Flood Defence Levels of Service - Stage 2

Annex A: Referencing of Reaches and Areas Benefiting from Protection

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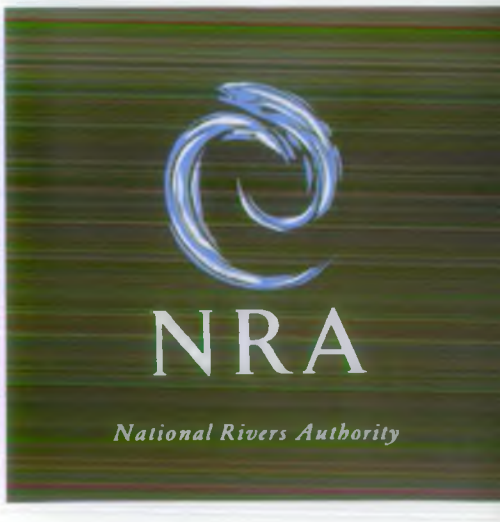
R&D Note 127



Contents

1. INTRODUCTION

This Annex is one of five annexes which, together, provide a description of a method of applying a flood defence levels of service strategy. The overall system is described in the main report, which contains references to the other Annexes where appropriate.

This particular annex deals with the method for defining the areas to be considered by the system and how such areas can be sub-divided and referenced for ease of management and application of the system.

2. DEFINITION OF AREAS TO BE CONSIDERED

2.1 DELINEATION OF AREAS

It is generally accepted that the standard of protection to be provided should be determined by the extent of customer interests benefiting from this protection. In order to assess the extent of customer interests, it is necessary to delineate an area which can be subject to adverse effects in the event of a flood.

Various alternative methods of drawing up this line are possible:

- the 'Medway Letter' line;
- section 24/5 survey areas;
- extent of maximum known flooding;
- byelaw maps based on composite flood event and survey data (as available in Thames NRA).

The Medway Letter line alternative has been rejected because:

- the appropriateness of its use, particularly in low-lying, flat areas of land, is questionable;
- waterlogging is not included, at this stage;
- methods for its definition are not well-developed;
- little data exists at present on the location of the line.

In preference, it is proposed that the area of maximum known flooding is used, although it is recognised that the area so defined will be:

- made up of data derived by different methods in different areas;
- made up of data of varying degrees of accuracy;
- subject to change, as hydraulic conditions change and knowledge of local hydrology improves.

Consequently, it is appropriate that the method by which this boundary is defined and the sources of data used should be clearly stated by each region.

The base data on which any assessment of flood defence LOS relies should therefore be maps showing the extent of maximum known flooding. Where major Flood Defence Assets are present, such as embankments, the maximum flooding extent if such assets completely failed should be delineated. For most areas, a scale of 1:25,000 is appropriate, however in urban areas maps of 1:10,000 scale provide extra detail and increase the efficiency of any survey work.

The pilot study and stage 1 report highlighted the deficiency of suitable mapping in some NRA regions. The resource implications of bringing these to an appropriate standard are discussed more fully at the end of the main report, but it is stressed that these maps form the basis of the system, and, as such, should be prepared with care.

2.2 LENGTHS OF RIVER REACHES

Having defined the areas at risk, it is considered necessary to sub-divide them into smaller units, because:

- of hydrological and hydraulic differences;
- of changes in land use;
- management of data is made easier;
- land use features can be more easily linked to the assets and work which affects their protection.

To maintain a balance between the quantity of data to be handled in total and the ability to assess the LOS provision over meaningfully short lengths, rivers should be divided into reaches of between four and seven km in length. In some areas land use can change markedly over relatively short distances. In this case it may be necessary to define reaches of shorter than four km in length. However this should only be done where significant changes in use occur, and should not be applied to every change from agricultural land to urban land.

Land use and topography can also vary widely form one bank to another and in such cases it may be appropriate to provide flood defence to a different standard on each side. A division should therefore be made between the left and right bank to allow separate land use assessment to be completed. The following notes will explain how reach limits are defined for right and left banks. However the notes begin by assuming that the same end point for reaches is used with no specific left and right bank division, as this makes the explanation more straightforward. Subsequent to these explanations the differentiation of left and right banks and possible use of different reach limits for left and right banks is discussed. In practice most reaches are defined with the same end points, such as road crossings. In only a few situations is it advantageous to have different reach end points for the different banks.

