CHAPTER THIRTEEN

GROWTH OF TRAFFIC AND EFFECT ON PROGRAMMES

Chapter 13

Growth of Traffic

13.1 *Introduction*

13.1.1. Having made an assessment in Chapter 12 of the annual costs of operating and maintaining the Commercial and Cruising waterways for the alternative programmes, we are required by paragraph 16 of the Terms of Reference: (a) to consider to what extent further growth in waterway usage might be limited by physical considerations, (b) to discuss how and at what costs those limitations might be overcome, and (c) to advise on any increased works required and any effect on the alternative programmes, assuming general increases in traffic of 100% and 200% above present levels.

13.1.2 As no time scale or growth rate has been specified for the purpose of making the assessments called for in (c) above, it is necessary to examine such information relating to past trends as is available in order to establish when the higher traffic levels are likely to be reached and thus how the programmes may be affected. Since conditions, both of the waterways themselves and of their traffics, differ considerably on Commercial and Cruising waterways, the two categories will be considered separately and are discussed in Sections 13.2 and 13.3 respectively.

13.1.3 Whilst we have endeavoured throughout the course of this Study to ascertain from our own observations, as well as by discussions with the Board, those parts of the system which may be sensitive to increased traffic considerations, we cannot be certain that all such situations have been identified. Some will undoubtedly be due to the limitations of fixed structures, others to operating factors. The effects of these can be forecast with reasonable confidence, as discussed in Section 13.4.

13.1.4 Any close assessment of the effect of substantially increased traffic levels on the system must however also depend on the resources and yield of the water supply network, which vary unpredictably according to the incidence of wet and dry periods. Forecasts can only be made on an empirical basis and as a complete study of the whole system would take several years we must therefore base this chapter on our general appreciation of the situation. This aspect is also developed further in Section 13.4.

13.1.5 In making the following assessments we have based growth considerations on 1974 traffic levels and have assumed that the terms "increase in traffic" and "growth in waterway usage" refer to tonneage and craft numbers, and do not imply any increase in the statutory dimensions of the Table 10.1 craft.

13.2 *Trends – Commercial Waterways*

13.2.1 Although primarily concerned with commercial traffic the Board's Commercial waterways are used, in some cases fairly extensively, for pleasure boating. For this reason it will be necessary to examine the past trends for each activity separately.

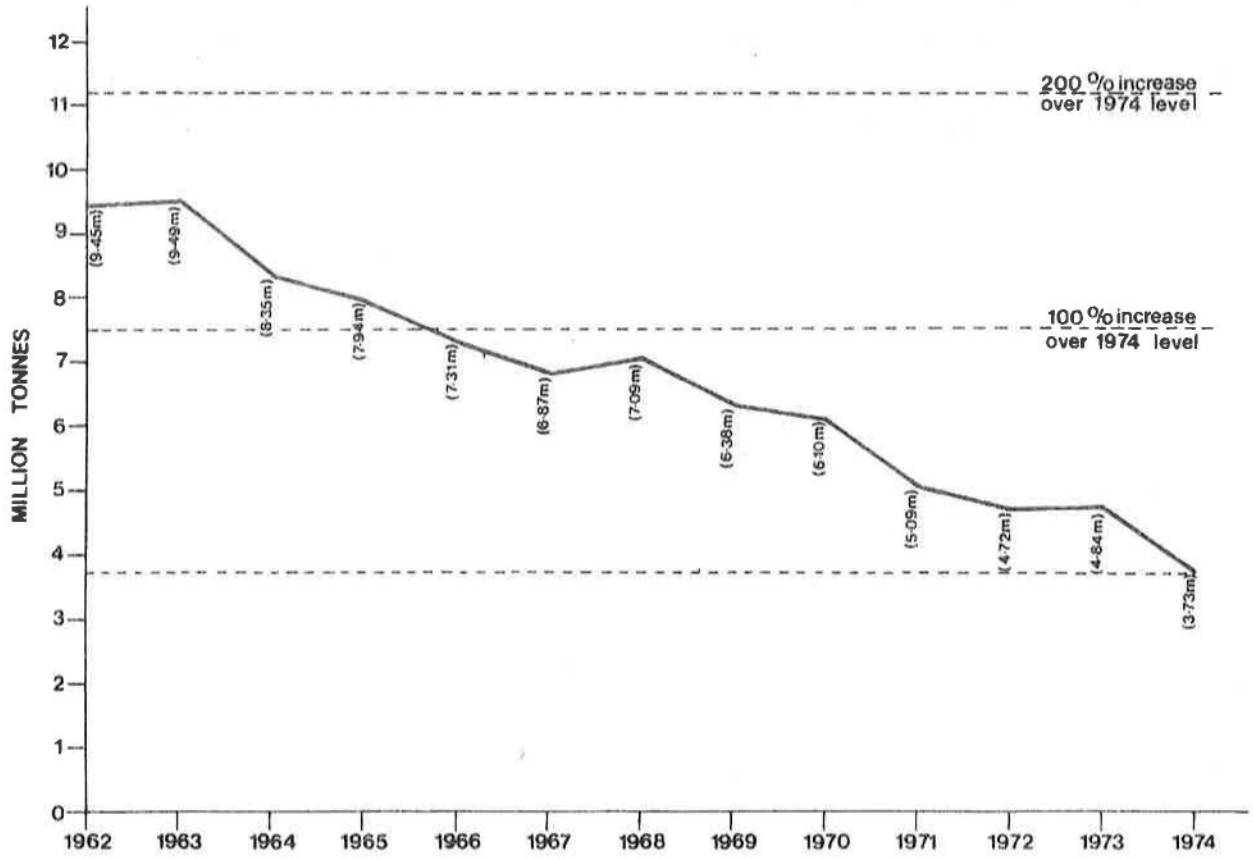

Fig 13.1 TONNEAGE OF FREIGHT CARRIED / YEARS

Commercial Traffic

13.2.2 From Fig. 13.1, which has been developed from statistics provided by the Board for the period 1962 to 1974, it can be seen that there has been a steady decline in traffic and that the total tonneage of freight carried in 1962 was about 150% greater than that handled in 1974. More particularly it can be seen that the level of traffic as recently as 1965 is equivalent to a 100% increase on the 1974 tonneage which is therefore well within the capacity of the Commercial waterways.

13.2.3 Although we have obtained, from the British Transport Commission's annual reports, figures of the annual tonneage of freight carried on the waterways within their jurisdiction during the period 1948 to 1962 it has not been possible to abstract data relating solely to Commercial waterways. As these overall tonneage figures indicate that traffic levels were also falling during the earlier period it would seem that these waterways may well have sustained a level of traffic 200% greater than that of 1974.

13.2.4 In view of the foregoing, and if as we have assumed in paragraph 13.1.5 craft sizes remain unaltered, there should be no general difficulty in accommodating the contemplated 200% increase in commercial traffic. However, since this traffic may not be distributed evenly throughout the system, certain waterways would require further and more detailed consideration if it were required to examine the effects of the same proportionate increase at all points.

Cruising Traffic

13.2.5 From Table 13.1, the figures for which have been extracted from the results of the one-day pleasure boat count, it can be shown that there has been a general, if somewhat erratic, growth in pleasure boating on the Board's Commercial waterways of about 27% during the last five years.

13.2.6 Examination of Table 13.1 shows that no less than 68% (in 1973) and up to 85% (in 1970) of the total number of pleasure craft observed were associated with three waterways, the River Severn and the Lee and Trent Navigations. The density of traffic on the Severn and the Lee in 1974 was as high as 18 boats per kilometre which is greater than that found on most of the more popular Cruising waterways, referred to in paragraph 13.3.5 and Table 13.3. Even on some of the other Commercial waterways the density is comparable with the figure of about 8 boats per kilometre which is the pleasure boat average for the whole of the navigable system

Combined Traffic

13.2.7 Whereas we can see no general difficulty under a 100% increase in traffic the substantial increment of total craft movements represented by a 200% increase in cruising traffic makes it necessary to consider the effect of these total movements on the capacity of the Commercial waterways. There are three factors which in our view make the difficulties less serious than might be thought likely.

13.2.8 The main limitation on the capacity of a Commercial waterway arises from the locks, as discussed in Section 13.4. These locks are large in comparison with the average size of pleasure boats so that in most cases several craft can be locked through together at one penning. Secondly, as some of the pleasure boating on these waterways is of a local character the number of pennings required to deal with existing numbers of pleasure craft is not necessarily large in comparison with those for commercial freight carrying craft. If the respective traffics increase in the same proportion this ratio of pennings may not increase; it may even decrease if more pleasure craft are taken through at one time. Thirdly, the locks on the Commercial waterways are generally under the supervision of lock keepers. This would enable the increased traffic to be worked through under control and thus with better operating efficiency.

13.2.9 It seems likely to be the case that commercial freight traffic will not increase as quickly or to the same extent as cruising traffic. Alternatively a substantial increase in commercial traffic would probably have the effect of discouraging a corresponding further increase of cruising activity. Nevertheless we have assumed, for the purpose of the assessments made in Section 13.5, that the growth rate on the Commercial waterways as a whole would keep pace with that for the Cruising waterways as summarised in paragraph 13.3.6, i.e. the 100% increase would be reached in 1982 and the 200% level in 1988.

13.3 *Trends – Cruising Waterways*

13.3.1 Although the traffic considerations under this heading are mainly concerned with cruising we should mention that

Table 13.1

Waterway Ref. No.	Commercial Waterway	Length km	Number of Pleasure Boats				
			1970	1971	1972	1973	1974
1a	Lee Navigation	49.5	734	797	1237	717	915
15	Gloucester & Sharpness Canal	27.0	104	171	197	222	232
16	River Severn	69.0	1159	1051	1020	1064	1244
22	Weaver Navigation	32.0	65	75	101	145	116
28	Trent Navigation	88.0	794	829	677	667	832
34	Sheffield & South Yorkshire Navigation	71.5	128	170	226	286	339
35	Aire & Calder Navigation	85.5	134	133	151	177	221
36	Calder & Hebble Navigation	15.0	38	47	54	73	102
47	Caledonian Canal	96.5	*	137	155	156	211
48	Crinan Canal	14.5	*	95	102	86	89
* No record	TOTALS	548.5	3156	3505	3920	3593	4301

some traditional narrow boats still operate commercially over the system. From Chapter 5 it is seen that 59 craft held commercial carrying licences in 1974 and that the freight carried by these craft on Cruising and Remainder waterways was some 134,000 tonnes.

13.3.2 In view of this relatively small volume of traffic and the fact that commercial narrow boats make the same kind of demands on the system as the more traditional cruising craft, i.e. converted narrow boats, we have examined the past trends of both cruising and commercial traffic in one assessment as follows. Two sets of information, namely the one-day count figures and the numbers of craft licensed and registered, were available from which to establish a growth pattern and hence provide an indication of when the higher traffic levels of 100% and 200% may reasonably be anticipated.

13.3.3 As the records of the total number of craft licensed and registered do not reflect actual usage of the system directly, we consider that for the purpose of estimating the timing of increased growth levels the one-day count figures are more satisfactory. This count includes all boats using the waterways, boats in private arms and basins and ashore along the waterways, but excludes commercial craft on Commercial waterways; it was designed by the Board to provide an index to the changing use of the system year by year.

