A619 HASLAND</th>
<th>A617 GLAPWELL</th>
<th>A6020 ASHFORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>'HIDDEN FACTORS'</td>
<td>C</td>
<td>P</td>
<td>C</td>
<td>P</td>
<td>C</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Visual Intrusion</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Visual Obstruction</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pollution</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Community Severance</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Effects on Agriculture</td>
<td>-</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>/</td>
<td>-</td>
</tr>
<tr>
<td>Heritage and Conservation</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>/</td>
</tr>
<tr>
<td>Disruption due to Construction</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pedestrians and Cyclists</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>View from the Road</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Driver Stress</td>
<td>-</td>
<td>-</td>
<td>/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### TABLE 29

**KEY**

- **C** = Environmental impact of commercial routes.
- **P** = Environmental impact of preferred routes.
- **/** = Represents judgemental impact
- **-** = Represents no judgemental impact.
### SUMMARY OF CAPITAL COSTS OF UNQUANTIFIABLE ENVIRONMENTAL IMPACTS (E) FOR SEVEN SCHEMES TESTED IN CHAPTERS 9 AND 10

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Construction Date/Estimate</th>
<th>£</th>
<th>Cost Index</th>
<th>1988 Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brimington Bypass</td>
<td>(EST) 1988</td>
<td>1,700,100</td>
<td>-</td>
<td>1,700,100</td>
</tr>
<tr>
<td>Ripley Bypass</td>
<td>1983</td>
<td>487,131</td>
<td>32.8</td>
<td>646,910</td>
</tr>
<tr>
<td>Langley Mill Bypass</td>
<td>1982</td>
<td>371,282</td>
<td>47.0</td>
<td>545,784</td>
</tr>
<tr>
<td>Pleasley Bypass</td>
<td>1975</td>
<td>120,422</td>
<td>261.0</td>
<td>433,723</td>
</tr>
<tr>
<td>Hasland Bypass</td>
<td>1977</td>
<td>110,000</td>
<td>177.9</td>
<td>305,690</td>
</tr>
<tr>
<td>Glapwell Bypass</td>
<td>(EST) 1973</td>
<td>105,000</td>
<td>298.1</td>
<td>418,005</td>
</tr>
<tr>
<td>Ashford Diversion</td>
<td>1978</td>
<td>132,000</td>
<td>139.3</td>
<td>315,876</td>
</tr>
</tbody>
</table>

| TOTAL £ at 1988 prices | 4,366,088 |

**TABLE 30**

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### 10.12 SUMMARY OF CAPITAL COST OF UNGUANTIFIABLE ENVIRONMENTAL IMPACTS

(E) AS PERCENTAGE OF SCHEME COSTS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>(P)</td>
<td>(C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A619 Brimington By-Pass</td>
<td>7,125,000 (1988)</td>
<td>7,125,000</td>
<td>5,424,900</td>
<td>1,700,100</td>
<td>23.86</td>
</tr>
<tr>
<td>A610 Ripley By-Pass</td>
<td>2,088,845 (1983)</td>
<td>2,775,030</td>
<td>2,128,120</td>
<td>646,910</td>
<td>23.31</td>
</tr>
<tr>
<td>A610 Langley Mill By-Pass</td>
<td>1,669,566 (1982)</td>
<td>2,454,262</td>
<td>1,908,479</td>
<td>545,784</td>
<td>22.24</td>
</tr>
<tr>
<td>A617 Pleasley By-Pass</td>
<td>723,851 (1975)</td>
<td>2,612,102</td>
<td>2,178,379</td>
<td>433,723</td>
<td>16.60</td>
</tr>
<tr>
<td>A617 Hasland By-Pass</td>
<td>2,206,000 (1977)</td>
<td>6,130,474</td>
<td>5,824,784</td>
<td>305,690</td>
<td>4.98</td>
</tr>
<tr>
<td>A617 Clapwell By-Pass</td>
<td>715,000 (1973)</td>
<td>2,846,415</td>
<td>2,428,414</td>
<td>418,005</td>
<td>14.68</td>
</tr>
<tr>
<td>A6020 Ashford Diversion</td>
<td>510,000 (1978)</td>
<td>1,220,430</td>
<td>904,554</td>
<td>315,876</td>
<td>25.88</td>
</tr>
</tbody>
</table>

**TABLE 31**
CHAPTER 11

11.0 DISCUSSION ON TEST RESULTS

11.1 PREAMBLE TO DISCUSSION

The test results are based on the application of the Commercial Route Methodology to seven test examples. The examples are all approved schemes of the Derbyshire County Council Highway Authority. The schemes are shown in chapter 9 and are as follows:

Test scheme No 1 - A619 Brimington bypass
Test scheme No 2 - A610 Ripley bypass
Test scheme No 3 - A610 Langley Mill bypass
Test scheme No 4 - A617 Pleasley bypass
Test scheme No 5 - A6175 Hasland bypass
Test scheme No 6 - A617 Glapwell bypass
Test scheme No 7 - A6020 Ashford diversion

The results are in three forms, viz:-

a) Measured environmental impact
b) Judgemental environmental impact
c) Capital costs of unquantifiable environmental impacts

11.2 MEASURED ENVIRONMENTAL IMPACT

These impacts are as shown in tables 13, 15, 17, 19, 21, 23 and 25 and are summarised in table 27.
11.2.1 Properties to be demolished

In terms of numbers of properties to be demolished the net effect was that the Commercial Route affected a higher number of properties than did the Preferred Route.

From inspection of particular schemes this was the case on Brimington, Ripley, Langley Mill and Glapwell bypasses. Brimington bypass had a particularly high effect because the available corridor for the Commercial Route was close to the village centre and hence (in this case) the residential area.