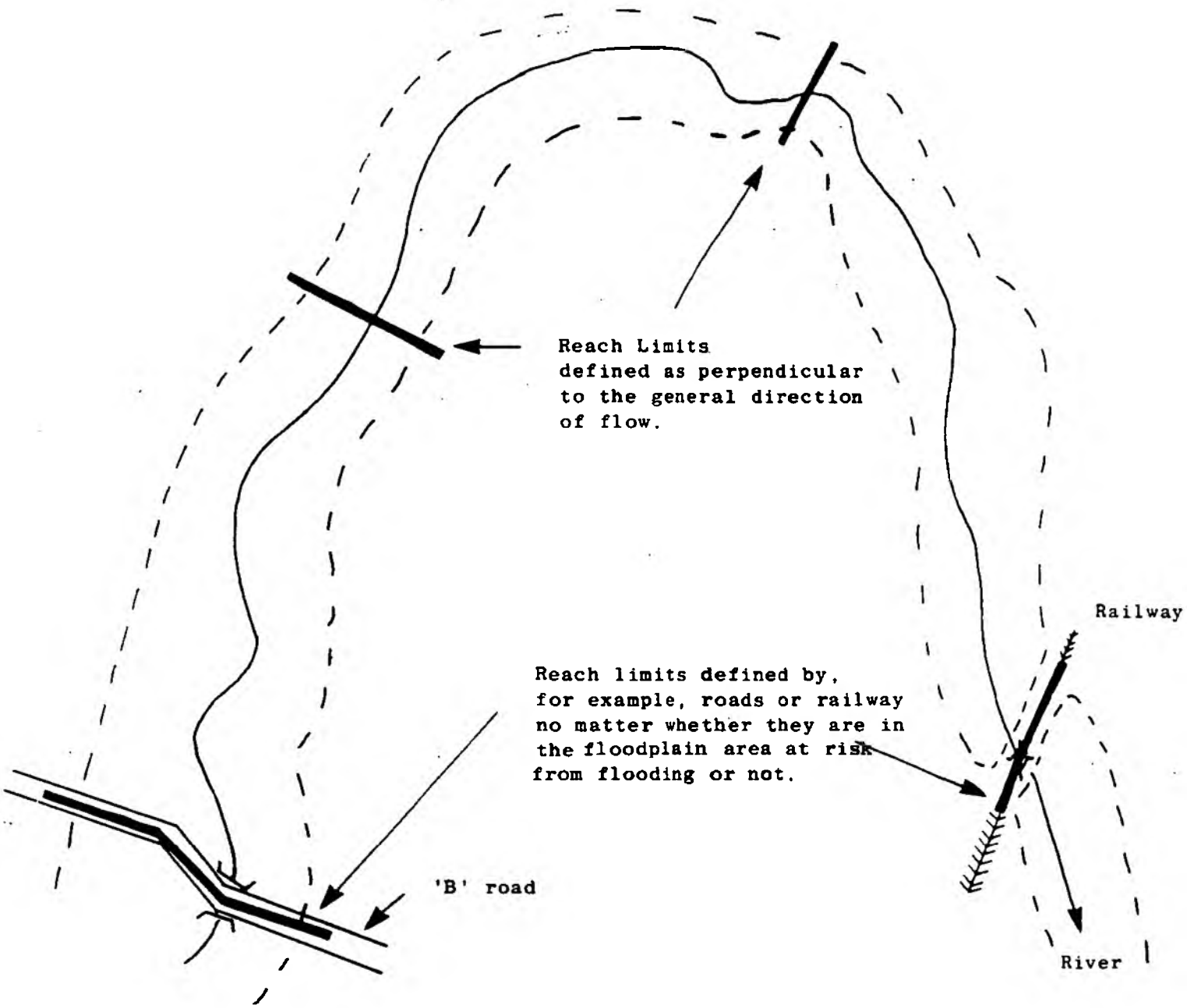
2.3 ALLOCATING RIVER FLOODPLAINS TO EACH REACH

Reaches should be defined for each length of main river provided that the length of river is not a loop nor is completely within the area at risk from flooding of another more major river. The limit of each LOS reach can be defined on the watercourse itself but must also be defined for the area at risk which can extend for considerable distances away from the channel.

Defining reach limits on rivers is relatively straightforward with points chosen to coincide with easily distinguishable features on the river channel or, if none exist, at convenient distances which coincide with any operations reach definitions.

Defining reach limits in the area at risk from flooding away from the channel is also relatively straightforward using one of the following rules.

Figure A.1. Definition of Reach Limits



a) If the reach limit is say, a road bridge, then the extent of the area at risk in each reach is determined by the road on either side.

b) Where no obvious division exists a line drawn perpendicular to the general direction of flow of the river (ignoring small meanderings) can be used.

Both these examples are illustrated in Figure A.1 opposite .

Division of reaches and flood risk areas on these straight single channel lengths of river is relatively straightforward; complications arise when tributaries and their risk areas are considered. Figure A.2 overleaf illustrates this situation. In this example two tributaries, numbered 2 and 3 join the river number 1. Each tributary has its own area at risk from flooding. Definition of reaches is completed as described above with the additional guidelines that at confluences, the reach limit of the tributary is formed by the river it joins. The small tributary numbered 4 is not separately defined as an LOS reach.

Having defined reaches in terms of points on the rivers and extending this out and across the area at risk the areas of land can be ascribed to a LOS reach for assessment. In Figure A2 this gives the following result.

River	Reach	Areas to be Assessed
1	X	D & E
1	Y	A & C
2	V	F & E
3	W	B & C
4	Not Applicable	No area designated

Areas C and E are each assessed against two rivers because they could be flooded by either.

In some instances the tributaries are not large enough to have an area at risk from flooding sufficiently independent of the major river, to be assessed separately. Figures A3.1 and A3.2 overleaf illustrate the criteria proposed to decide when a tributary has its own separate floodplain and when not.

In Figure A3.1, b is greater than a and it is assumed that the shaded risk area is independent of the main channel and is attributed to the tributary.