13.3.4 From Table 13.2, the figures for which have been extracted from the results of the one-day count for the period 1970 to 1974 inclusive, it can be seen that, in recent years, there has been a steady growth in pleasure boating on the Board's 1,743 km of Cruising waterway of the order of 10% per annum. The average density of craft at 9.0 boats per kilometre over these waterways in 1974, may be compared with 7.8 for the Commercial waterways and 4.6 for the navigable Remainder waterways – the total count being 21,200 craft over 2,659 km (8.0 boats per kilometre).

Table 13.2

Year	1970	1971	1972	1973	1974
Number of Craft	10,542	11,679	12,563	14,125	15,634
Increase		1,137	884	1,562	1,509
% Increase		10	8	12	11

13.3.5 On inspection of the breakdown of the 1974 boat count into individual Cruising waterways, in Table 13.3 below, it can be seen that the density of craft on these varies considerably from a minimum of 2 boats per kilometre on the Stourbridge Canal to the exceptional maximum of 47 boats per kilometre on the upper reaches of the River Trent above Nottingham. It should be noted that these figures are averaged over the whole length of each canal, and cannot be used as a reliable index of congestion at any particular point in the system. There are at present a number of critical locations where congestion is experienced at the peak of the season, for example Hurleston Locks (at the junction between the Shropshire Union Canal Main Line and the Llangollen Branch), and in the Braunston area (where a number of popular through-routes converge).

13.3.6 While it is true that the present economic climate, coupled with the signs of incipient congestion at certain points, may serve to discourage growth of cruising traffic in the immediate future, we have nevertheless used the cumulative

Table 13.3

Waterway Ref. No.	Cruising waterway	Length km	1974 count	Density boats/km
1b	River Stort	22	246	11
	Grand Union Canal			
2	Regents Canal, Hertford Union Canal and Paddington Arm.	37	425	11
3	Main Line (Brentford-Napton)	177	1,564	9
6	Main Line (Napton-Birmingham)	63	396	6
5	Leicester Section South (Norton-Foxton)	37.5	163	4
26	Erewash Canal	1.5	28	19
27a	Leicester Section North (Market Harborough-Leicester)	37	134	4
27b	River Soar Navigation	41.5	661	16
7	Stratford-on-Avon Canal	20	285	14
8	Coventry Canal	61	293	5
9	Ashby Canal	34	86	3
10	Oxford Canal North	38.5	309	8
11	Oxford Canal South	80.5	581	7
12	Kennet & Avon Canal	39.5	488	12
17	Worcester & Birmingham Canal	48	465	10
18	Staffordshire & Worcestershire Canal	75.5	834	11
19	Stourbridge Canal	8.5	21	2
20a	B.C.N. – Main Lines	37	116	3
20b	Birmingham & Fazeley Canal	24	133	6
	Shropshire Union Canal			
21a,b,c	Main Line (N) & (S) and Middlewich Branch	124	1,789	14
21d	Llangollen Branch	75	318	4
23	Trent & Mersey Canal	148.5	966	7
28	Trent Navigation	21.5	1,009	47
30	Witham and Fossdyke Navigations	71	857	12
31	Chesterfield Canal	41	230	6
33	Ripon Canal and River Ure Navigation	15	279	19
36	Calder & Hebble Navigation	20	116	6
37	Huddersfield Broad Canal	6	28	5
40	Peak Forest Canal	10.5	114	11
41	Macclesfield Canal	44	517	12
45	Leeds & Liverpool Canal	215	1,058	5
46	Lancaster Canal	68.5	1,125	16
	TOTALS	1,743	15,634	9

figure of 10% per annum to estimate the timing of longer term growth levels. On this basis a 100% increase would be reached after 7 years (in 1982) and a 200% increase after 11 years (in 1986). However since a tailing-off of this growth rate must be expected as the ultimate capacity of the system is approached we feel it is reasonable to extend the second stage by another two years so that the 200% increase will be reached after 13 years (in 1988). Since the programmes in Chapter 12 have been taken to commence in January 1976 the increased traffic levels of 100% and 200% would be realised in their 7th and 13th years respectively.

13.4 *Limitations on Growth*

13.4.1 The physical factors tending to limit growth of traffic on the waterways may be considered under three broad headings as follows:-

(a) Waterway Structure

(b) Infrastructure

(c) Water Supply

Waterway Structure

13.4.2 Under this heading there are first to be taken into account the dimensions of the waterways themselves, particularly the cross sectional dimensions discussed in Chapter 10, and their condition. Provided that they are brought into and maintained at a proper standard as prescribed in Chapter 12 there should be no difficulty in catering for a large increase in volume of traffic on the open waterways of normal section. On the Commercial waterways, increases in tonneage of freight carried would not necessarily involve a corresponding increase in the number of craft movements; craft of larger dimensions than those presently in service could be used so long as they do not exceed the statutory dimensions of Table 10.1.

13.4.3 On the Cruising waterways more practical limitations arise from the existence of such bottlenecks as extended flights of locks – especially staircase flights – and single-track tunnels and aqueducts. The obstructive effect of the latter varies with their length, as craft wishing to proceed in one direction may have to wait for several craft approaching from the other direction to clear the full length. Long tunnels and aqueducts would be very costly to widen or duplicate and the alternative, to improve traffic flow, is to install systems of traffic control with signals. Shorter bottleneck structures could be duplicated or widened at less expense though their delaying effects are correspondingly less serious.

13.4.4 Locks certainly give rise to limitations on the volume of traffic that can be passed in a given time. Where they are spaced out, so that craft travelling in opposite directions can pass each other in the intervening pounds, the delays suffered are simply those due to the operation of the locks themselves and no additional delay is caused by the existence of the opposing craft. Our observations confirm the general opinion that most locks on the Cruising waterways could cope with a much greater number of craft movements than occur at present so that, subject to the reservations made in the following paragraphs, even a 200% increase of traffic could be accommodated.

13.4.5 The statement just made must be qualified in two respects. Firstly, where locks are arranged in staircase flights their effect is very much more pronounced than that of the same number of locks well spaced out. As explained in Chapter 9, craft cannot pass and delays arise at each reversal of traffic flow. Furthermore the lock operations involve the use of more water than a series of single locks. Depending on the number of locks in the flight, staircase locks can impose a serious limitation on traffic capacity which will necessitate the undertaking of engineering works as detailed in Section 13.5.

13.4.6 Secondly there are places, such as those mentioned in paragraph 13.3.5, where congestion and delay are already apparent at peak periods. This indicates that any increase of traffic at these locations could be accommodated only if measures are taken to exercise more control of craft movements. More efficient working of locks would result from having experienced supervisors at peak periods, as is the present general practice on the Commercial waterways. Traffic signals at single-track tunnels and aqueducts were mentioned in paragraph 13.4.3 and elsewhere similar controls would be advantageous; a recent installation is at Reading, on the Kennet and Avon Canal. In other places, more particularly on Commercial waterways, an installation on the lines of the system (ARCLAB) proposed for the Aire and Calder Navigation would expedite traffic movements considerably.

13.4.7 Provision of traffic control systems, as of engineering works and the supervision at locks, is dealt with in Section 13.5 together with estimates of cost. While it is anticipated that the supervisors would be fully occupied throughout the busier seasons in controlling traffic, regulating pound levels and generally optimising the use of water resources, they would be usefully employed at other times in assisting with routine maintenance and contributing to the reserve of labour needed to be available in case of emergency.

13.4.8 In assessing the need for these additional supervisors – and also for the measures described in Section 13.5 – it is not realistic to suppose that the peaks of traffic already experienced at certain times and places would all be increased in proportion to the total growth of traffic. No amount of traffic control can speed up operations beyond a particular maximum and once that is reached any further pressure of traffic can be accommodated only by extending the peak rate movements over longer periods of time. This will mean that in some cases a 200%, or even a 100%, increase of traffic could be achieved only by the device of spreading the heavier concentrations out more uniformly over the season and by dispersing the traffic more evenly throughout the system.

13.4.9 Subject to the foregoing qualifications we consider that in general the physical limitations of the waterway system would not present any great difficulty in accepting 100% or 200% increase of traffic. There are, however, a few places where the limitations are more serious and where congestion and delays are experienced even in present conditions. These include those mentioned in paragraph 13.3.5 for which provision is made in Section 13.5. It must be stressed, however, that any assessment of limitations must take account of factors (such as the development of hire-cruiser operations, private cruising preferences, water supply conditions, etc.) which cannot be predicted accurately. We shall, therefore, adopt an empirical approach in Section 13.5 to determine the need for additional works and traffic control.

Infrastructure

13.4.10 On the Cruising waterways this heading covers such items as the availability of moorings, amenity services, hire bases and other operating needs. For all these suitable sites

must be provided by the BWB or private firms on or close to the waterways. The needs of pleasure boating and cruising must also be provided for on the Commercial waterways, although facilities for freight handling are outside our Terms of Reference.

13.4.11 For the Cruising waterways, the provision of moorings is already a cause of concern as discussed in Chapter 5. Further increases of traffic are bound to aggravate the congestion caused by the presence of permanent linear moorings (both BWB and privately owned) along the banks and would have the effect of restricting the navigation of the channel and reducing the capacity of the waterways. The Board are already giving consideration to other means of providing berths and moorings and we agree that it will be essential to remove permanent moorings from the main channel though their function as overnight moorings could remain. To some extent it would be convenient and economical to re-open branches and basins now closed to traffic in addition to the construction of marinas and the like to cater for the needs of present and future traffic.

13.4.12 Similarly an extension of various service facilities would be needed – boatyards, accessory shops, fueling stations, water and refuse and sewage disposal points. Such facilities would often be provided by hire-cruiser operators at their bases but the BWB would also find it necessary to act in respect of water and refuse and sewage disposal, especially for chemical toilets. Consideration would also have to be given to the proximity of general shops for groceries and provisions, perhaps pharmacies and certainly public houses and off-licences.

13.4.13 Just as peaks of operating intensity will necessarily have to be spread out in time, so the effects of local congestion will lead to a physical dispersion. The siting of marinas, service centres, hire-cruiser bases, etc. will become increasingly important for this reason, in addition to the considerations of water supply mentioned in Chapter 9 and touched on again below.

Water Supply

13.4.14 The problems of water supplies were discussed in some detail in Chapter 9, and indications were given in Tables 9.2 and 9.3 of the kind of provision that would become necessary in dealing with increased traffics. It is, however, desirable to repeat here that although increased traffic will, through a larger number of lock operations, make greater demands on water resources, such demands will not generally increase in proportion to the traffic. This is because (a) there are losses of water that remain sensibly constant irrespective of traffic movements, and (b) more efficient usage of locks, arising from greater traffic control, enables more craft to be passed for the same consumption of water.

13.4.15 It is not possible to make calculations of water demand that would be of general application. Conditions vary greatly from place to place and we can only give broad indications of the way in which existing limitations of water supplies might be overcome with a view to meeting the needs of increased traffics. We have already pointed out that any proposal for a large new storage reservoir would involve such lengthy and detailed examination, in conjunction with the various authorities concerned, that we have not considered it feasible for inclusion in our assessments.

13.4.16 The BWB water engineers are well placed to make detailed and practical proposals for additional water supplies where and when the need should arise and we are not aware of any fundamental limitation that would make it impossible to meet the demands of the increased traffics now contemplated. We would again stress, however, the value, and indeed importance, of full consultation between the BWB and the RWA concerned in any particular area of need, with a view to a better appreciation of possibilities in the interests of all who may be affected.

13.4.17 Finally, under this heading, it would not seem necessary to provide for entire sufficiency of water supplies for the increased levels of traffic under the unfavourable conditions of a long succession of dry years. Drought conditions impose exceptional limitations on traffic capacity even in present circumstances and we would not consider it unreasonable to expect corresponding limitations for short periods in dry spells even after provision has been made for extra supplies to meet increased traffics.