The Brimington bypass Preferred Route avoids the residential areas by some 0.5 km on the northern perimeter of the village. It is noted that with the Pleasley and Hasland bypasses and the Ashford diversion the Commercial Route and the Preferred Route were occupying similar horizontal alignments (Hasland being exactly the same). The overall view based on the data is that the Preferred Route will go to some lengths to avoid residential areas and this is supported by the properties to be demolished ratio (see table 27) of 21:46 (ie 46 properties to be demolished by the Commercial Routes).

11.2.2 Properties within 20 m and 50 m of the new road

With the exception of Hasland and Pleasley the Commercial Route schemes have a higher impact relative to the proximity of dwelling houses than does the Preferred Route. In the 50 m zone Langley Mill has a significantly higher ratio 7:62 (ie 62 properties affected by Commercial Route) indicating that the Preferred Route has been constructed with
residential blight very much as a consideration. Hasland and Pleasley are schemes without the benefit of a clear corridor around the village perimeter, therefore gaps within the village residential fabric must be utilised - it therefore presents no useful Commercial Route option. As in chapter 11.2.1 the Preferred Route schemes appear to avoid as far as is practicable residential properties and adjacent areas, the total ratios are 71:109 (20 m) and 149:247 (50 m), from table 27: ratio (Preferred/Commercial).

11.2.3 Woodland and recreational areas

Generally the effect of this impact is higher in respect of the Preferred Route and significantly so on the Ripley and Glapwell bypasses and the Ashford diversion.

The ratio (from table 27) is 54.1:47.0, ie (Preferred/Commercial).

11.2.4 Residential areas

With the exception of Hasland the Preferred Route has less effect than the Commercial Route in respect of this category. The ratio from table 27 is 11.3:29.1 (Preferred/Commercial).

11.2.5 Agricultural land

The Commercial Routes have the least effect in this category. The significant figures are at Langley Mill where the ratio from table 27 is
57:0.25 (Preferred/Commercial). This would appear to indicate a desire to keep the Preferred Route well clear of the residential and urban areas at the expense of agriculture. This is in contrast with chapter 11.2.2 (properties within 50 m) where the ratio at Langley Mill is 7:62, (Preferred/Commercial).

11.2.6 Derelict, vacant or industrial land

The Preferred Routes use this category rather more than the Commercial Route particularly at Brimington, Langley Mill, Pleasley and Hasland. Disused railway lines are utilised at Brimington and Pleasley for the Preferred Route and also at Ripley with the Commercial Route.

11.2.7 Heritage and conservation areas

Generally this category involves only small areas of land. However in all cases the Preferred Route uses less of this category than the Commercial Route. Churches, Churchyards and cemeteries are affected on the Commercial Route alignments at Brimington, Ripley, Langley Mill, Pleasley and Clapwell. The only Heritage and Conservation area affected by the Preferred Route is at Brimington - this is the corner of a site of Special Scientific Interest (SSSI).
11.3 **NET EFFECTS OF ENVIRONMENTAL IMPACTS**

*(MEASURED VALUES)*

Table 28 illustrates the net effects of each environmental impact with respect to the seven test schemes and is derived directly from table 27. The impact of the Preferred Routes is greater on open areas, viz, woodland and recreational, agricultural, derelict vacant and industrial land. By comparison with the Commercial Route, the Preferred Route also avoids 25 properties (which would otherwise have to be demolished), 17.8 Ha of residential land, 4.8 Ha of heritage and conservation land and within the 20 m zone, 38 properties are avoided and in the 50 m zone, 98 properties are avoided. Roads and public footpaths are not significantly affected (the net effect is one additional public footpath affected by the Commercial Route).

11.4 **JUDGEMENTAL ENVIRONMENTAL IMPACTS**

These impacts are as shown in tables 14, 16, 18, 20, 22, 24, 26 and are summarised in table 29. These are value judgements applied by the design engineer to those environmental impacts which cannot normally be evaluated in capital cost terms. Table 29 indicates in red how the Commercial Route affects a range of environmental impacts, whilst the blue strip shows how the Preferred Route affects mainly agricultural land. Although these are value judgements and cannot be numerically substantiated, the summary outlined in table 29 does show for the purpose of comparison a link with the measured environmental impacts as shown in table 28.
11.5 **DISCUSSION ON CAPITAL COSTS OF UNQUANTIFIABLE ENVIRONMENTAL IMPACTS (E) FOR SEVEN TEST EXAMPLES** (ref chapters 8, 9, 10 and 11)

Table 30 summarises the cost of each scheme with the appropriate E value (ref chapter 8.6.4) indexed up to the year 1988. Table 31 summarises the Preferred (P) and Commercial (C) routes and E costs at (ref chapter 8.6) 1988 values and shows E (the unquantifiable environmental impact costs) as a percentage of the test scheme costs. The range is from 4.98 per cent to 25.88 per cent with an average E percentage for the seven test schemes of 18.79.

The highest E percentage at 25.88 is for the Ashford Diversion - a scheme located in the Peak District National Park. There is little difference in this example between the lengths of the Preferred and the Commercial Routes. Many of the features incorporated into this scheme solely for environmental purposes are expensive; typically these are natural stone cladding to the reinforced concrete bridges and extra earthworks on the embankments, giving side slopes of 1:6 instead of the normal 1:2 side slopes. These earthworks were also extensively landscaped. Accommodation works to the village cricket pitch, Ashford Hall entrance and drive and the perimeter stone walls all contributed to an overall extension of the final construction costs, none of which are in the Commercial Route costs. The next highest - A619 Brimington bypass reflects the higher costs associated with a longer Preferred Route across difficult terrain. This route also has an extensive landscaping element, noise attenuation works and recreational facilities in connection with the disused canal and with the associated footpaths.
The A619 Pleasley bypass and the A617 Glapwell bypass have similar E percentages, largely because the Commercial Route is reduced in length and consequently has lower capital costs. It should be noted that the schemes are different in character because the Pleasley scheme has no tolerance in terms of space, but the Preferred Route does go to some lengths to avoid school playing fields and grounds and the church and church yard. Glapwell bypass uses the farm and parkland available on the south side of the village in contrast to the Commercial Route aligned closer to the village and utilising the sports ground.