Figure A2 Definition of reach limits at confluences

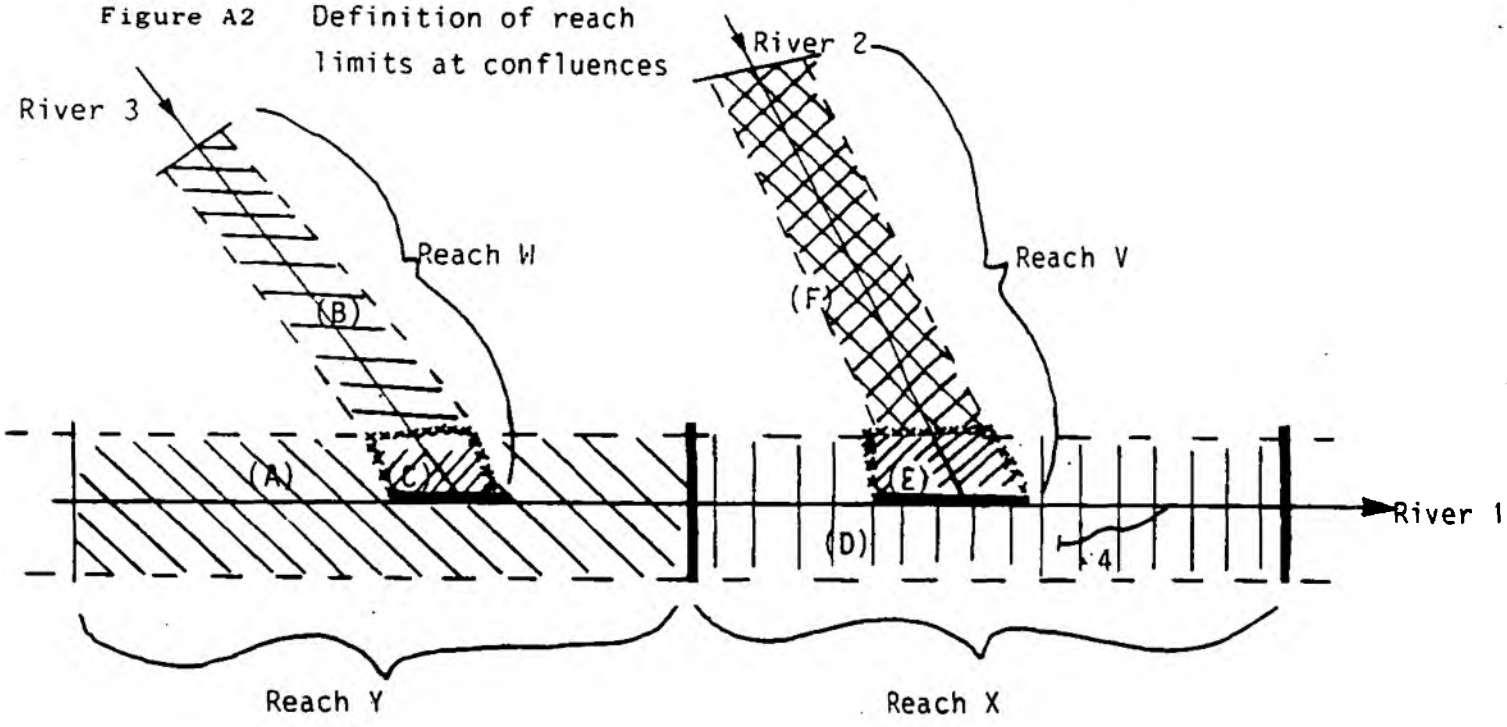


Figure A3 Allocation of floodplain areas to LOS reaches

Figure A3.1

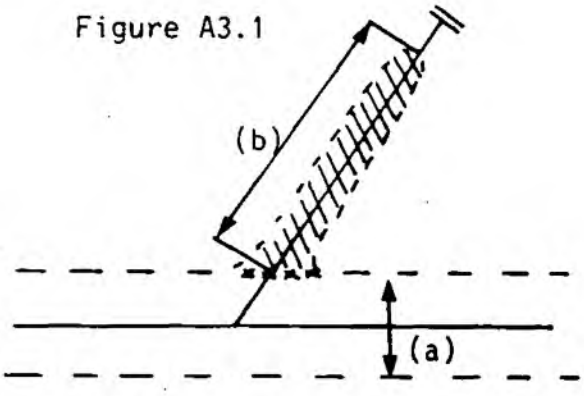


Figure A3.2

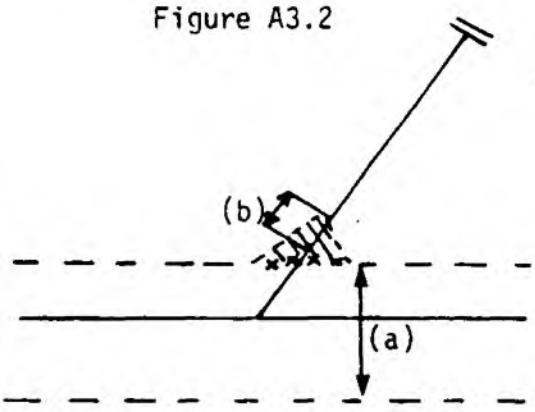
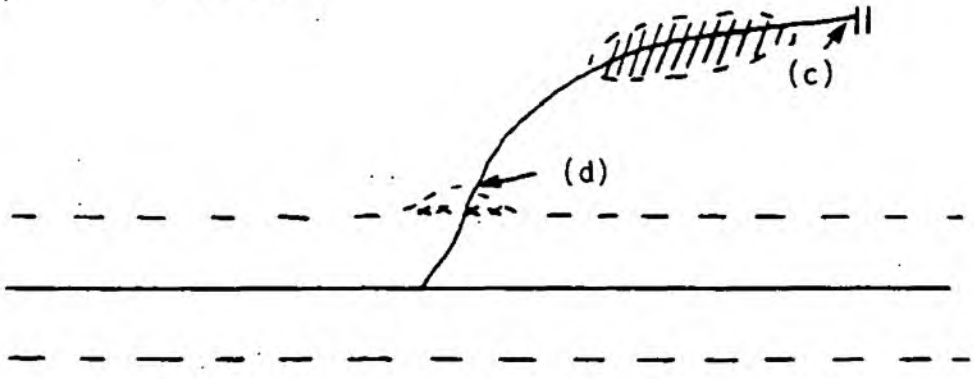


Figure A3.3



In Figure A3.2, a is greater than b and we therefore assume that the shaded risk area is due to the main channel and is assessed as part of the main channel. The tributary would therefore be assessed as having no area at risk from flooding.

A complication sometimes found is illustrated in Figure A3.3 opposite. In this situation the area shaded between points c and d is assessed as the floodplain of the tributary. Treatment of the floodplain area which could be common to both the major river and tributary also varies. In Figure A3.1, the flood risk area common to both the tributary and the major river, assessed against each river, as in Figure A2, but in Figure A3.2 and A3.3 the common area is only assessed against the major river.