13.5 *Measures Required and Associated Costs for 100% and 200% Growth*

13.5.1 The following assessment, which has been based on the general considerations outlined in Section 13.4, under the three headings of waterway structure, infrastructure, and water supply, examines the timing and associated costs (at March 1974 prices) of the measures necessary to overcome the physical limitations of the system under the contemplated increases in traffic. The three assessments are combined at the end of this Section to provide a programme which will be used in Section 13.6, where the effects of traffic growth on the alternative programmes are considered.

13.5.2 We have made no provision in this assessment for any increase in traffic in excess of the 200% level. It should be noted, however, that if further growth is to be accommodated at least some of the extra measures involved would need to be planned and executed before the 200% level is reached.

Waterway Structure

13.5.3 From Section 13.4 it can be seen that limitations on growth arising from considerations of the waterway structure can be overcome by providing traffic control and undertaking engineering works. Traffic control in the form of signalling, i.e. traffic lights or more sophisticated systems, or direct supervision will be required at many locations throughout the system.

13.5.4 The cost of providing for signalling devices, which is dependent on such factors as availability of power supply, accessibility and the form of system adopted, differ from location to location. For example we estimate that the cost of installing a set of suitably phased traffic lights at single track tunnels would vary between £1,000 for the 300m long Maida Hill Tunnel on the Regents Canal, to £7,000 for the 2680m long Harecastle Tunnel on the Trent and Mersey Canal. Similarly for long aqueducts e.g. Pontcysyllte and Chirk we have made allowances of £3,000 and £2,000 respectively. However a centralised electronic lock control system on similar lines to the 'ARCLAB' scheme, which would be necessary on the Commercial length of the Calder and Hebble Navigation for the 200% growth level, would cost some £150,000. On this basis we estimate that the total cost of signalling devices on Commercial and Cruising waterways would be £220,000 at the 100%, and a further £500,000 at the 200%, growth levels. As the ongoing costs of such devices would be relatively small and therefore have no significant effect on this assessment we have absorbed them in the general summary of annual operating and maintenance costs in paragraph 13.5.26.

13.5.5 As mentioned in paragraph 13.5.3, direct supervision will be required at many locations over the system. Although in general all the locks on Commercial waterways are manned, there has been a decline in the numbers of lock keepers on Cruising waterways. Whilst we do not expect that the 200% growth level would warrant the manning of all locks, as in many cases one lock keeper is able to supervise several, permanent attendance will be necessary at some intermediate stage at critical locks and multiple lock situations such as flights and staircases. In assessing the need for lock supervision we have also taken account of the benefit gained by having experienced personnel controlling the pound levels, thus optimising the use of existing water resources.

13.5.6 With these considerations in mind we estimate that 87 additional lock keepers (20 in the first year) would be required to cope with the 100% growth, with a further 84 in the succeeding years for the 200% growth. The operating cost for each lock keeper has been taken as £1700 per annum which gives an annual expenditure of some £150,000 in 1982 and £300,000 in 1988 consequent upon the 100% and 200% increases respectively.

13.5.7 It will be essential to provide canal-side housing for many of these permanent lock keepers. In this context we estimate that the Board would find it necessary to build 10 additional properties for the 100% growth and a further 30 under the conditions of 200% growth to compensate for those existing lock cottages which, because of leasing arrangements, they would be unable to reallocate. Assuming that the cost of building is £15,000 per house this would give a total of £600,000. For the purpose of this exercise we have spread this figure evenly over the 200% growth period, i.e. 12 years, to give an expenditure of £50,000 per annum.

13.5.8 After taking account of the effects of traffic control measures any further relief of congestion will entail engineering works in the construction of duplicate lock flights, or perhaps a lift. We consider that at the 100% level duplication would be required of the triple rise staircase locks at Grindley Brook on the Llangollen Branch of the Shropshire Union Canal; the cost is likely to be of the order of £200,000.

13.5.9 For the accommodation of 200% traffic increase we consider it would also be necessary to provide duplicate lock flights at Foxton and Watford, at either end of the Leicester Section summit level of the Grand Union Canal. The estimated costs would be of the order of £600,000 and £450,000 respectively. At Foxton it is possible that an electrically powered inclined lift, similar to the one in operation there between 1900 and 1910, might be a slightly cheaper alternative, but at Watford it is likely to be rather more expensive. For present purposes, therefore, the figures quoted for the locks are sufficiently close.

13.5.10 We have considered the case for extending the number of lock duplications to other sites, but justification can be found only at staircase flights where both delays and water demands are inevitably more serious than at a series of individual locks. Even so we are of the opinion that staircase formations of wide locks, such as exist at Banavie and Muirtown on the Caledonian Canal and at Bingley on the Leeds and Liverpool Canal, could accommodate the increased traffic levels without undue difficulty. In the latter case this is because of the absence of wide craft and the consequent possibility of passing several narrow craft at each penning.

13.5.11 The total capital costs of all works likely to be required under the heading of 'waterway structure' would therefore be £720,000 for the 100%, and an additional £1,850,000 at the 200% traffic increase levels. The associated additional operating and maintenance costs would be £150,000 and £300,000 per annum respectively.

13.5.12 On the assumption that the growth of traffic would be a continuous process, as discussed in paragraph 13.3.6, and that the various measures and works would need to have been provided before the respective levels are reached, it is considered that capital expenditure would need to rise from a figure of approximately £75,000 in 1976 to a peak of about £450,000 in 1983, thereafter tailed off completely by the end of 1988. These variations, and the increasing operating costs mentioned in the previous paragraph, are illustrated in Fig. 13.2.

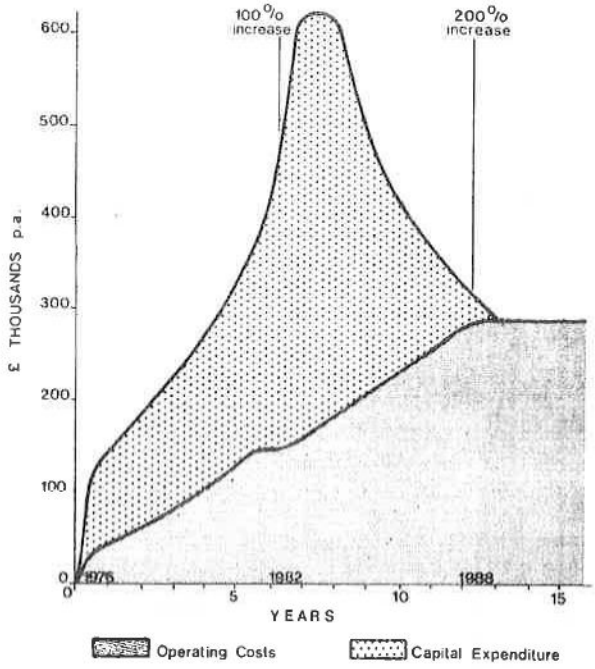

Fig. 13.2 WATERWAY STRUCTURE – EXPENDITURE PROGRAMME

Infrastructure

13.5.13 Requirements under this heading are concerned with the provision of moorings and essential services. From the preliminary results of the recent moorings survey referred to in paragraph 5.4.5 it has been ascertained that of the total of 16,500 moorings on the Commercial and Cruising waterways the Board own some 3,300 and that 3,000 of these are linear moorings located on the main navigable channel.

13.5.14 As noted in paragraph 13.4.11 we are in agreement with the Board that it is desirable for navigational reasons, particularly under the contemplated levels of traffic, to remove permanent moorings from the main channel. In this context, assuming that the Board will continue to provide the same proportion of total future moorings as at present, allowance has been made for the provision of alternative berths for their existing 3,000 linear moorings as well as those required for growth considerations. This results in a requirement of 6,000 berths for the 100% increase and a further 3,000 berths for the 200% increase.

13.5.15 We estimate the average cost of providing a berth to be £400 and have allocated the annual cost of such provision in direct proportion to the expected growth. The cost of resiting the existing berths has been spread over the first three years of the programme. The total expenditure therefore for a 100% increase is £2,400,000 with a further £1,200,000 for the 200% increase.

13.5.16 Although we consider that private enterprise would provide such facilities as general stores, chandleries and fuelling stations it would be necessary for the Board to extend their provision of water points and refuse and sewage disposal points over the system. For an eventual increase of traffic of 200% we consider that the spacing of these essential services should be no greater than 25 km. We have ascertained the respective numbers of the existing facilities and therefore the additional numbers required to build up to this density. Allowing a cost of £500 per refuse disposal point, £200 per water point, and £2,000 per sanitary station we estimate that the total cost of additional facilities for the 200% growth would be £137,000, of which some £40,000 would be required as the 100% growth level is reached.

13.5.17 The totals of capital expenditure under the heading 'infrastructure' thus amount to £2,440,000 at the 100% level and a further £1,297,000 for the 200% level. The programme for this is illustrated in Fig.13.3. No additional operating costs are allowed for as it is considered that in practice they could be absorbed in the allowances made in Chapter 12.

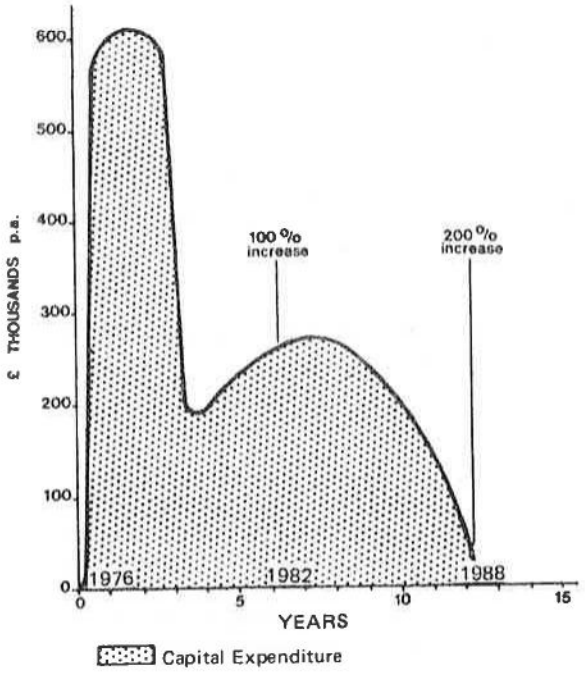

Fig. 13.3 INFRASTRUCTURE – EXPENDITURE PROGRAMME

Water Supply

13.5.18 A close assessment of water demands for sustaining the contemplated levels of traffic would require detailed studies and could only be based on assumed patterns of rainfall; as previously stated we have adopted a more empirical approach in identifying situations where the various measures would be necessary. Chapter 9 includes a discussion of the principal features and in particular Table 9.3 (Parts I and II) provides some indication of the additional pumping installations that would be required. Other measures would include the improvement of reservoir storage capacity and the reduction of bed and bank leakage.

13.5.19 In compiling estimates of cost we have allowed for all the works and measures to be completed before the 200% increase in traffic level is expected to be reached. It is not possible to predict the incidence of dry periods, which might make earlier completion desirable, nor to make accurate allowances for the benefits to be obtained from tighter control of locks at different times and places. For these reasons our estimates are based on a succession of average years; as mentioned in paragraph 13.4.17 we consider it unnecessary to provide for full supplies under extreme conditions.