The A610 Ripley bypass and the Langley Mill bypass are similar in character – the Preferred Routes both costing more with regard to the structure, which are made available to reduce community severance and also to avoid residential areas. In the case of Langley Mill a church yard is included in the middle of the residential area. Both schemes have a convenient area of farmland, parkland and derelict land at some 400 m to the north of the village centres and this is utilised by the Preferred Routes. The lowest E percentage is on the A6175 Hasland bypass where the Commercial and Preferred Routes were exactly the same. There is no reasonable alternative in engineering and legal terms other than the Preferred (and as-built) Route. However the Commercial Route omits the two over-bridges which are utilised for overcoming community severance problems.
12.0 Conclusions and Recommendations

The conclusions and recommendations differ in that the former deals with facts drawn from the data used in this study, whilst the latter represents the author's (a professional highway engineer) personal interpretation of situations relating to or stemming from these facts.

Comments on associated issues which have been raised in conjunction with this study are included in the recommendations section so that the full value of this work can be used to its full potential.

The study focuses on the implicit and quantifiable environmental impact mitigation costs \( (M) \) of new highway schemes and similarly on unquantifiable and concealed environmental impact costs \( (E) \). These costs are obtained by the application of the new design technique - the Commercial Route Methodology (CRM).

12.1 Conclusions relating to the original terms of reference for this study

The original terms of reference for this study were ... 'The capital cost aspects of the environmental impact of new highways...' which in turn led to the new design technique - the Commercial Route Methodology (CRM).

The conclusions have been set down in five sections, as follows:

(i) Those relating to the capital costs of environmental impact mitigation of new highways obtained from published sources and directly from Highway Authorities or their Agents.

(ii) Those relating to Commercial Route Methodology (CRM).
(iii) Those derived from the application of the Commercial Route Methodology (CRM) to seven schemes of the Derbyshire County Council.

(iv) Those relating to the comparison of M data obtained directly from Derbyshire County Council and with E results obtained from the application of the Commercial Route Methodology (CRM).

(v) Conclusions relating to the application of the Commercial Route Methodology (CRM) to the Derbyshire County Council and the United Kingdom new Roads Programme.
The direct quantifiable cost of mitigating environmental impact for a variety of highway schemes is as summarised below. Comments have been made in chapter 7 and will be referred to again in chapter 12.1.4.

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>M%</th>
<th>MITIGATION COST (M)</th>
<th>TOTAL SCHEME COST</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>9.0</td>
<td>£37,800,000</td>
<td>£420,000,000</td>
<td>Table 7</td>
</tr>
<tr>
<td>Lowest</td>
<td>3.0</td>
<td>£22,500</td>
<td>£727,000</td>
<td>&quot;</td>
</tr>
<tr>
<td>Average</td>
<td>5.0</td>
<td>-</td>
<td>-</td>
<td>&quot;</td>
</tr>
<tr>
<td>International</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>17.0</td>
<td>$19,000,000</td>
<td>$111,000,000</td>
<td>Table 8</td>
</tr>
<tr>
<td>Lowest</td>
<td>2.2</td>
<td>$3,300,000</td>
<td>$150,000,000</td>
<td>&quot;</td>
</tr>
<tr>
<td>Average</td>
<td>13.85</td>
<td>-</td>
<td>-</td>
<td>&quot;</td>
</tr>
<tr>
<td>English Midlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>11.1</td>
<td>£122,270</td>
<td>£1,100,000</td>
<td>Table 9</td>
</tr>
<tr>
<td>Lowest</td>
<td>1.62</td>
<td>£65,000</td>
<td>£4,000,000</td>
<td>&quot;</td>
</tr>
<tr>
<td>Average</td>
<td>4.46</td>
<td>-</td>
<td>-</td>
<td>&quot;</td>
</tr>
<tr>
<td>Derbyshire County Council</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>19.23</td>
<td>£98,000</td>
<td>£510,000</td>
<td>Table 10</td>
</tr>
<tr>
<td>Lowest</td>
<td>0.26</td>
<td>£18,000</td>
<td>£7,000,000</td>
<td>&quot;</td>
</tr>
<tr>
<td>Average</td>
<td>3.00</td>
<td>-</td>
<td>-</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
12.1.2 Conclusions Relating to the Commercial Route Methodology (CRM)

The new design technique the Commercial Route Methodology (CRM) has been developed to evaluate in capital cost terms the concealed and unquantifiable environmental impact considerations consequent to the construction of a new highway; this cost is termed $E$.

Where $E = P - C$ (ref. chapter 8)

and $P =$ capital cost of the Preferred Route selected by the public and the engineer after consultation procedures. This route will not only be consistent with all legal provisions but will include for all environmental considerations.

and $C =$ capital cost of the Commercial Route designed to the bare minimum of legal provisions applied to environmental considerations.
12.1.3 The application of the Commercial Route Methodology (CRM) to seven approved schemes of the Derbyshire County Council Highways Authority

The premier objective in the analysis is to obtain E for each scheme, i.e. the capital cost of the unquantifiable environmental impacts (ref. chapter 8). The E values were obtained for seven schemes and also E as a percentage of total scheme capital cost (E%). The schemes with the appropriate E and E% values are listed below (from table 31).