Loops are not separately identified as LOS reaches, the area at risk of flooding around a loop being allocated to the LOS reach in which the loop is located, see Figure A4 overleaf, or divided by the reach limit if the reach limit occurs at a loop as in the right of Figure A4 overleaf.

The treatment of areas which could be flooded from more than one river is similar to that described for confluences. The whole area which can be flooded by each river is allocated to the assessment of each stretch of river. It is recommended that reach lengths are chosen to coincide with the limits of such areas, which may often be embanked channels. In Figure A5 overleaf the area at risk from flooding marked x is allocated to the assessment of reaches A, B and C with reach A being relatively short, defined between the two embanked tributaries.

Allocation of interests to both rivers in this way is in effect double counting. However, it is considered important to do this to fully deal with those interests that could be affected by failure to provide adequate protection along the full length of particular LOS reaches. In addition this ensures a consistency of approach to the situation shown in Figure A5 and that shown in Figure A2.

A note could be made on the assessment forms of those interests that are multiple counted and provision made for their identification of any database. Any regional summing of interests could then take note of such counting so that only the true number of interests was reported for the region as a whole.

Figure A4 Treatment of floodplains around loops

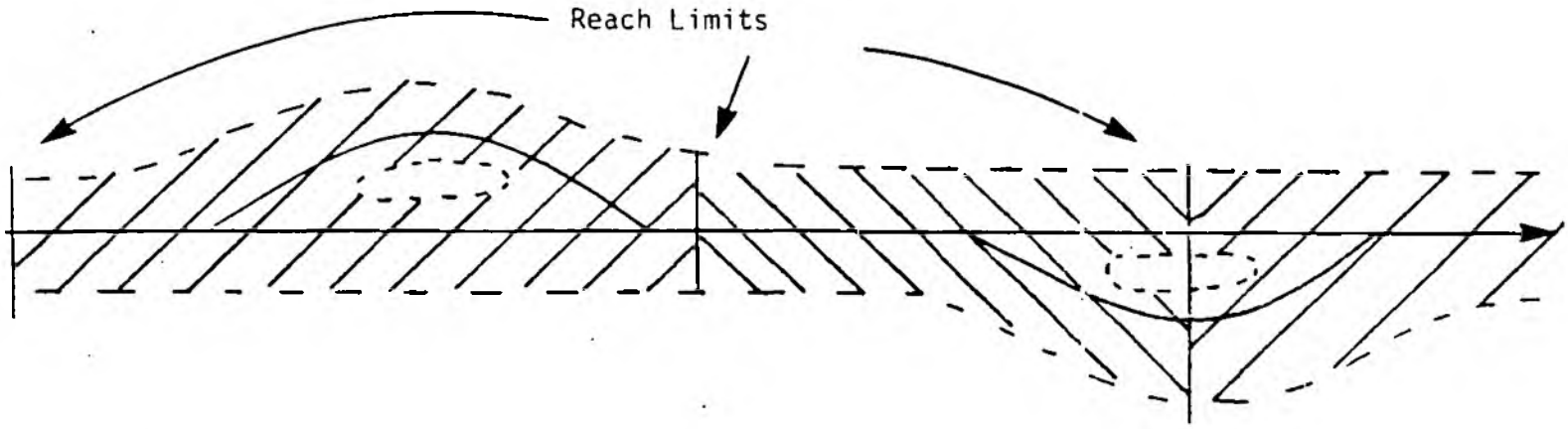
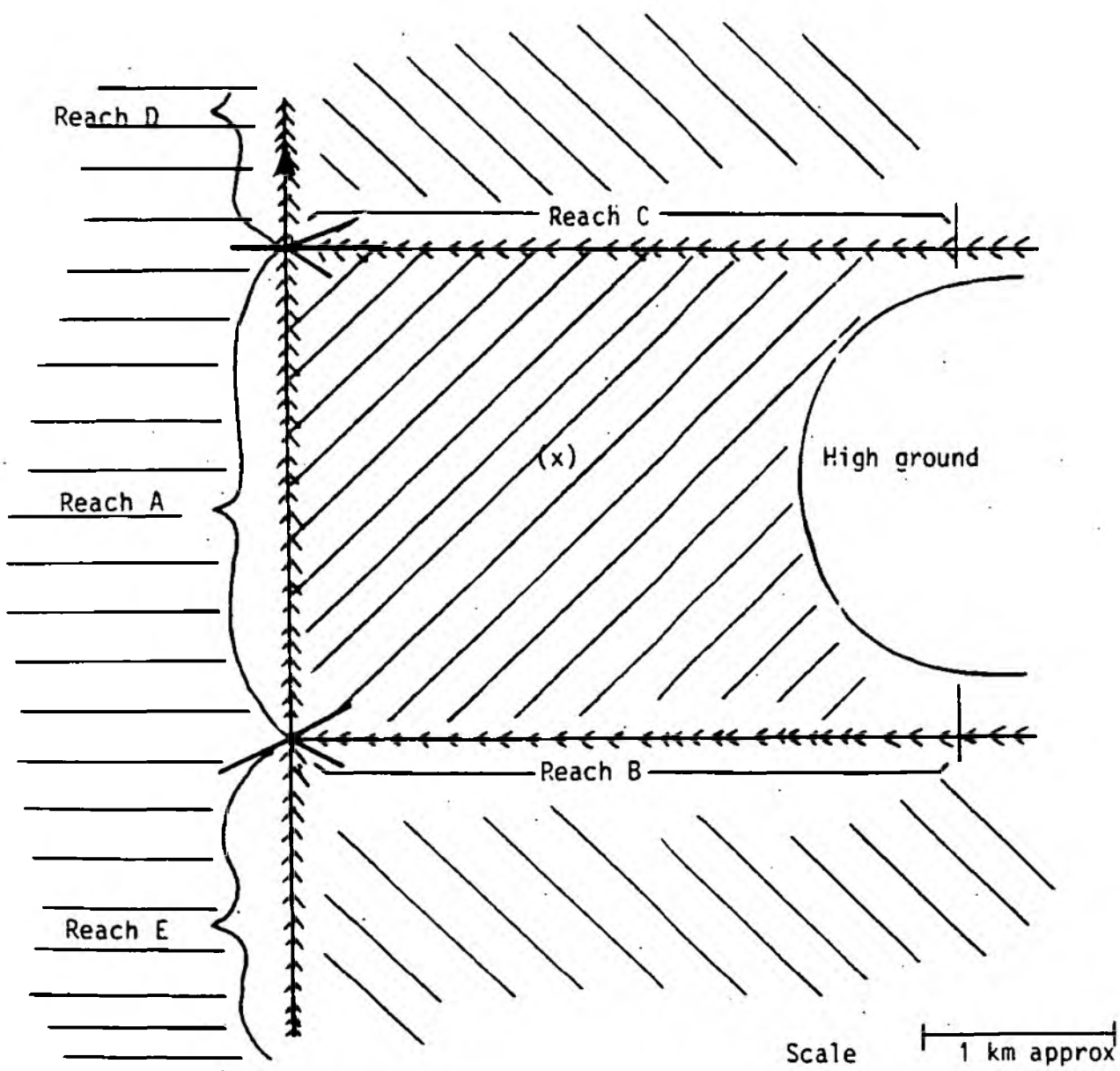