13.5.20 We have examined requirements throughout the system on the basis of a canal-by-canal analysis, with a view to identifying as realistically as possible the places where water supplies would be critical, and the most appropriate means of meeting needs in each case. In selecting suitable sites for pumping installations we have not overlooked the fact that at many places the water taken down by the locks from the higher levels may be their only form of supply. Table 9.3 Part I lists under Note C former or existing pumps which should be replaced, either for back pumping or for supply from other sources; Note D in Part II indicates some of the new installations which would be required in addition and these are mainly for back pumping. The installation suggested at Newton Harcourt for pumping from the River Sence would be a new supply, requiring approval from the Regional Water Authority, and no doubt detailed studies undertaken jointly by the BWB and the RWAs would bring out other similar possibilities.

13.5.21 Costs of individual pumping installations will show considerable variation depending on the number of locks involved, the required output from the pump, the lengths of rising main involved, the availability of power supply and the type of control equipment required. On the average however we consider that the capital cost of installing one pumping unit with a rated output of about 0.4 Mlh would range between some £7000 for a single isolated lock and about £25,000 for eight locks in a close series; costs for lock flights would be greater if the locks were spaced out more widely. The cost of operation and maintenance in an average year would be of the order of £750 per lock. Costs for installations drawing water from rivers, etc., would be similar to those of back lockage pumps operating over the same hydrostatic head. Exceptional items include the replacement of the existing pumps and the installation of automatic control equipment at Salford Bridge and Bowyer Street Pumping Stations in Birmingham, and the cleansing and repair of the 2.6 km. culvert of 1.4 m diameter between these two stations, at a total estimated cost of £80,000.

13.5.22 On the assumption that growth of traffic would be continuous it is reasonable to suppose that a programme of pumping installation works would be spread fairly uniformly over the twelve year period before the 200% increase level is reached. Operating and maintenance costs would tend to rise more steeply since not only would new costs be incurred as the later units are brought into service but those units installed in the earlier years would need to operate more intensively as the traffic densities increase. Having regard to these factors, and on the basis of the canal-by-canal analysis mentioned in paragraph 13.5.20, our estimate of capital investment required for pumping installations and of the corresponding operating and

maintenance costs for the 100% and 200% increases are as follows:-

	Capital Cost £000	Operating and Maintenance Costs £000 p.a.
At 100% increase level	560	60
Additional for 200% " "	450	60
Total at 200% " "	1,010	120

13.5.23 In addition to these pumping installations we consider that allowance would need to be made for increasing the storage capacity of certain reservoirs. The principal items would be at Winterburn Reservoir on the Leeds and Liverpool Canal and at Boddington Reservoir on the Oxford Canal (South). All works of this nature require detailed studies in accordance with the requirements of the Reservoirs Acts so that close estimates cannot be made at this stage, but we consider that similar increases in capacity should be feasible at other reservoirs such as Welford, Olton and Napton on the Grand Union Canal, and Upper Bittell on the Worcester and Birmingham Canal. We have therefore made provision in our estimates for the likely cost of such works, and for other possible augmentation of water supplies such as improving the yield of the chalk aquifers near Tring.

13.5.24 Finally under the heading of 'water supply' it would be necessary to undertake remedial works where canals and feeders lose considerable quantities of water through bed and bank leakage. As indicated in paragraph 9.6.5 it is not possible to estimate the extent to which it would be economical to carry out such works. For this reason we have included notional allowances of £50,000 for both the Chesterfield and Lancaster Canals, £200,000 for the Llangollen Branch of the Shropshire Union Canal, and a further £200,000 for grouting operations on the Leeds and Liverpool Canal.

13.5.25 The total expenditure estimated to be required in respect of the 'water supply' heading may therefore be summarised as follows:-

	Capital Cost £M	Operating and Maintenance Costs £000 p.a.
At 100% increase level	1.6	60
Additional for 200% " "	2.2	60
Total at 200% " "	3.8	120

and the corresponding programmes are illustrated in Fig. 13.4. It should again be emphasised that all these figures are based on the assumption of a continuous succession of years of average rainfall. In practice there would certainly be considerable variations of both supply and demand, and in some years quite substantial deficiencies would be experienced as at present. In all the circumstances, however, we do not consider that any substantially larger provision for water supplies to meet the needs of increased traffic would be justifiable.

Summary

13.5.26 The estimated total capital costs of making provision for growth of traffic, under the three headings of 'waterway

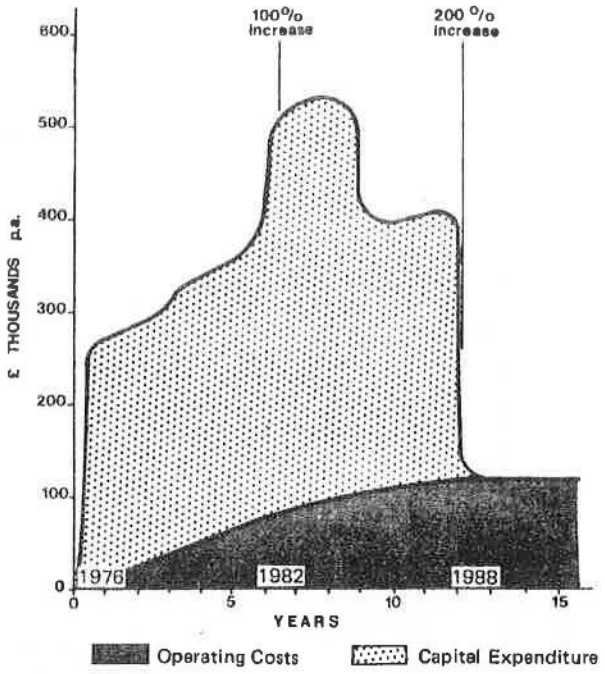

Fig. 13.4 WATER SUPPLY – EXPENDITURE PROGRAMME

structure', 'infrastructure' and 'water supply' would thus amount to £4.8M at the 100% level and a further £5.3M at the 200% level, making the total of £10.1M referred to below in paragraph 13.6.8. The corresponding additional operating and maintenance costs are estimated to amount to £210,000 and £420,000 per annum respectively. The incidence of these costs, related to the anticipated rate of growth of traffic and the timing of the works designed to cope with it, is illustrated in Fig. 13.5. The hump of capital expenditure in the first few years is due to the replacement of the existing linear moorings mentioned in paragraph 13.5.15; in other respects the present system can accommodate some increase of traffic but the need for expenditure rises rapidly as the 100% level is approached.

13.6 *Effect of Traffic Growth on the Alternative Programmes of Chapter 12.*

13.6.1 We are asked to consider the effect of increased traffic levels on the programmes outlined in paragraph 13 of the Terms of Reference, which were developed (on the assumption that traffic would remain at present levels) in Section 6 of Chapter 12. The four programmes A, B, C and D are illustrated there in Figs. 12.3 to 12.6. For a number of reasons programme B is not comparable with the others, nor do we consider that it can be accepted as realistic for a fifteen year period from 1976 without reappraisal on a number of counts (see paragraph 12.7.4). We shall therefore confine our discussion in the following paragraphs to the three remaining programmes (A, C and D). Changes necessitated directly by heavier traffic, in the cost and timing of the arrears works and on the levels of continuing future maintenance, are first considered, leading to adjusted annual expenditure and assessments of Net Present Cost in Table 13.4 (compared with Table 12.13). The costs of the extra measures and works described in Section 5 of this Chapter are then superimposed on these adjusted programmes and the resulting overall patterns of expenditure over the fifteen year period are illustrated in Figs. 13.6, 13.7 and 13.8 for programmes A, C and D respectively.

13.6.2 Increased traffic levels will have the effect of accelerating the deterioration due to the passage and handling of craft. The main influence will be on bank protection, where

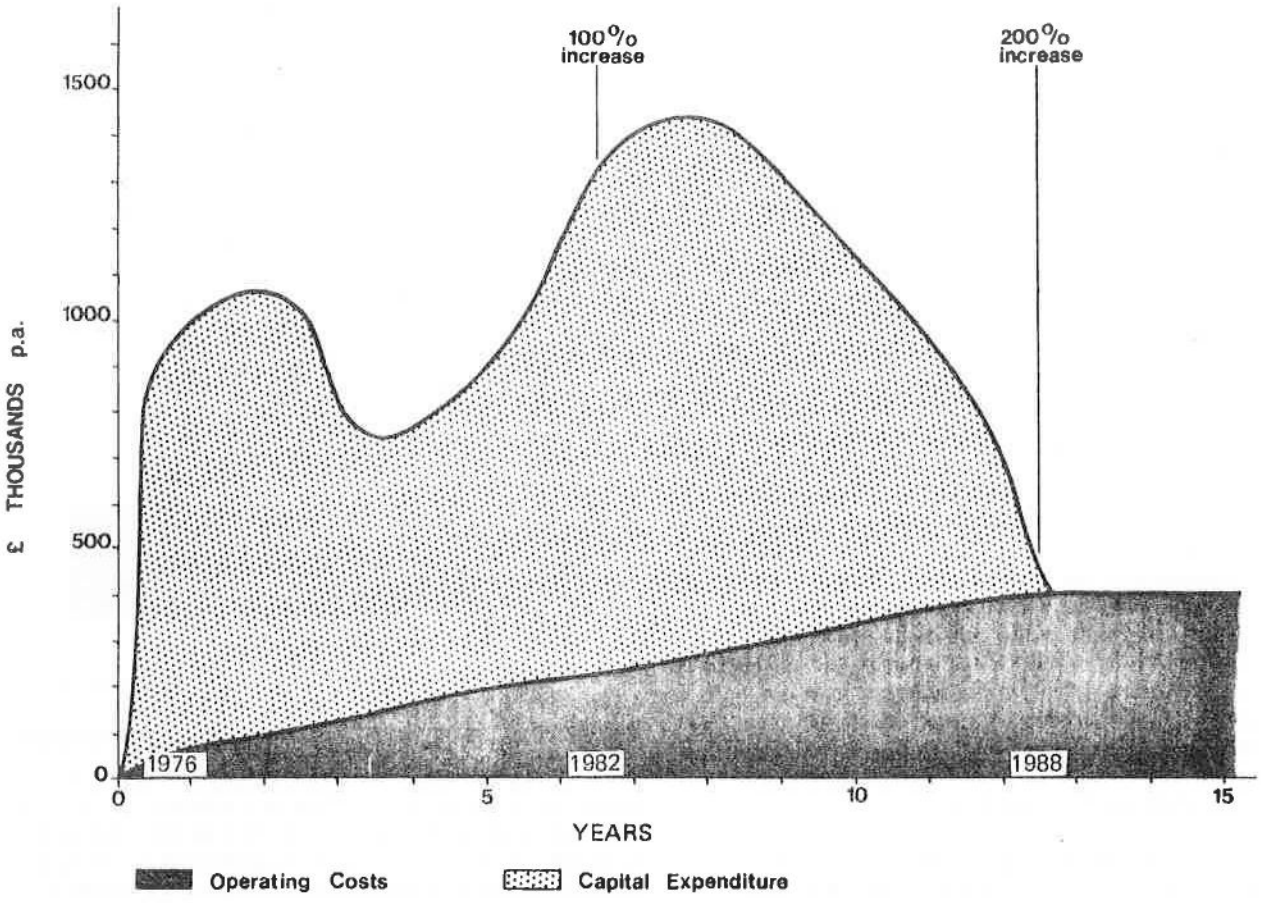

Fig. 13.5 COMBINED EXPENDITURE PROGRAMME

damage to existing revetments and erosion of presently unprotected banks will occur at an increased rate because of the greater incidence of wash waves. This will also shorten the periods between successive attentions to the brickwork and masonry of bridges, locks, aqueducts, tunnels etc. at water level. As far as *arrears of maintenance* are concerned, it will be necessary to carry out works earlier than we have foreseen in Chapter 12, but not to increase the total provisions, for two reasons; firstly because situations with implications for public safety will become critical sooner, and secondly because of the disproportionate cost penalties incurred when damage is allowed to pass the point at which piecemeal repairs can be carried out. For *continuing annual maintenance*, we have previously argued that the programmed long-term levels of expenditure must be reached within one or two years of the start of the programmes if further arrears are not to accrue. With rising traffic levels these continuing maintenance figures would be higher and. although their introduction might strictly be phased in according to the anticipated rate of increase of use, we have allowed for the full increment from the second year. This is instead of modifying the arrears figure (i.e. works which should already have been carried out, or would need to be put in hand before any programme can be implemented) which would otherwise have had to be increased under each programme.