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Total Cost (1988 prices)</th>
<th>E (1988 prices)</th>
<th>E%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A619 Brimington bypass</td>
<td>£7,125,000</td>
<td>£1,700,100</td>
<td>23.86</td>
</tr>
<tr>
<td>A610 Ripley bypass</td>
<td>£2,775,030</td>
<td>£646,910</td>
<td>23.31</td>
</tr>
<tr>
<td>A610 Langley Mill bypass</td>
<td>£2,454,262</td>
<td>£545,784</td>
<td>22.24</td>
</tr>
<tr>
<td>A617 Pleasley bypass</td>
<td>£2,612,102</td>
<td>£433,723</td>
<td>16.60</td>
</tr>
<tr>
<td>A6175 Hasland bypass</td>
<td>£6,130,474</td>
<td>£305,690</td>
<td>4.98</td>
</tr>
<tr>
<td>A617 Glapwell bypass</td>
<td>£2,846,415</td>
<td>£418,005</td>
<td>14.68</td>
</tr>
<tr>
<td>A6020 Ashford diversion</td>
<td>£1,220,430</td>
<td>£315,876</td>
<td>25.88</td>
</tr>
</tbody>
</table>

The average E% for seven schemes = 18.79 per cent.

In summary the range of E Values is from £305,690 to £1,700,100 and E% in the Range of 4.98 per cent to 25.88 per cent.

The highest E% value is for Ashford diversion (ref. chapter 10.7) which is in the Peak District National Park, an area of high scenic beauty and in this respect a high E value is to be expected. However the next highest E value related to the Brimington bypass which passes through a predominantly industrialised landscape including steelworks and opencast mining sites. The
E and E% values for both are similar and yet the schemes are quite different in terms of topography and in demographic background. However the latter scheme (Brimington bypass) which is currently being designed by the County Surveyor's Design Section of Derbyshire County Council reflects the concern which has developed with respect to environmental matters in recent years (1984-1989), i.e. the incorporation of increased environmental mitigation measures into new highway schemes.

The smallest E% value is on the A617 Hasland bypass where the only viable corridor for a new highway is used by both the Preferred Route and the Commercial Route (ref. chapter 10). The only corridor available is via a disused railway line and no other legal and planning possibility exists to align a Commercial Route (ref. chapter 8). The main differences being that with the Preferred Route it was considered necessary to reduce community severance (to overcome objections to the scheme) by introducing two overbridges - the Commercial Route omits these structures.
12.1.4 Comparison of $M$ data obtained directly from Derbyshire County Council with $E$ values obtained from the application of Commercial Route Methodology (CRM)

NB. Environmental mitigation costs as percentage of total scheme actual costs obtained directly from Derbyshire County Council = $M\%$.

For clarity the results from the Derbyshire County Council data and the $E$ and $E\%$ values are listed below.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brimington bypass</td>
<td>195,000</td>
<td>2.80</td>
<td>1,700,100</td>
<td>23.86</td>
</tr>
<tr>
<td>Ripley bypass</td>
<td>23,326</td>
<td>0.80</td>
<td>646,910</td>
<td>23.31</td>
</tr>
<tr>
<td>Langley Mill bypass</td>
<td>23,520</td>
<td>0.80</td>
<td>545,784</td>
<td>22.24</td>
</tr>
<tr>
<td>Pleasley bypass</td>
<td>92,055</td>
<td>3.53</td>
<td>433,723</td>
<td>16.60</td>
</tr>
<tr>
<td>Hasland bypass</td>
<td>48,632</td>
<td>1.50</td>
<td>305,690</td>
<td>4.98</td>
</tr>
<tr>
<td>Glapwell bypass</td>
<td>27,860</td>
<td>0.98</td>
<td>418,005</td>
<td>14.68</td>
</tr>
<tr>
<td>Ashford diversion</td>
<td>234,753</td>
<td>19.23</td>
<td>315,876</td>
<td>25.88</td>
</tr>
</tbody>
</table>

|  | 645,146 | Average $M\%$ 4.23 | 4,366,088 | Average $E\%$ 18.79 |

The $M\%$ figures from the data listed above are in the range 0.80 per cent to 19.23 per cent with an average figure of 4.23 per cent. This latter figure could be reduced if the data relating to the Ashford diversion was omitted. This could be justified on the basis of the Ashford $M\%$ value being almost
twice that of the aggregate of the remaining six schemes.

The Ashford M% is high because the scheme is located in the Peak District National Park and also is in a particularly aesthetically sensitive location. The expensive facilities used in the scheme were the extensive use of natural stone on all structures and the purchase of additional land for landscaping. With Ashford omitted the average M% is reduced to 1.73 per cent.

This means that the Derbyshire County Council highway engineers have incorporated an average of 1.73 per cent of total capital costs directly to the implicit environmental impact mitigation.

Further comparisons with M% from all sources are listed below.