Figure A5. Allocation to LOS reaches of floodplains at risk from flooding from more than one source.



2.4 LEFT AND RIGHT BANK DIFFERENTIATION

The examples illustrated so far have concentrated on how to divide rivers into reaches and define the areas at risk from flooding allocated to those lengths of rivers.

The assessment that is to be completed will need to be undertaken on the basis of the split of interests between left and right banks.

In most cases this is a simple exercise with the flood risk area on the left and right banks recorded separately between the reach limits that have been defined. Throughout it is assumed that left and right are defined when facing downstream (ie the 'true' left and right banks. **The same reach end points should be used for left and right banks.** It is recognised however that on a very limited number of occasions the region may need to consider the use of staggered reach limits, though this should be avoided whenever possible.

The variation in interests that may occur between opposite banks of a stretch of river and often bank specific maintenance practices, make it appropriate to consider differing standards of flood protection and thus the need for separate assessments of the opposite banks. In addition the coastal situation is one-bank only and so for consistency to allow use of the same targets a left and right bank split is also advantageous. The need for differing reach limits comes from practical considerations where it may be appropriate in a relatively few instances to use a tributary as the end of a reach on one side and a different tributary on the other side as a reach limit.

Figure A.6 overleaf illustrates the sub-division of areas at risk from flooding between left and right banks

The allocation of marked flood risk areas to reaches for Figure A6. is as follows.

Main Channel

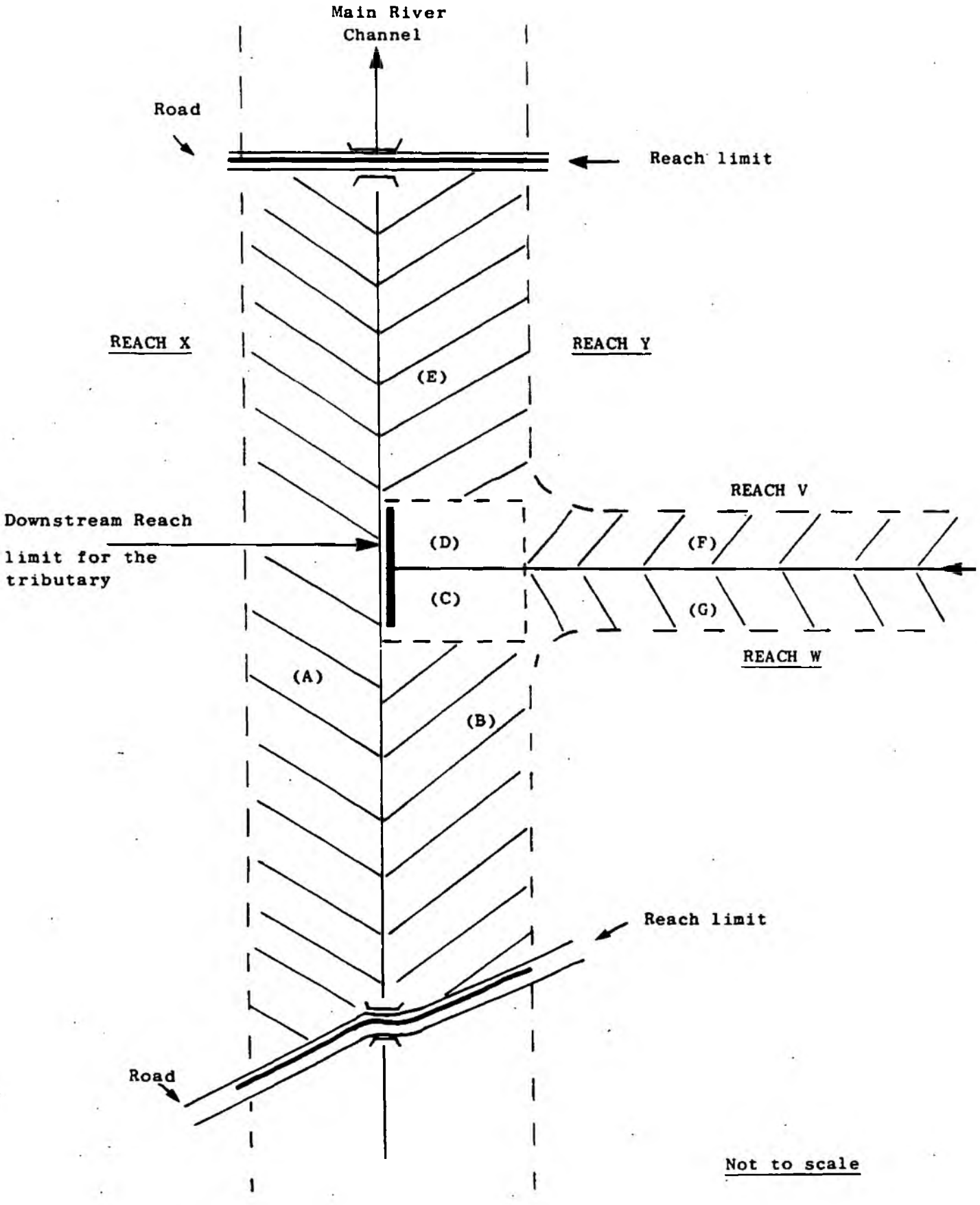
Left Bank	Flood Areas	Right Bank	Flood Areas
Reach X	A	Reach Y	B + C + D + E