13.6.3 Turning now to the individual programmes, and dealing first with changes in the annual distribution of *arrears costs*:-

Programme A needs no adjustment as the arrears are all overtaken within five years, and there should be no difficulty in phasing the works so that the more critical aspects are remedied in good time, even under the accelerating effects of rising traffic levels. We should mention, however, that the disadvantages inherent in such a crash programme (as discussed in Section 12.6) still lead us to conclude that this is not in the Board's best overall interest.

Programme C is designed to incorporate as little work as possible in the first five years. We found in Chapter 12 that in spite of this a total of £7.6M had to be spent in those early years, and we estimate that this would become £9.6M under conditions of rising traffic use. In addition to this it would be necessary to telescope expenditure for the remaining ten years so that works associated with the water channel (i.e bank protection, structures, bed and embankment repairs, etc.) are completed earlier. To this end we have increased the total value of works programmed for years 5 to 8 by £2.5 M and subtracted the total of £4.5M from the later years so that the overall cost of the arrears programme remains the same as in Chapter 12. The alternative course of action would have been to continue with the earlier programme of expenditure and catch up on the resulting new arrears as they arise -- this would be likely to prove markedly more expensive and would have implications for public safety (paragraph 13.6.2 above).

Programme D is our recommended pattern of expenditure over the next 15 years. With the projected increase in traffic levels we are now considering, this pattern must be reconsidered in order that it may continue to meet the criteria set out in paragraph 12.7.2. Our assessment of the changes will not be accurate within close limits as the effects

of, for example, wash waves cannot be quantified or predicted in detail. We have examined the information available however, and consider that works to a value of £3M programmed between years 10 and 15 would have to be brought forward – £2M of this to the first five years, and the remaining £1M to the second five years.

13.6.4 Following the argument of paragraph 13.6.2, the effect on continuing maintenance levels will be the same for each of the programmes A, C and D. This is analysed under three headings as follows:-

Bank Protection: Two of the three sub-headings of paragraph 12.4.6 are expected to increase, i.e. (i) regular minor maintenance and dealing with flood and impact damage by £25,000 to £125,000 per annum and (iii) new protection to virgin banks by about 50% to £700,000 per annum. We have not allowed for any reduction in the average useful life of protection under the increased effects of wash waves etc., though deterioration would be more rapid once the lower limit of acceptable condition is reached. The annual cost of (ii), replacing existing protection, would therefore remain unchanged at £315,000. Hence we estimate that the annual cost of bank protection works would increase by £255,000 to £1,140,000.

Structures: Pointing and patching of brickwork and masonry in the 'splash zone' about water level would increase, and this would be particularly expensive for aqueducts and tunnels with their greater areas of such construction, and for locks because of increased craft impact and changes in water levels due to operation. The average life of lock gates would similarly reduce to some extent. We have allowed £100,000 per annum to cover the increased intensity of maintenance of the structures of the present system.

Others: There would be indirect effects of augmented craft usage across all elements of the system, for example we expect a consequential increase in use of operational equipment and property, and of reservoirs, feeders, etc. These considerations are comparatively minor but will be significant when taken together. We have put a notional figure of £50,000 per annum to this total.

We conclude, therefore, that as a direct result of the projected increase in traffic use continuing maintenance costs would be increased by some £400,000 per annum, which we have applied from the second year as explained in paragraph 13.6.2.

13.6.5 In making the adjustments referred to in the preceding paragraphs the total expenditure for each programme is increased, by the additional annual operating and maintenance costs for the elements of the present system, to the amounts shown in Table 13.4. below.

13.6.6 From Table 13.4 it is seen that although the actual cost of overcoming the arrears for each of the programmes remains unaltered the effect of telescoping this expenditure for programmes C and D is to increase the associated Net Present Costs. This, when combined with that of the discounted annual expenditure (due to the alterations in the basic annual operating and maintenance cost figures) results in increases in the total Net Present Cost of £3.3M, £3.9M and £4.3M for programmes A, C and D respectively.

13.6.7 These figures show that although the N.P.C. of Programme D has increased by more than that of either A or C (which is to be expected, as no change was made to the timing of the arrears of Programme A, and C is designed to have as little expenditure as possible in the initial years), it remains the lowest of the three.

13.6.8 Dealing now with the extra measures and works from Section 13.5, the total expenditure to accommodate a 200% increase on the 1974 traffic level is £13.0M, which comprises both capital (£10.1M) and operating and maintenance (£2.9M) costs. This assessment is illustrated by Fig. 13.5, and has been superimposed on the adjusted programmes as detailed in Table 13.4 to obtain alternative total programmes of expenditure over the fifteen year period. These are illustrated by Figs. 13.6, 13.7 and 13.8.

13.6.9 The effect of this superimposition results in a further increase of £7.4M in the Table 13.4 Net Present Cost totals for each programme. Out of this £5.8M is due to the recommended programme of capital expenditure, and the remaining £1.6M to the increase in continuing annual costs. The resulting total and discounted costs of the alternative programmes are given in Table 13.5, where it may be seen that programme D is again the least expensive of the three. The considerations of Chapter 12 which led to the choice of this programme are equally relevant in this context, and we therefore consider that the form of the modified programme D represents the best value for expenditure under increasing levels of traffic.

Table 13.4 Adjusted Chapter 12 Programmes – Total and Discounted Costs Excluding Paragraph 13.5.26 Expenditure

Programme	Arrears	Continuing Annual Expenditure	Total Expenditure 15 years	Net Present Cost (Discounted for Interest at 10% p.a.)		
				Arrears	Annual Expenditure	Total
	£M	£M	£M	£M	£M	£M
A	40.6(40.6)	9.2 (8.8)	177.1(171.7)	30.5 (30.5)	68.6 (65.3)	99.1 (95.8)
C	47.0(47.0)	9.6/9.2 (9.2/8.8)	185.5(180.1)	23.6 (22.3)	70.0 (67.4)	93.6 (89.7)
D	37.6(37.6)	9.2 (8.8)	174.1(168.7)	23.1 (22.0)	68.6 (65.3)	91.6 (87.3)

(Figures in brackets from Table 12.13)

Table 13.5 Alternative Total Programmes – Total and Discounted Costs Including Paragraph 13.5.26 Expenditure

Programme	Capital Expenditure incl. Arrears £M	Continuing Annual Expenditure £M	Total Cost 15 years £M	(Discounted for interest at 10% p.a.) Capital Expenditure £M	Annual Expenditure £M	Total £M
A	50.7 (40.6)	9.4 (8.8)	191.0 (171.7)	36.3 (30.5)	70.2 (65.3)	106.5 (95.8)
C	57.1 (47.0)	9.5 (9.2/8.8)	199.4 (180.1)	29.4 (22.3)	71.6 (67.4)	101.0 (89.7)
D	47.7 (37.6)	9.4 (8.8)	188.0 (168.7)	28.9 (22.0)	70.2 (65.3)	99.0 (87.3)

(Figures in brackets from Table 12.13)