<table>
<thead>
<tr>
<th>Source</th>
<th>Average M%</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>5.0</td>
<td>Table 7</td>
</tr>
<tr>
<td>International</td>
<td>13.85</td>
<td>Table 8</td>
</tr>
<tr>
<td>English Midlands</td>
<td>4.46</td>
<td>Table 9</td>
</tr>
<tr>
<td>Derbyshire County Council</td>
<td>3.00</td>
<td>Table 10</td>
</tr>
<tr>
<td>Derbyshire County Council</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(seven schemes)</td>
<td>4.23</td>
<td></td>
</tr>
<tr>
<td>Derbyshire County Council</td>
<td>1.73</td>
<td></td>
</tr>
<tr>
<td>(Ashford omitted)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12.1.5 Conclusions relating to the application of the Commercial Route Methodology (CRM) to the Derbyshire County Council and the United Kingdom New Roads Programme

(a) Derbyshire County Council

From data outlined in the previous chapter it is apparent that the Derbyshire County Council does already spend in the region of 4.23 per cent of its new highways budget on environmental mitigation, this capital spending is typically applied to landscaping, screen fencing, special finishes and additional land and earthworks.

Using the Commercial Route Methodology (CRM) however the figure spent on total unquantifiable environmental considerations is 18.79 per cent which represents a sum (on the basis of seven test schemes) of £4,366,088 (1988 prices).

The choice facing the engineer therefore lies between designing new roads to CRM standards or continuing as now with implicit environmental considerations taken into account at each stage of design. If the CRM had been followed by Derbyshire engineers the sum of £4,366,088 could have been available for other purposes including the option of building more roads and thus expedite the highways programme. In terms of the Derbyshire County Council's new roads budget the entire major works programme could have been brought forward by four years.
(b) **United Kingdom**

By applying the CRM nationally (on the same basis as for Derbyshire) with an $E_z = 18.79$, it can be argued that a sum in excess of £2,000,000,000 has been spent on the mitigation of unquantifiable environmental impact considerations. The above sum represents at least three years total expenditure over the period 1975 to 1985 and similarly had the CRM been applied the National programme could have been brought forward by three years.

Highway engineers have informally argued that more money is spent on environmental mitigation than the directly quantifiable figure (ref. chapters 1, 2 and 6)—this study has shown that this is the case.

In summary the Highway Engineer spends approximately 18 per cent of his capital budget rather than 4 per cent (outlined in (a) on previous page) on the mitigation of environmental impact.
12.2 RECOMMENDATIONS AND COMMENTS RESULTING FROM THIS STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

Several important recommendations are to be made as a result of this unique study and from which many side-issues have emerged. This chapter will attempt to comment on these issues where appropriate and to suggest areas which would benefit from further research.

(a) It is recommended that the Commercial Route Methodology (CRM) be incorporated into the current highway design network (ref chapter 2.5). The proposed network and its relationship with the current highway design process and associated funding is shown in fig 29 on the following page. This recommendation stems from this study and in particular from the tests applied to the Derbyshire County Council highway schemes (ref chapters 9 and 10). The importance of this methodology is that it identifies the capital costs which the Highway Authority has invested in its new highway schemes for the purpose of environmental impact mitigation.

(b) Essentially the CRM is a system which identifies a sum of capital funds in relation to an area of highway design - environmental impact, which is either difficult or impossible to quantify using previously established highway design techniques. The financial quantification of environmental impacts is particularly important when presenting new highway schemes to the public at either exhibitions, consultations or inquiries. The basis of this comment stems from the Leitch Report (1977 and 1979) where the basic premise was to supply
PROPOSED HIGHWAY DESIGN NETWORK
INCLUDING THE COMMERCIAL ROUTE METHODOLOGY 
TO RANK SCHEMES AND ASSESS TOTAL 
ENVIRONMENTAL COSTS.
more information about proposed highways to the public in an understandable manner, so that the new scheme preparation and design could be expedited in a less confusing and speedier system. (ref chapter 6).

This view is shared in respect of CRM in that the methodology is used to provide all interested parties in a particular scheme with further information and in particular the cost of the unquantifiable environmental impacts. This provision of information assists in the clarification of environmental and funding queries and will in this regard assist the speeding up of the public consultation and inquiry aspects of highway design procedures.

(c) An important aspect of CRM is its potential use as a datum or 'bottom-line' against which all other schemes can be judged or compared. For example if the Commercial Route of a particular village bypass was given as 1.0 then all alternative routes would be a function of the CRM datum. This would present a quick and simple presentational method for incorporation into the existing environmental impact framework aspect of scheme preparation.

(d) The highways programme does not only consist of the well publicised major schemes such as motorways but includes small highway works in the financial category £10,000 to £100,000 - usually for accident remedial measures. It is interesting to speculate on the potential savings in respect of accidents in terms of fatalities and personal injuries assuming CRM had been applied to the local and national highways programme.

(e) A notable feature of this study is the identification of certain types and areas of land which are used in the establishment of Preferred Routes.
The premier category of land in this respect is \textit{Residential land} where the Preferred routes go with some persistence on alignments which avoid houses and residential property. This is because residents in these area are likely to be the most vociferous objectors to proposed routes in their vicinity.

The fear experienced by the residents is typically about the possible decline in their property values, the loss of a view, or the increase in traffic noise and the construction phase nuisance.

An interesting side-issue developed in this study is the avoidance of \textit{used or disused church property}; this is property not necessarily protected by statutory provisions and includes churchyards, churches and cemeteries. The schemes in Derbyshire went to some lengths to avoid this category of land and provides a degree of speculation into the psychology of the highway engineer (and his employer) in that there appears to be (even in a secular society) a reluctance to involve such land in new highway schemes.

A related category of land is \textit{Heritage and Conservation} which is not protected by existing legal provisions such as listed monuments or buildings. Whilst in the Derbyshire test schemes this was not shown to be a particular problem, elsewhere in the UK this could be a potential problem, an excellent example being the M40 in Oxfordshire and the associated Preferred Route and its impact on the Otmoor nature reserve.