Tributary

Left Bank	Flood Areas	Right Bank	Flood Areas
Reach W	G + C	Reach V	F & D

More often than not application of the techniques to dividing rivers and their areas at risk from flooding results in the use of the same reach end point on left and right banks.

Figure A6. Left and Right bank differentiation of flood risk areas at confluences.



2.5 APPLICATION TO TIDAL AREAS

The examples used so far in this report have principally been related to the river situation where either tidal or fluvial flooding could occur. For coastlines and sea defence assets the method described is equally applicable with only slight modifications. The main change relates to reach length identification. In the river situation broadly similar lengths of between four and seven km were chosen. For the coastal situation it is recommended that the reach lengths be chosen more with regard to the defences present, with lengths equating to specific defence structures; an exception being when the defence is uniform over a long distance, in which case it would be sub-divided into lengths of between four and seven km and the flood risk area apportioned accordingly. Reach limits must be defined so that they coincide both with the demarcation point between estuary and sea defences as specified in schedule 4 of the 1949 Coast Protection Act and with the MAFF limit of tidal dominance ie the MAFF perceived location for Sea Defence supplement. It is also desirable for reach limits to coincide with any delineation between tidal and estuary defences. NRA Anglian for example use the definition of "Tidal defences lead to estuary defences when the effect of wind generated waves becomes a major design consideration leading to the necessity for revetment."

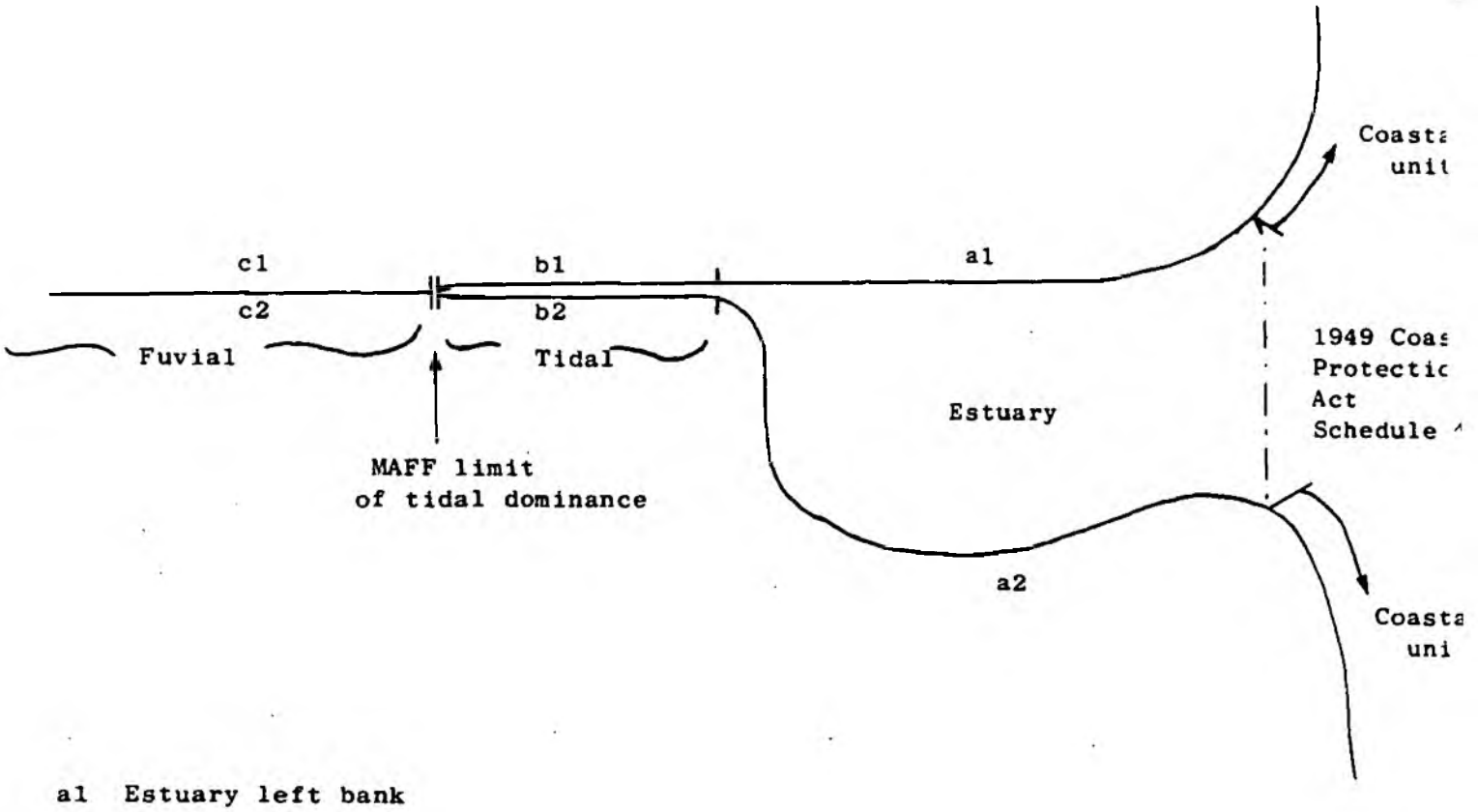
Figure A7 overleaf illustrates the divisions between Coastal, Estuary, Tidal and Fluvial areas.