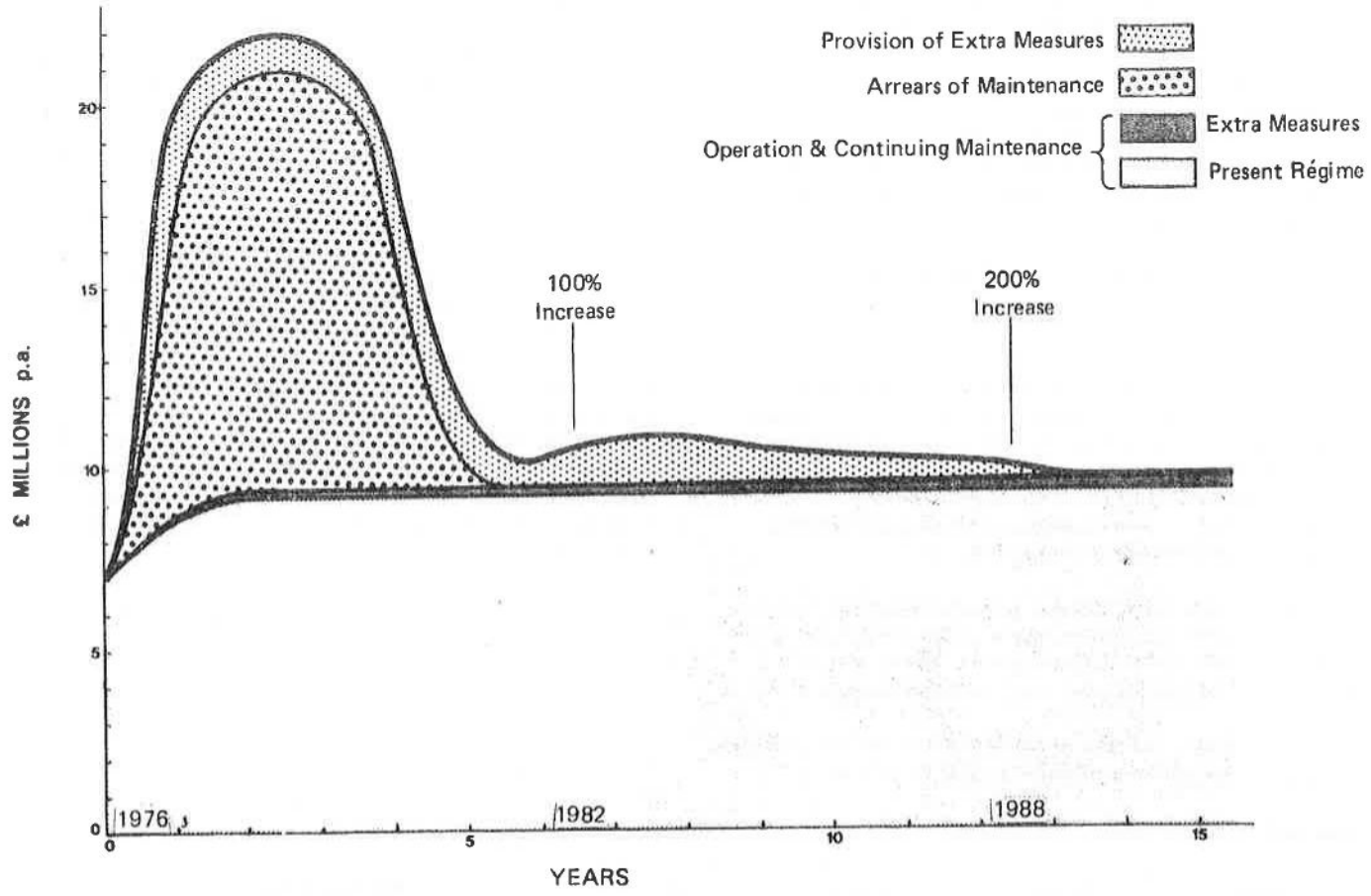

Fig. 13.6 PROGRAMME (A) UNDER INCREASED TRAFFIC

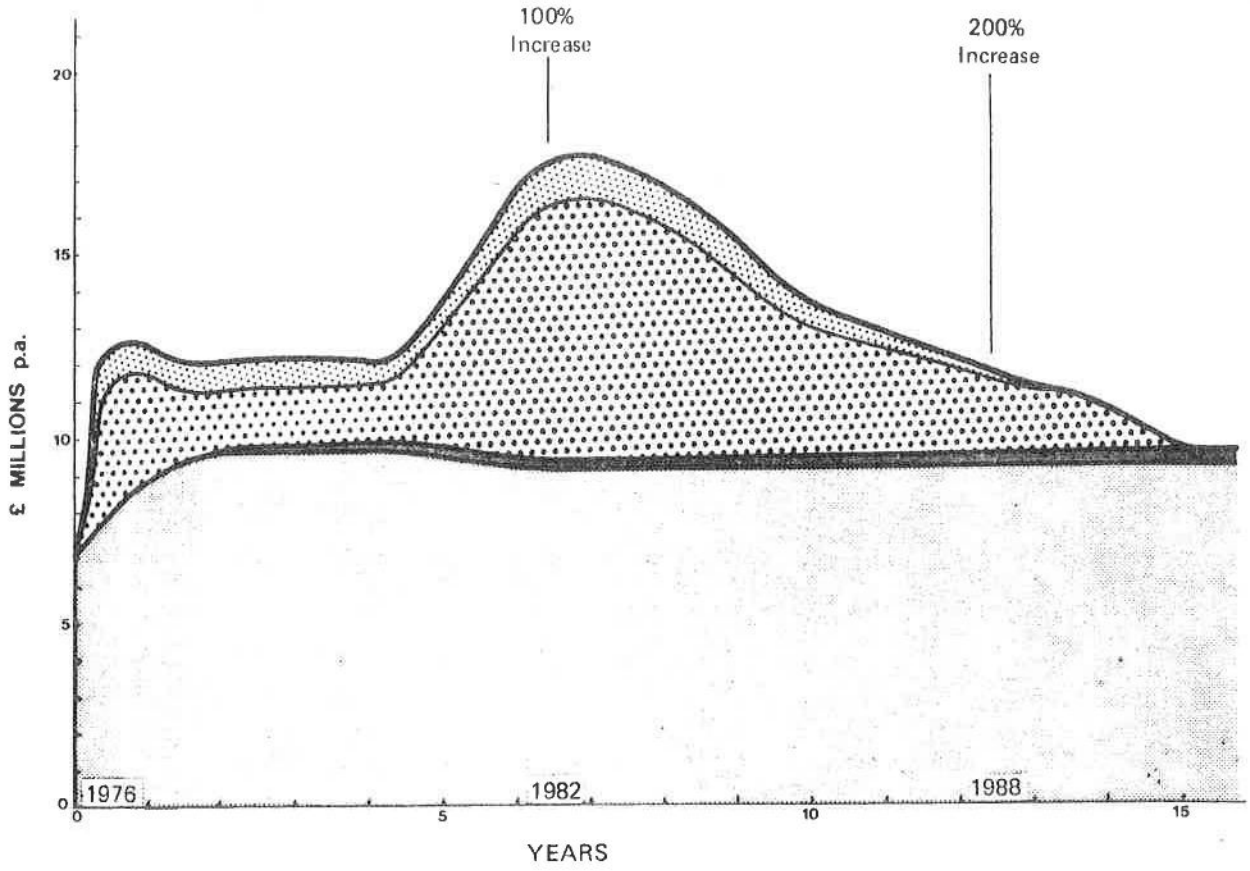

Fig. 13.7 PROGRAMME (C) UNDER INCREASED TRAFFIC

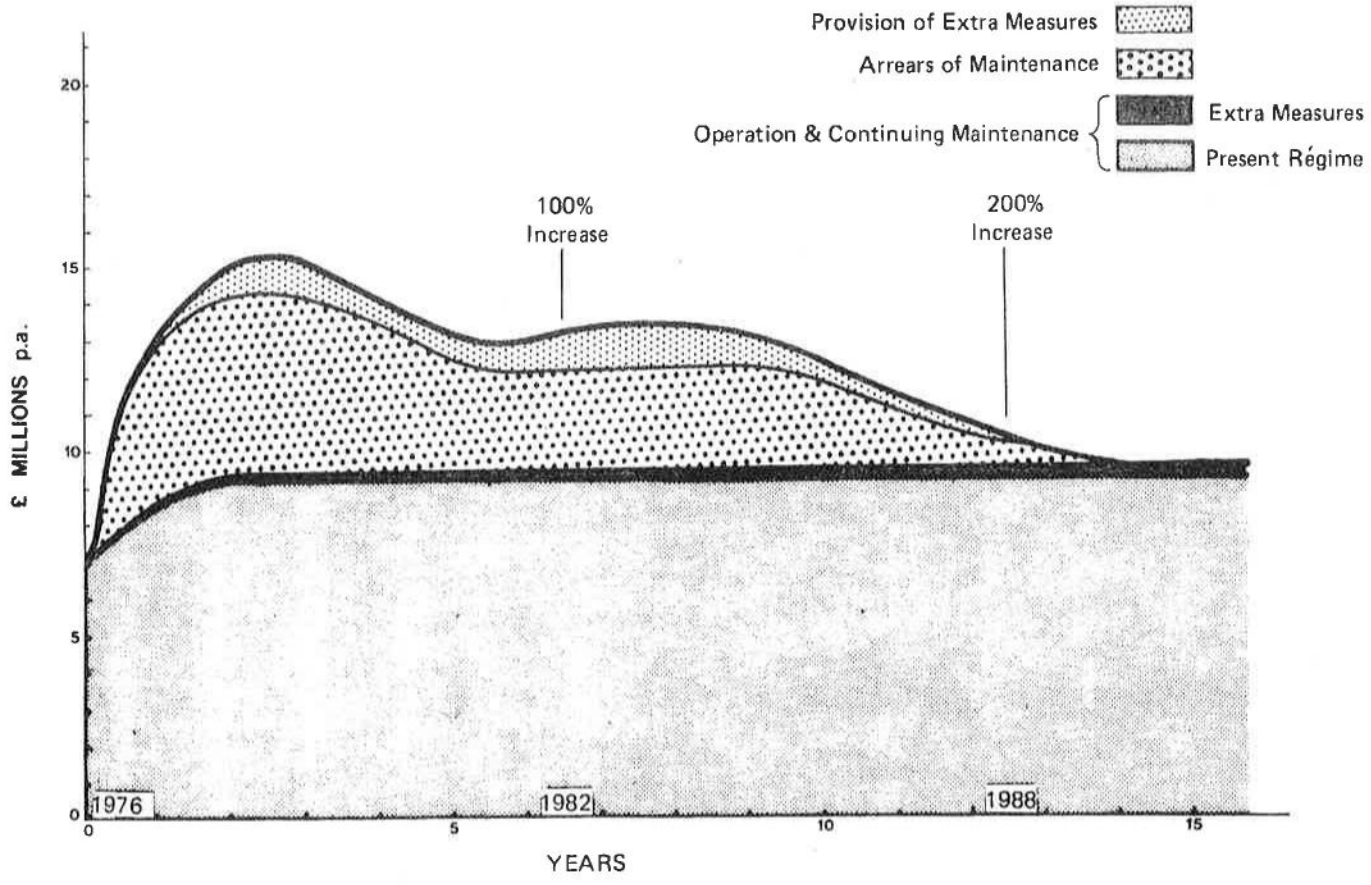

Fig. 13.8 PROGRAMME (D) UNDER INCREASED TRAFFIC

CHAPTER 14

THE COST OF PROVIDING FOR SPECIFIC NAVIGATIONAL STANDARDS

Chapter 14

The Cost of Providing for Specific Navigational Standards

14.1 *Introduction*

14.1.1 This chapter deals with paragraphs 4 and 17 of the Terms of Reference, "The Cost of Providing for Specific Navigational Standards". We are asked to consider what elements of the costs of operation and maintenance, identified in Chapter 12, arise from the provisions of Section 105 of the Transport Act 1968, i.e. in maintaining the waterway concerned at the specific 'Cruising waterway', and where appropriate the specific 'Commercial waterway', standards of Chapter 10. We are then to advise on these costs disregarding the need to provide for such 'Commercial' and 'Cruising' navigation.

14.1.2 The standards we have defined in Chapter 10 broadly comprise the quantitative requirements of Section 105 of the Transport Act 1968, together with qualitative engineering considerations relating to effective and economical maintenance. It is the first of these – the physical dimensions of the waterway and its structures in order that the relevant craft may be properly accommodated – which are the 'specific' navigational standards, and these are discussed in Section 10.3 and paragraphs 10.5.15 & 16.

14.1.3 In this connection it seems appropriate to consider the possible consequences of completely disregarding the need for navigation, even on certain river navigations where "custom and use" rights may exist. Our analyses are therefore based: (a) on the expectation of continued but diminishing use by craft which could navigate even when works related to the "specific" standards are not carried out, and (b) on the assumption that all navigation would cease immediately.

14.1.4 As paragraph 17 of the Terms of Reference does not call for consideration of any particular alternative forms of treatment, we have assumed for each of the above approaches that after navigation ceases the waterways would remain in being, and would continue to act as water channels for such purposes as water sales, land drainage and incidental amenity pursuits. There is accordingly no reference in this chapter to such possibilities as elimination, piping, closure, etc., nor is there any detailed analysis of what the most economical treatment might imply for individual waterways.

14.1.5 The elements of expenditure which are affected by navigational requirements are identified in Section 2 of this chapter and where relevant the fall-back standards which will need to be applied instead are discussed. Consideration is also given to the possibility of closing locks and bridges in certain cases. Consequent changes in the costs both of overtaking the present arrears of maintenance and of operation and continuing maintenance are developed in Section 3, and the results of our analyses are presented in tabular form and summarised in Section 4.

14.2 *Affected Elements of Maintenance*

14.2.1 Before considering individual elements of maintenance there is one question affecting virtually the whole field which must be discussed the economics of providing for maintenance craft of various types. It is a normal prerequisite of canal maintenance organisation that dimensional standards sufficient to afford passage to workboats, weedcutters, tugs, dredgers and particularly loaded dredging hoppers in transit between work sites and discharging tips, should be maintained as a minimum requirement. If all navigation on the waterways were to cease, then these requirements would no longer have to be met as a matter of course and their provision might make the overall costing of waterborne maintenance less economical than a land-based alternative, if such an alternative would be feasible in particular cases.

(a) *Removal of Specific Navigational Requirements*

14.2.2 Whilst any navigational use is made of the waterways, there are a number of maintenance tasks for which no savings would result from a change to land-based methods so that we would expect the use of craft and floating plant to continue in the foreseeable future. The prime example is the installation of bank protection involving driving of piles; weed cutting, attention to clay puddle seals and maintenance of most structures (with the possible exception of bridges which are by definition accessible to vehicles) are also important. On some Remainder waterways, where there is no fundamental objection to weiring locks, lowering or culverting bridges etc., the BWB have avoided such changes by showing that the use of through-navigating craft is the more economical maintenance method. Their arguments would be still more forceful when applied to Commercial or Cruising waterways, even when specific navigational requirements are ignored. We therefore consider that for the above maintenance tasks the 900mm draught dimension discussed in paragraph 10.3.15 should be generally adhered to throughout the system. The width of waterway over which dredging to the depth of 900mm (plus the appropriate allowances) would need to be provided would, however, be reduced since only a 'single track' channel would be necessary, though unladen hoppers of lesser draught travelling in the opposite direction might need to pass.