(f) \textit{Recreational areas} such as sports grounds are affected by the Preferred Routes analysed in this study. Three of the seven schemes impinge on cricket grounds, these are at Ashford, Hasland and Pleasley. The remaining schemes also affect this category of land; in the other schemes this is manifested in general parkland, fishing ponds, footpaths and woodland.
Another land type affected by Preferred Routes is Agricultural which is much favoured by highway engineers. The principal reason appears to be that agricultural land (poor to middle grade in the Derbyshire study) is one of the least expensive categories of land on which a new highway can impinge. Currently there is much speculation about agricultural land values, especially in respect of proposed relaxations in the 'green belt' and other planning regulations which could lead to a greater availability of agricultural land for building and other commercial uses. This could have the related effect of creating alternative corridors for future new roads in, for example, residential areas, where the balance of capital cost and political attitudes may create a swing in land-use away from the traditional agricultural areas.

(g) Vacant Derelict and Industrial Land is used by highway engineers whenever possible because in many cases this land is the cheapest and has central government encouragement in respect of its use and reclamation. Disused railways and canals are particularly useful because in highway terms the severance element is already installed and the vertical geometry is often suitable.

The corollary to the latter comment is that the 'recreational lobby' and to some extent environmental groups have now come to look upon many disused industrial works as recreational facilities. A current example is the Chesterfield Canal Society and its involvement with the Highway Authority in respect of the Brimington bypass. The Society is urging the Authority to spend an additional £1,700,000 to provide culverts to allow for a navigable canal. The canal in question is silted up and has been severed in many places since the 1930s. The disused railway at Brimington is also wanted by interested groups for use as part of a long distance public cycleway. 
then are emerging problems in a land category which was previously thought to be 'ideal' for highway engineering purposes and whilst the Brimington example is a scheme causing immediate concern, most of the Derbyshire examples have involved similar difficulties.

In regard to poor or 'fringe' industrial land, a further deterrent to its use is the potential re-grading of this land category to 'useful industrial land' which could be achieved by reclamation engineering; this would have the effect of making its use prohibitive in terms of increased land values.

In this respect Derbyshire may not be typical of many parts of the United Kingdom - particularly when compared to the South of England. Old mine workings are a feature of north-east Derbyshire and can often be stabilised by the use of the latest compaction techniques. After treatment such areas can be considered for further industrial use including the construction of new highways.

(h) There is a scope for this study to be extended so that the CRM can be adapted to a greater variety of schemes particularly in the North American system where there are potentially larger and more complicated schemes. An aspect of any American study should be the examination of the effect of the existing American Environmental Impact Analysis, and whether their longer experience of EIA's has made them (the American engineers and public) more 'environmentally aware' and because of this experience, whether the design process can be expedited more quickly and simply.

All scheme types in the United Kingdom should also be analysed using CRM; in this respect a range of schemes in areas closer to expensive residential areas (which was not generally the case in this study) would be of considerable interest in view of the changing land values and of potentially different local attitudes.
Of particular interest is the trend in the E and EX values with respect to new highway schemes, and whether these environmental mitigation capital costs are increasing or decreasing within the new generation of schemes planned for the next decade.

None of the Derbyshire schemes used in the application of CRM cost more than £7,125,000. Scope exists for further study into proposed urban motorways and trunk road schemes costing more than the above figure and preferably much higher; local examples are the Derby Southern bypass estimated at £60,000,000 and the Birmingham - Nottingham Motorway (Ashby - M1) estimated at £40,000,000.

(i) Trends in future land use provides scope for further research particularly in respect of land containing old disused industrial workings. This study should be carried out in tandem with land use and land values pertaining to rural areas and in particular agricultural land adjacent to residential land. An adjunct to this study should be the monitoring of proposed planning regulation changes made possible by the current National Government Legislative proposals - which has the potential to affect the 'Green Belt'.

(j) Trends in future legislation should be examined in respect of ecological sites and Sites of Special Scientific Interest, where future statutory protection could possibly be changed. Concomitant with this study it would be of value to also examine future recreational areas linked to old industrial sites such as canals, and industrial archeological sites. It is important to forecast how the foregoing trends will develop because the land (or land value) has a direct bearing on the CRM, for example statutory protection is not currently available for certain ecological sites - and should this change, the input to the CRM would also change.
(k) Environmental impacts such as visual intrusion and visual obstruction remain unquantifiable as disparate environmental impacts. Scope exists for further research into the psychological reaction to various types of schemes and highway structures. For example, an assessment could be made of public reaction to high embankments and elevated structures and to various types of landscaping techniques. An analysis of the reaction and opinions could be related typically to distances from the proposed impact which in turn should be related to land value changes. In tandem with this assessment it would be pertinent to relate the data to the immediate surroundings occupied by the new highway works, typically rural, semi-rural or urban.

Germane to the above topic is the impact of driver stress about which little is known. A useful research programme could be implemented with assistance from motor manufacturers in association with traffic engineering specialists and ergonomists.
The foregoing chapters have examined and analysed the capital cost aspects of the environmental impacts created by the construction of new highways. In this connection the premier achievement of the study has been the development of the new design technique, the Commercial Route Methodology, to enable engineers to understand and evaluate the capital cost of the combined but disparate environmental impacts.

As this study has progressed, interest in the environment has continued as a major force both in politics and in everyday life. The subject matter making up the environment is of almost limitless interest and indeed on a practical level in 1988 the European Economic Community made Environmental Impact Analysis a statutory planning requirement for all major works, including highway schemes.

The highway engineer must show himself to be equal to the challenge presented by such a multi-faceted topic, which takes the engineer into many areas of interest not normally associated with engineering.