To allocate floodplain areas to particular lengths of coastline, similar principles are used to those defined for fluvial situations with either road or rail lines defining the area or alternatively divisions drawn in land perpendicular to the coastline from the reach limit defined on the coast.

The same principle illustrated in Figure A5 applies to areas that may be affected by flooding from overtopping or failure of a sea defence as well as from failure or overtopping of river defences. In these cases the area that may be affected is included in the land use assessment of both reaches for LOS purposes.

There is a need for close attention to be paid when defining flood risk areas for sea defences particularly where there are very flat coastal plains behind the defences.

Figure A7. Definition of reaches Coastal, Estuary, Tidal and Fluvial.



a1 Estuary left bank

a2 Estuary right bank

b1 Tidal left bank

b2 Tidal right bank

c1 Fluvial left bank

c2 Fluvial right bank

3. REACH REFERENCING AND NUMBERING

3.1 REFERENCING

Computerisation of the data handling and analysis is essential in view of the volume of data being stored and used.

This aspect and the potential application of geographical information systems (GIS) for this data handling will be discussed more fully in a section of the main report. However for any system it is essential that a common form of referencing the reaches is established. In this way the same handling and analysis programme can be used by each NRA region, thus reducing cost and allowing consistency of reporting.

The common form of referencing can be supported within each regions version of the analysis programme by a cross referencing system identifying sections of watercourse allocated to each LOS reach.

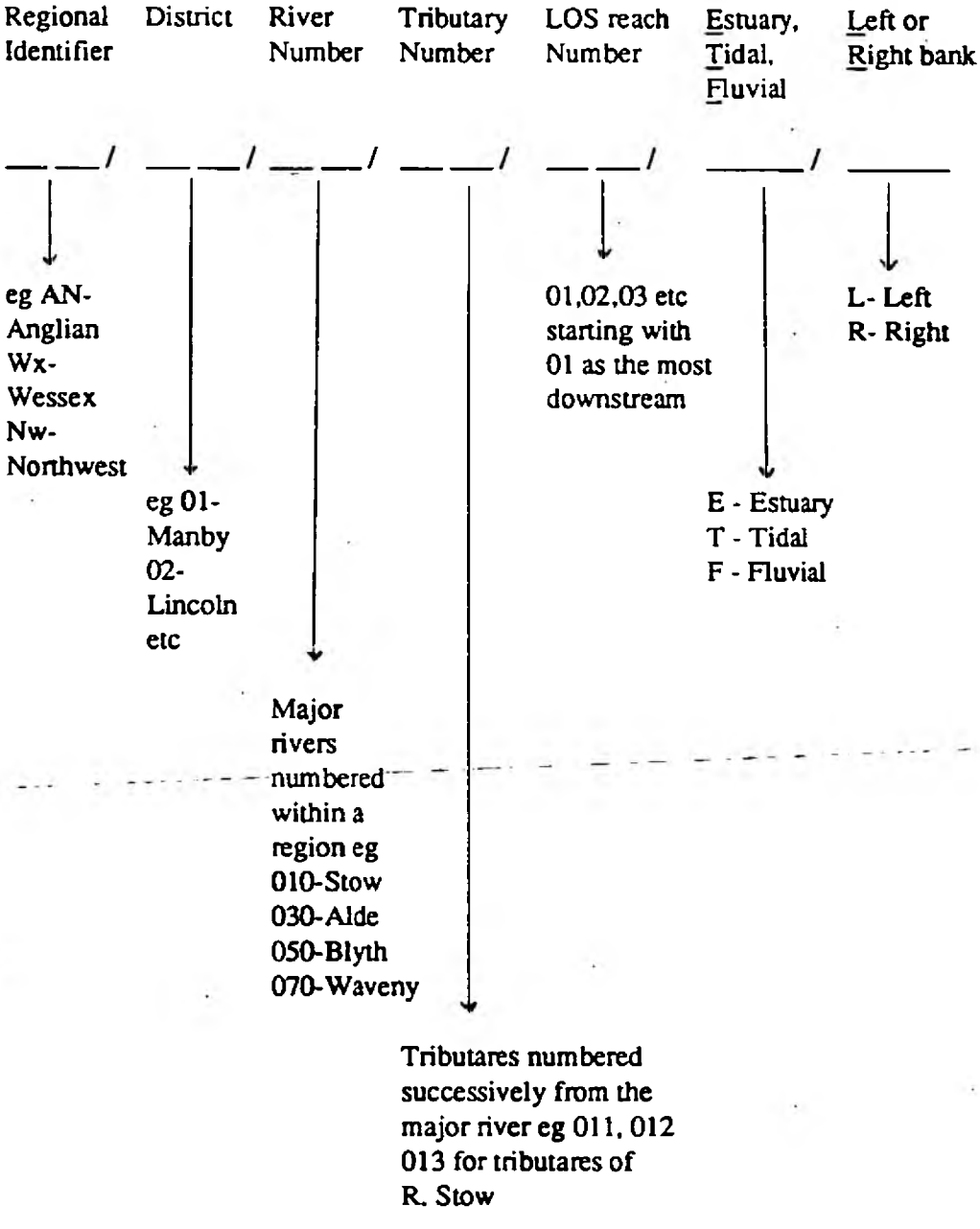
For computer analysis an alpha numerical system is most appropriate.