14.2.3 The conditions under which use of land-based dredging plant is feasible have been discussed in paragraphs 10.4.6 and 11.7.18. Although there is scope for a considerable extension of such methods in favourable circumstances we cannot see any likelihood of their replacing the waterborne alternatives over, for example, long continuous stretches of waterway, on the wider waterways, in many urban areas, in cuttings or on embankments with restricted shoulder width. On the assumption that access could economically be provided for land-based dredging plant on one fifth of the artificial Cruising waterways, and that this would in the long term halve the cost of dredging in those places, a saving of 10% of the annual cost might be expected. We have included this reduction in the calculations for the ongoing dredging cost estimates of paragraph 14.3.3.

14.2.4 Considerations of speed and hydraulic efficiency, including the ratio of the cross-sectional area of the waterway to the immersed cross-sectional area of the vessel, would no longer be of importance as the extra cost of any dredging involved would not be justifiable. Dredging to provide greater depths of water at

wharves, moorings etc. is directly related to dimensional standards and would no longer take place. In general, however, maintenance and dredging works due to the requirements of water supply and bulk transportation are not directly related in this way, and they would be continued in order to provide sufficient water for the Board's licensed abstractors and the craft which continue to use the waterways.

14.2.5 The necessity to preserve air-draught clearances (headroom and width) would no longer be a critical consideration if the specific navigational standards were not to apply, although an economic assessment would need to be made in some instances where maintenance craft would otherwise become unable to pass due to repair or reconstruction work reducing these dimensions. In isolated instances the financial saving might be considerable, as for example when ground subsidence had reduced the headroom in a tunnel to a point where the lining would otherwise need cutting out and rebuilding with increased clearance. In some cases also the relaxation of the dimensional standard of width might allow a sensitive structure to be protected from craft by new fendering within the waterway instead of major repair or reconstruction being necessary. Overall, however, arrears and continuing maintenance on structures would not be affected to any great extent.

14.2.6 There is one aspect of bank protection arrears which is directly affected by the dimensional standards. In some cases the arrears dredging to the waterway profiles required from Chapter 10 would involve a significant increase in the depth of water immediately alongside the bank, and here it was considered that the existing protection would not be capable of supporting the bank under this increased loading and would need replacing, or if there were no protection it might then become necessary. Without the specific dimensional standards these conditions would not arise.

14.2.7 The consequences of not providing for deeper water to meet the dimensional standards would not only include a saving in the cost of these protective works but might, in some cases, extend to a saving in continuing maintenance costs. This could be appreciable in conditions where gradual siltation at the sides of a canal would reduce the depth of water alongside the banks and ultimately prevent further deterioration. Neither still water nor river currents would favour such a situation, but slow dispersal of drainage effluents and siltation due to storm run-off would do so. The total effect is however likely to be local in character and of limited amount.

14.2.8 The foregoing maintenance headings are the only ones which would be affected as a direct consequence of disregarding the specific navigational obligations of the Transport Act 1968. If the extent of use of the waterways by traffic which could continue to navigate were to remain at about the same level as at present, then we would not expect any appreciable further changes in the costs of maintenance. Although removal of specific navigational obligations for Commercial waterways would not obviate maintenance for such profitable operations as might remain, it is likely that traffic levels would continue to fall, and probably fall more quickly. For Cruising waterways it is difficult to say what the trend might be, but we have discussed the effects of increased traffic in Chapter 13, and it now therefore remains to consider the effects of diminishing traffic.

14.2.9 The major effect of a significant reduction in traffic levels would be that damage to waterway banks by wash waves would be diminished. Works on structures would not be affected except in respect of deterioration at and below the waterline and reduced wear and tear in operational elements. Some aspects of operating costs would be eliminated – for example it would not be necessary to man locks in order to ensure efficient use of water resources – while others such as regulation and management of storm water would remain. Works concerned with the state of the waterways in relation to the general requirements of fishing and other amenity activities, and of the Board's other obligations under the Enabling Acts and other considerations of Chapter 3, would not alter in character or extent. The engineering requirements of Chapter 10 related to other than specific navigational standards would also retain the same importance, an example of this being control of vegetation, tree growth, etc. facilitating proper inspection of embankments, cuttings, reservoir headbanks and so on.

14.2.10 A great reduction of commercial and cruising traffic would certainly be followed very quickly by a considerable growth of weeds in the waterways, with the result that not only would the passage of maintenance craft be impeded but the channel would before long cease to be effective for the conveyance of water. Periodic weed cutting and clearing would then become necessary to maintain supplies to abstractors and to allow of free disposal of flood water and storm drainage.

(b) *Immediate Cessation of All Navigation*

14.2.11 Considering now the notional immediate cessation of all navigation, the same general arguments hold good but there will be more situations where a satisfactory and economical alternative in the form of land-based, or hybrid water and land-based, maintenance systems could be devised. For example the amount of bank protection work to be carried out each year will be reduced and the cost of making special arrangements to overcome difficulties of access in rural areas will compare more favourably with that of keeping locks etc. in operational condition. This is particularly likely where there are several locks close together, in a flight or staircase formation.

14.2.12 It is essential that water shall not overtop the bank of an artificial canal, so that where an appreciable quantity of storm water might be expected safe channel dimensions will have to be maintained by dredging irrespective of navigational considerations. In urban areas canals carry a considerable amount of surface run-off so that a single track, 900 mm draught, channel (allowing for navigation by maintenance craft) will generally remain justifiable. Examination of each length of waterway in sufficient detail to allow of accurate predictions of the most economical methods of maintenance has not been possible, but we have considered what type of plant

might be developed for use on some of the lengths covered by our survey and conclude that any consequent savings in on-going maintenance costs will not be very great. In this connection we have borne in mind that where an operational structure such as a lock falls into disuse it may be necessary to construct a weir or to form a cascade as for Remainder waterways (see Chapter 15), and that such development costs must be included. On this account, therefore, we find it appropriate to allow a 10% reduction in all continuing maintenance costs following sudden removal of all traffic, but no corresponding reduction of arrears costs is made as it is likely that development and reorganisation costs will absorb any saving in the early years.

14.2.13 For these reasons we shall, in the next Section, discuss changes in the cost of overtaking arrears and of continuing maintenance separately for the two postulated conditions of (a) some navigation remaining for the time being, to such extent as ignoring the 'specific' standards might allow, and (b) the immediate and total removal of traffic from all of the Board's Commercial and Cruising waterways.

14.3 *Costs of Providing for Navigational Standards*

14.3.1 As indicated in the last Section, the direct costs of providing for specific navigational standards will be considered first, the headings mentioned in paragraphs 14.2.1 to 14.2.7 being examined in some detail. We then give a more general estimate of the eventual effects of gradual cessation of traffic on the waterways with broad assessments of financial savings relative to the costs of Chapter 12. Finally we examine the general effects of the immediate cessation of all navigation. Where appropriate, arrears as well as operating and continuing costs are considered.

(a) *Removal of Specific Navigational Requirements*

14.3.2 In order to assess the effect on arrears of *dredging* the calculations described in paragraph 12.3.3 were repeated, but using waterway profiles derived from Chapter 10 for a single narrow or broad-gauge craft with 900 mm draught (see paragraph 14.2.2). The quantities of dredging thus found to be necessary are quoted as Area totals in Table 14.1, and comparison with the equivalent figures in Table 12.1 shows the element of arrears of dredging due to the specific navigational standards in that table.

14.3.3 The expenditure on continuing annual dredging maintenance is impossible to forecast accurately. It is unlikely that any quantity of dredging will be required on the Commercial waterways as they are mainly river navigations and constructed or enlarged for use by vessels much larger than the maintenance craft of paragraph 14.2.2. We have therefore estimated that the whole of the annual costs there would be saved. For the Cruising waterways there is bound to be a need to undertake local dredging at various places from time to time, but the quantities removed will be much smaller and the intervals between operations more extended. In view of the long average distances separating the sites, however, it is difficult to anticipate any substantial reduction in plant and equipment needs; so that the existing plant is likely to be retained but used less intensively. It is evident, therefore, that the unit cost of dredging will be increased (by reason of intermittent and "spot" working, additional transport costs and unproductive time, etc.) so that the total costs for dredging the Cruising waterways are not likely to be reduced very substantially. We estimate that a reduction of some 20% could be expected in this category, and the sum of £330,000 is accordingly entered in Table 14.2.

14.3.4 The cost of preservation of air-draught clearances can only be approached indirectly from the information at our disposal. We have considered the work on bridges, locks, aqueducts and tunnels noted to be necessary by our field teams and where we could see that a dimension might be reduced, with consequent savings in the cost of the work recommended and bearing in mind the possible requirement for maintenance craft, we have estimated these possible savings and extrapolated the totals obtained in the same proportions as for Chapter 12. Typical examples of these are:-

(i) where a lock chamber needs reconstructing it might be cheaper to drive new piling in front of the present wall and tie back over the existing cope to ground anchors.

(ii) cutting back the arch of a bridge before applying gunite treatment might not be necessary in a presently critical case.

(iii) it might be possible to stabilise a deformed section of tunnel lining by rock bolting without cutting back and rebuilding.

(iv) fendering could be installed to protect aqueduct sides which have become sensitive to craft impact by progressive deterioration.

(v) bridge abutments which have begun to disintegrate at or below water level could be reinforced by installing shuttering along the water face and grouting up.

Our broad estimates of savings under this heading have been subtracted from the equivalent figures in Tables 12.1 and 12.2 and the resulting costs are quoted in Tables 14.1 and 14.2 for arrears and continuing maintenance respectively.

14.3.5 The arrears of *bank protection* directly occasioned by the specific craft dimensional standards of the Transport Act 1968 (as outlined in paragraph 14.2.6) were calculated in the office by comparing the required profiles deduced from Chapter 10 with existing cross-sections measured in the field. Where the resulting dredging involved an increase in the depth of water at the bank, the consequent costs of suitable new piling (depending on the changed depth of water) were measured. These costs have been subtracted from the Table 12.1 figures and the adjusted Area totals entered in Table 14.1 as the arrears of bank protection disregarding specific navigational standards.

14.3.6 Any attempt to quantify the long term reduction in continuing bank protection maintenance needs must rest on arguable assumptions. In deriving our estimates we have generally assumed firstly that complete

siltation at the waterway banks will not occur on the Commercial waterways because these are largely river navigations, nor on such Cruising lengths as the Fossdyke and Witham, the Rivers Soar, Stort and Ure Navigations, some parts of the Grand Union Canal, the Kennet and Avon river sections etc. Secondly that, because of storm and other water flow pattenrs, restrictions at structures etc., only some two thirds of the length of banks of the remaining Cruising canals will eventually silt up in this way. From our field reports we calculated in Chapter 12 that if there is no change in the statutory provisions of the Transport Act 1968 (and if traffic continues at the present levels) a total of some 15% of the banks will require attention under continuing maintenance provisions during the next 15 years at a cost of £885,000 per annum (see Table 12.2). The portion of this sum which would be cancelled by disregarding the specific obligations we calculate to be of the order of £400,000. The remaining £485,000 is distributed on an Area basis in Table 14.2.