The financial aspects become increasingly important as the 'value for money' ethos has become an integral part of today's society; a society increasingly interested in financial accountability and associated business and professional efficiency, in fact an ideal platform to present this new and important design technique - the Commercial Route Methodology (CRM).
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<tr>
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<td>Transport Supplementary Grant (Derbyshire County Council) 1987/88.</td>
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<td>3</td>
<td>Derbyshire County Council: Delays on planned scheme starting dates (1975-1989).</td>
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<tr>
<td>4</td>
<td>MAFF Classification of agricultural land and Department of Transport Productivity Index.</td>
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<td>5</td>
<td>Environmental Impacts capable of being costed.</td>
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<td>Final capital costs of environmental mitigation measures - Highway 13: Saskatchewan, Canada.</td>
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<td>United Kingdom Published Sources: Capital costs of environmental mitigation measures.</td>
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<td>8</td>
<td>International Published Sources: Capital costs of environmental mitigation measures.</td>
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<td>Highway design network - figure no. 1.</td>
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<td>2.</td>
<td>Highway design network - figure no. 2.</td>
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<td>Graph showing capital expenditure on roads in Derbyshire 1978/79 - 1987/88.</td>
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<td>11.</td>
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(All discounted to 1979 in £1000s)

<table>
<thead>
<tr>
<th>Capital Cost Including Prep'n &amp; Superv'n</th>
<th>Maintenance Costs</th>
<th>Total = PVC</th>
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<td>Cars</td>
<td>LGV</td>
<td>OGV</td>
<td>PSV</td>
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<tr>
<td>Local Traffic Only</td>
<td>2138</td>
<td>533</td>
<td>272</td>
<td>236</td>
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<td></td>
<td>699</td>
<td>379</td>
<td>307</td>
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<tr>
<td>Local and Attracted Traffic</td>
<td>5989</td>
<td>1482</td>
<td>1137</td>
<td>545</td>
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<tr>
<td>Difference</td>
<td>998</td>
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</table>

\[ PVB = \text{Local benefit} + 50\% \text{ Difference} \]

\[ \text{NPV} = PVB - PVC \]

\[ = \frac{3808}{783} \]

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<th>High Forecast Benefits</th>
<th>Link Transit Benefits</th>
<th>Junction Benefits</th>
<th>Accident Benefits</th>
<th>Total</th>
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<td></td>
<td>Cars</td>
<td>LGV</td>
<td>OGV</td>
<td>PSV</td>
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<tr>
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<td>545</td>
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<td>Difference</td>
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\[ PVB = \text{Local benefit} + 50\% \text{ Difference} \]

\[ \text{NPV} = PVB - PVC \]

\[ = 5067.5 \]

APPENDIX A
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<th>GROUP 3 USERS OF FACILITIES</th>
<th>EFFECT</th>
<th>PREFERRED ROUTE</th>
<th>MODIFIED SOUTHERN ROUTE</th>
<th>MODIFIED SOUTHERN ROUTE</th>
<th>DO MINIMUM</th>
<th>COMMENTS</th>
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<tr>
<td>SUB-GROUP: Users of:-</td>
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<td></td>
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<td></td>
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<tr>
<td>(a) Town Centre Shops</td>
<td>Reduction of</td>
<td>Reduced &amp; diverts</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>Existing</td>
<td>Traffic growth will increase pedestrian/traffic conflict in town centre</td>
</tr>
<tr>
<td>Church Street/Ringwood Road (Brimington Town Centre)</td>
<td>Vehicle/Pedestrian conflict</td>
<td>traffic such that pedestrian/traffic conflict substantially reduced</td>
<td>Some pedestrian could be considered</td>
<td></td>
<td></td>
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<tr>
<td>(b) Crematorium Chapel (Chesterfield Road)</td>
<td>(a) Noise Change in Chapel</td>
<td>Reduction in noise level by 5dB(A)L10</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>Existing noise will increase with traffic growth</td>
</tr>
<tr>
<td></td>
<td>(b) Visual Obstruction</td>
<td>None (some intrusion whilst Tapton operating without Brimington)</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>(c) Severance</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>No effect</td>
</tr>
<tr>
<td>(c) Two Churches on Church St &amp; Ringwood Road (Town Centre)</td>
<td>(a) Noise Change in Building</td>
<td>5 dB(A)L10 Decrease</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>Existing noise will increase with traffic growth</td>
</tr>
<tr>
<td></td>
<td>(b) Visual Obstruction</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>(c) Severance</td>
<td>Easier to obtain access to each Church</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>As Preferred</td>
</tr>
<tr>
<td>(d) Library (on Church Street)</td>
<td>(a) Noise Change in Reading Room</td>
<td>Reduction of 5 dB(A)L10 reduction</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>(b) Visual Obstruction</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>(c) Severance</td>
<td>Considerable reduction on existing conditions</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>As Preferred</td>
<td>No effect</td>
</tr>
<tr>
<td>POLICY</td>
<td>AUTHORITY</td>
<td>INTEREST</td>
<td>PREFERRED ROUTE</td>
<td>MODIFIED PREFERRED ROUTE</td>
<td>SOUTHERN ROUTE</td>
<td>MODIFIED SOUTHERN ROUTE</td>
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<tr>
<td>--------</td>
<td>-----------</td>
<td>----------</td>
<td>-----------------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>------------------------</td>
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<tr>
<td>(a)</td>
<td>To protect the conservation area around Brimington Church</td>
<td>Derby CC Chesterfield Borough</td>
<td>Improvement of the environmental quality of the Conservation area and reduction of pedestrian/vehicle conflict</td>
<td>Reduces and diverts traffic away from Conservation area</td>
<td>As Preferred</td>
<td>As Preferred</td>
</tr>
<tr>
<td>(b)</td>
<td>To protect Tree Preservation Area</td>
<td>&quot;</td>
<td>Effect on Trees</td>
<td>None</td>
<td>None</td>
<td>Small area destroyed inRingwood Park</td>
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<tr>
<td>(c)</td>
<td>To protect the habitat of rare plants etc located in SSSI at Blue Bank Wood/ Pools</td>
<td>&quot;</td>
<td>Effect on SSSI</td>
<td>Destroys small area of Blue Bank Pools</td>
<td>As Preferred</td>
<td>No effect</td>
</tr>
<tr>
<td>(d)</td>
<td>To maintain and improve footpath &amp; cycleway network</td>
<td>&quot;</td>
<td>Use of existing towpath/footpath &amp; create new cycleway</td>
<td>Create new cycleway - Tepton to Newbridge Lane</td>
<td>As preferred</td>
<td>No effect</td>
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<tr>
<td>(e)</td>
<td>To maintain canal as continuous waterway</td>
<td>British Waterways</td>
<td>Use of existing canal at 6 points but kept in water by piping</td>
<td>Sewers Canal As Preferred</td>
<td>No effect but canal continuous waterway</td>
<td>As Southern Route</td>
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### PUBLIC INQUIRY FRAMEWORK