Two systems are recommended, one for coastal reaches and the second for all Estuary, Tidal and Fluvial reaches.

A - Coastal Reaches

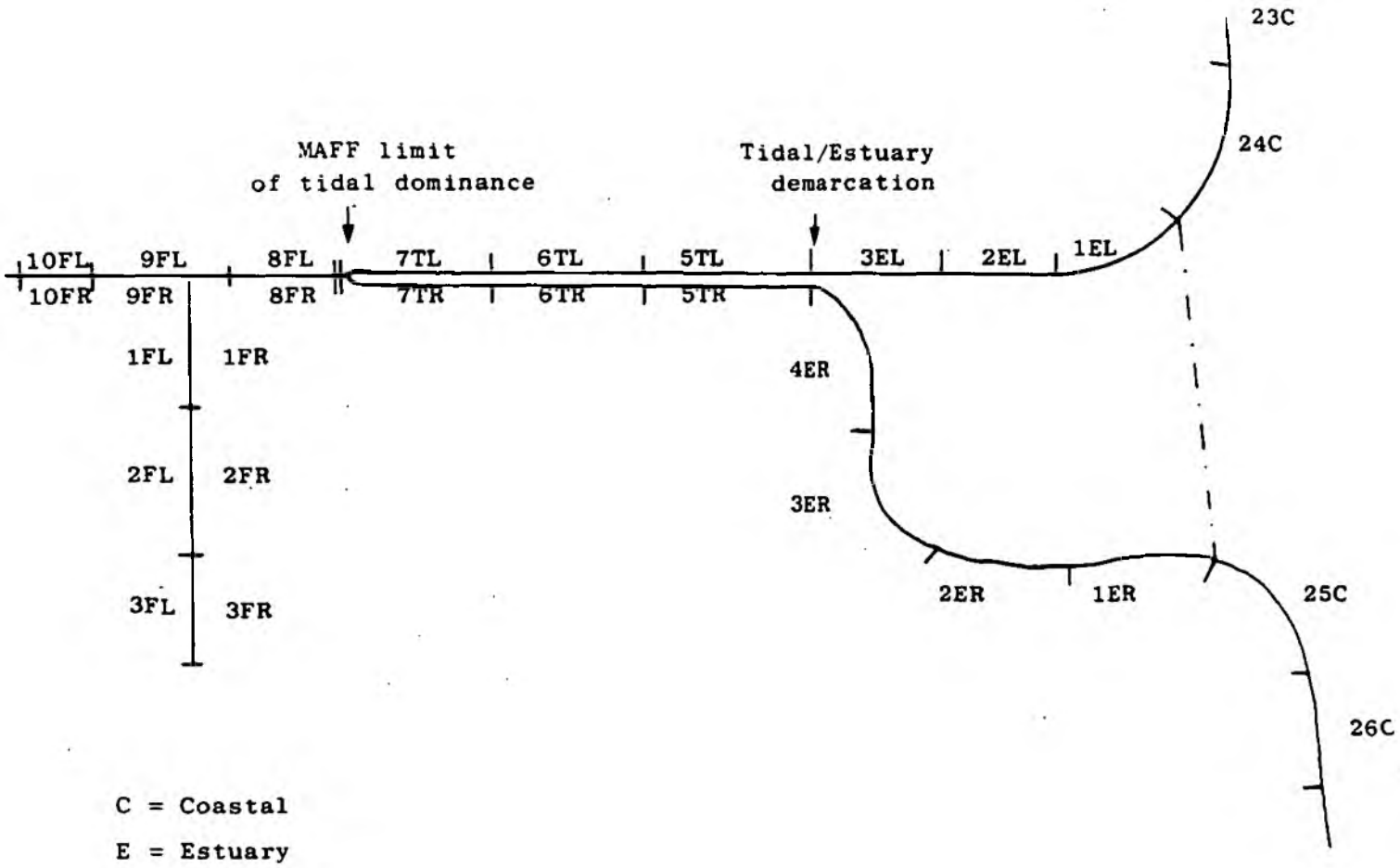
Regional Identifier	Coastal Unit Number	LOS Reach Number
----/	----/	----
eg An-Anglian Wx-Wessex etc		Numbered Clockwise

B - Estuary, Tidal and Fluvial reach referencing



Within most NRA regions there are a variety of different numbering or referencing systems used by different divisions. In Anglian region the need for a single cross functional referencing system has been recognised though as yet no firm initiatives to define a new system have commenced. There are obviously advantages of introducing a new system at the same time as LOS. It is not possible within the remits of this study to consider the needs for reach referencing of the various divisions operating within each NRA region. For the present LOS reaches should be referred as recommended in the preceding text.

Figure A8. Numbering of defined LOS reaches.



C = Coastal

E = Estuary

T = Tidal

F = Fluvial

L = Left bank

R = Right bank

If central development of computer analysis programmes is undertaken and a reach referencing system defined within this then a cross referencing section will need to be included to identify watercourses allocated to and included in each LOS reach to allow for any possible variations in current regional referencing systems.

3.2 NUMBERING

Numbering of LOS reaches is illustrated in Figure A8 opposite. Coastal reaches are numbered clockwise within each region starting from 1. Numbering of all other reaches is done separately for each river or tributary starting with 1 as the most downstream. Wherever possible reaches on opposite banks will have common end points however the nature of estuaries may mean that one side of the estuary may be significantly longer and have been defined with more reaches. In this instance common numbering starts when common reach limits are first used, as shown in Figure A8 opposite.