14.3.7 Where there would be no significant direct effect on arrears or operating and continuing maintenance costs if the specific standards were disregarded, the estimates from Tables 12.1 and 12.2 have been transposed unaltered into Tables 14.1 and 14.2 respectively. This applies to the *other items* in both cases, and to the *operating costs* in Table 14.2. The main change in the *Special Items* from the totals of Table 12.5 is an estimated reduction in the annual provision for major works from £600,000 to £450,000, due mostly to lower costs of stabilising tunnel linings and the reduced likelihood of larger craft damaging sensitive structures by impact (obviating the need for some major works on public safety grounds). There would also be a marginal reduction in administration costs, so that our revised total for inclusion in Table 14.2 is £4.0 M per annum.

14.3.8 In order to complete our discussion of the consequences of disregarding the specific navigational standards we indicate below, and in Table 14.3, the ultimate extent of the indirect effects of this action if it results in gradual withdrawal of all traffic. In this connection only the continuing maintenance and operation elements of Table 14.2 are considered since the arrears works listed in Table 14.1 are due for action now or in the near future and will not therefore be obviated.

14.3.9 As suggested in paragraph 14.2.9 there would be a major effect on *bank protection* requirements, additional to that estimated in paragraph 14.3.5, if the element of deterioration due to craft wash waves were removed. Over the years considerable research has been carried out into the creation and effects of wash waves produced by self-propelled craft, and this is generally accepted as being the prime cause of damage to revetments. An accurate assessment of the proportion of total damage due to this cause is not possible, however, as it will depend on several factors such as the corrosive properties of the water, the extent of wind generated waves, variations in water level etc. We estimate that the continuing annual cost of £885,000 in Table 12.2, reduced to £485,000 in Table 14.2 would in the long term stabilise at a level of the order of £200,000.

14.3.10 We have noted in paragraph 14.2.1 that the requirement to pass maintenance craft will no longer remain as a matter of course in the absence of other traffic. Some other *dredging* works, for example those connected with water supply for navigation purposes, would also cease to be necessary, and we have therefore reduced the annual estimate of paragraph 14.3.3 by £50,000. The remaining £280,000 is entered in Table 14.3, together with an allowance of £70,000 for weed cutting as this growth will no longer be controlled by the passage of craft; it will still be necessary to keep channels clear for water supply and transportation, including management of storm water and supplies to licensed abstractors.

14.3.11 Turning to the *structures* listed in Table 12.3, we do not foresee any appreciable reduction in the continuing annual maintenance costs for stop-planks, dams, weirs and sluices, culverts, bridges, aqueducts or tunnels, but would expect some saving on lock works. We have reduced the total for these from £685,000 to £435,000, so that the annual total for structures as a whole becomes £725,000 (excluding the special provisions for bridges).

14.3.12 The costs under the various headings of Table 12.4 (*other items*) would remain substantially the same for agricultural works on reservoirs, ditches, boundaries etc. BWB staff would not, however, need to spend time on operational duties related directly to craft usage and there would be some reduction in the overall maintenance complement as a result. We expect that there would be savings under some lesser maintenance headings such as transport and telephones, and also for operational property and equipment. The annual total is therefore reduced by 25% to £800,000 for Table 14.3.

14.3.13 The remaining items to be considered are the *operating costs*, so far transposed intact from Table 12.2 to Table 14.2, and the *special items* of Table 12.5. We consider that within the limitations of the information at our disposal a reduction in the operating costs (Table 12.2) from £765,000 per annum to £350,000 per annum is reasonable and have included this in Table 14.3. Similarly we feel that the special items identified in Table 12.5 would further reduce as follows:-

	from Table 12.5 £000	to Table 14.3 £000
Departmental administration, Area and Section Costs	1,750	750
Specialist services and major works	600	400
Breaches and emergencies	100	100
Funds and special provisions	1,800	1,800
Total	4,250	3,050

(b) *Immediate Cessation of All Navigation*

14.3.14 The following paragraphs discuss the cost consequences both to the arrears of maintenance and to the continuing maintenance liability of the Commercial and Cruising waterways system following immediate removal of all craft from these waterways.

The resulting arrears of maintenance and on-going operational and maintenance costs are summarised in Table 14.4.

14.3.15 Arrears of *bank protection* were defined in Chapter 12 on the assumption that traffic would continue at present levels, and the resulting total cost was £22.4 M. If navigation were to cease immediately and completely, then the overall major damaging influence on bank protection, that of wash waves, would no longer need to be considered. The result of this would be a considerable reduction in the total arrears, though most of the Board's other obligations would remain. It would still be necessary to embark on a major programme of works for public safety (at a cost of £2.2 M, from paragraph 12.4.45), and to cover those places where we decided in paragraph 12.6.6 that, also from considerations of safety, protection works could not be put off for even 5 years (a further £2.3 M).

14.3.16 We reported in Chapter 12 that the cost of carrying out repair work to existing protection would total about £2.2 M (from paragraph 12.4.5), and that a further £0.8 M would need to be expended on capping the trench sheeting installed as bank protection in recent years (paragraph 12.4.15). Without further navigational use of the waterways some of this work could be re-programmed as the rate of deterioration following failure of walling or piling would then be reduced. Our survey records indicate, however, that in most instances there would still be potential danger to public safety or that the remaining functions of the waterways, such as drainage and water abstraction, would eventually become impaired if these repairs were not carried out, and we therefore estimate that some 80% of this work (at a cost of say £2.4 M) would still be necessary. On river navigations, and in other places where washwaves are not the only serious cause of deterioration to banks, continuing attention to protection would still be required, and this would include most of the expensive longer lengths of piling (e.g. paragraph 12.4.13). As a broad estimate the total in this further category might be £3.0 M, equivalent to about three quarters of the cost of new and replacement protection to Commercial waterways.

14.3.17 Finally there is the need to reinstate and safeguard land, particularly on the offside, which has been eroded beyond the Board's territorial boundaries. The total length of presently unprotected banks requiring urgent treatment is some 365 km, and the total cost of the recommended protection there is £8.8 M (from paragraph 12.4.5); much of this is already accounted for above, but we estimate that of the remainder, and including places where old protection has been breached leading to erosion, about £3.0 M would have to be spent on this account. Summing up, therefore, we conclude that the total cost of overtaking arrears of bank protection following immediate cessation of all navigation would be in the order of £12.1 M, or just over half of the Chapter 12 figure.

14.3.18 Arrears of *dredging* would cover only work necessary to ensure adequate channel dimensions for water passage, and for maintenance craft where necessary (see paragraph 14.2.12). We foresee some saving over the £105,000 of paragraph 14.3.2 in this case and have therefore reduced this figure to £100,000 for the purposes of Table 14.4. For *structures* the cessation of navigation would have no significant effect on the work required on bridges, culverts and aqueducts, nor on sluices, dams, weirs and stop planks. For locks, however, the Table 12.3 figures would no longer apply as we estimate that about one third of the expenditure on chambers and approaches, half of the expenditure on gates and most of that on paddles etc. would be saved, thus reducing this total from £2.6 M to £1.4 M. Certain works previously governed by craft dimensions could also be carried out in a cheaper alternative manner, and, as discussed in paragraph 14.3.4, the savings due to such considerations might be a further £0.2 M. The total arrears of maintenance for structures in Table 14.4 is therefore £5.4 M. For the *other items* we would expect some savings under the headings of operational property and equipment, access roads, towing path repairs and feeders, and also in the administration costs for the arrears programme. The total of £4.9 M in Table 12.4 is accordingly reduced to £4.0 M for inclusion in Table 14.4. If all navigation were to cease immediately, therefore, the total cost of overtaking arrears of maintenance would become £21.6 M.

14.3.19 Lastly we have examined the continuing maintenance and operation costs of the system without navigation by other than maintenance craft (where such craft are necessary or economic). The arguments of paragraphs 14.3.9 to 14.3.13 are equally valid for this situation except for possible savings due to development of new methods of maintenance where it is no longer economical to keep locks in operation. As discussed in paragraph 14.3.12 we allow a notional 10% saving on the totals of Table 14.3 on this account, though this will not apply to *bank protection* as the broad estimate of £200,000 per annum given in paragraph 14.3.9 is intended to include such considerations. The £3.1 M for *special items* (paragraph 14.3.13) is also transferred to Table 14.4 intact. The right hand column of Table 14.4 thus shows the continuing annual costs in this postulated situation, totalling £5.3 M.

14.4 *Conclusions*

14.4.1 If the specific navigational requirements of the Transport Act 1968 were to be disregarded, then the basic cost of overtaking arrears (as seen by comparing Table 12.1 with Table 14.1) would be reduced by some £4.8 M to £32.8 M. The corresponding direct consequences to the costs of operation and continuing maintenance (comparing Table 12.2 with Table 14.2) would be a reduction from £8.8 M to £7.6 M per annum.

14.4.2 If, following such a change in the Board's statutory responsibilities, levels of traffic were to fall off until commercial and cruising activities effectively ceased, then eventually the operating and continued maintenance costs might reduce further to approximately £5.5 M per year (see Table 14.3).

14.4.3 On the notional basis that navigation on Commercial and Cruising waterways were to cease immediately and completely, Table 14.4 shows that the effect would be a reduced assessment of arrears of maintenance -- a total of some £21.6 M instead of the £37.6 M of Table 12.1 -- and a continuing annual cost of £5.3 M, which is £3.5 M less than that assessed for Chapter 12.

Table 14.1 **Arrears of Maintenance Disregarding the Specific Navigational Standards**

Estimates from Table 12.1 less costs due directly to Specific Navigational Standards

Area / Description	Scotland £000	Wigan £000	Castleford £000	Northwich £000	Nottingham £000	Birmingham £000	Gloucester £000	London £000	TOTALS £000
Bank Protection	430	1,970	3,535	5,985	1,290	5,760	380	1,835	21,185
Dredging	0	15	5	25	10	30	5	15	105
Structures	475	1,130	435	1,490	285	1,340	465	965	6,585
Other Items	515	460	775	925	375	995	345	530	4,920
TOTALS	1,420	3,575	4,750	8,425	1,960	8,125	1,195	3,345	32,795

Table 14.2 **Costs of Operation and Continuing Maintenance Disregarding the Specific Navigational Standards**

Estimates from Table 12.2 less costs due directly to Specific Navigational Standards

Area / Description	Scotland £000	Wigan £000	Castleford £000	Northwich £000	Nottingham £000	Birmingham £000	Gloucester £000	London £000	TOTALS £000
Bank Protection	10	50	20	110	50	150	15	80	485
Dredging	0	30	45	100	75	45	5	30	330
Structures	20	110	95	190	70	250	30	190	955
Other Items	20	80	210	120	75	260	110	185	1,060
Operating Costs	60	25	225	80	60	80	85	150	765
Special Items	190	500	360	790	505	810	225	620	4,000
TOTALS	300	795	955	1,390	835	1,595	470	1,255	7,595

Table 14.3 Effects if Traffic Levels Reduce

Ultimate Annual Costs Disregarding the Specific Navigational Standards

Description	Total £000
Bank Protection	200
Dredging and weed clearance	350
Structures	725
Other Items	800
Operating Costs	350
Special Items	3,050
TOTALS £000	5,475

Table 14.4 Arrears and Continuing Maintenance Costs following Notional Cessation of All Navigation

Description	Arrears of Maintenance £000	Continuing Annual Costs £000
Bank Protection	12,100	200
Dredging and weed clearance	100	330
Structures	5,400	650
Other Items	4,000	720
Operating Costs	–	320
Special Items	–	3,050
TOTALS £000	21,600	5,270