<table>
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<th>TRANSPORT, DEVELOPMENT AND ECONOMIC POLICIES</th>
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<td>POLICY</td>
<td>AUTHORITY</td>
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<tr>
<td>TRANSPORT</td>
<td></td>
</tr>
<tr>
<td>(a) To improve Principal Road Route To M1</td>
<td>DCC</td>
</tr>
<tr>
<td>(b) To relieve local traffic problems in Brimington and District</td>
<td>DCC</td>
</tr>
<tr>
<td>(c) To concentrate Heavy Goods Vehicles on suitable roads</td>
<td>DCC</td>
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<tr>
<td>DEVELOPMENT &amp; ECONOMIC</td>
<td></td>
</tr>
<tr>
<td>(a) To develop New Industrial Estate North of Brimington</td>
<td>DCC</td>
</tr>
<tr>
<td>(b) To develop Brimington and District Shopping Centres</td>
<td>DCC</td>
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</table>
Costs of Environmental Factors In New Road Schemes

I am a Chartered Civil Engineer working on a post-graduate research project into the 'financial implications of incorporating environmental factors in new road schemes'.

In order to collect a reasonable amount of data I should be grateful if you would give me some idea of the environmental costs which have gone into any examples of major schemes (say over £500,000) over the last 5 or 6 years which you feel able to discuss.

The costs I have in mind are any of the following:

Landscaping, planting, natural stone and reconstructed stone, noise insulation, special finishes, noise bunds, etc. (The total scheme cost would be useful). There may be other special features eg roads in cuttings for environmental reasons or, say, flatter batters than is technically necessary.

The theme behind the project is to show that highway engineers do usually put a major effort into accommodating environmental factors in new works and this may be reflected in the scheme costs (including design costs).

Should you be able to assist please reply to Loughborough University of Technology, Department of Civil Engineering (for the attention of Mr F Shaw or Mr W Dutch).

I would be pleased to pay for any 1/2500 or 1/10,000 plans you may feel able to release at this time.

Yours sincerely

W G DUTCH
Dear Mr. Dutch,

Cost of Environmental Factors in New Road Schemes

I have been considering the request you have made in your letter of the 22nd November and regret that I do not believe I can be of help to you.

Devon, as you are probably aware, has many areas of great landscape value and of great natural beauty. Other areas have been defined as Coastal Preservation Areas or Nature Conservation Zones. My Engineers, when designing schemes in this County are naturally very sensitive as to the effect their proposals will have on the countryside into which new road schemes are to be located. This sensitivity has been built into the schemes at the outset so it is not possible to put a cash value on specific environmental factors since they are part of the ethos of my organisation.

What I can tell you is that the cost of planting on highway schemes varies from between 1.5% and 5% of the overall works cost depending upon local circumstances. This figure includes the cost of aftercare which is so important if the planting scheme is to flourish.

I am sorry that this reply does not answer your specific questions, but I am sure you will appreciate that these issues are not seen in isolation but as an integral part of the design process.

Yours faithfully,

[Signature]

COUNTY ENGINEER & PLANNING OFFICER

APPENDIX D
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**STATUTORY AUTHORITIES WORKS**
- Add 20% to 1984 Estimates

- **EMEA (Derby)**
  (Allow for moving pylons)
  - £250,000

- **EMEA (Chesterfield)**
  - Chesterfield Borough
  - £132,000
  - British Telecom
  - £210,000
  - Savan Trust (Chesterfield)
  - Gas (Doncaster)
  - Mansfield (15 c.f.)
  - £75,000

**Sub Total - Stat £919,000.00**

**STRUCTURES** (Pre-Data 1986/87)
- Est in Tannew with Tapton
- Tinkerside (Brook) and Troughbrook
- 150 l.m @ £400/l.m.
  - £59,000

**Sub Total - Structures £952,000.00**
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\(\text{Works Cost} \approx £7,125,000\)
### Check Commercial and Preferred Against

**Similar Scheme Actual Costs - Tapton Bypass**

**Basic Rate:**
\[
\frac{192}{m^2} \text{ carriageway,}
\]

\[
4400 \times 10 \times \frac{1}{92}
= £4,048,000
\]

**Add Junctions / Side Roads**

\[
3.14 \times 2.5 \times 2 \times 10 \times 29 \times 3
= £433,332
\]

**Total:**

\[
\text{SAY } £5,200,000
\]

*(Against £5,424,900)*

*ie Comparison of correct order*