Flood Defence Levels of Service - Stage 2

Summary Report Detailing by Use of Examples the Component Stages Involved in Undertaking an LOS assessment

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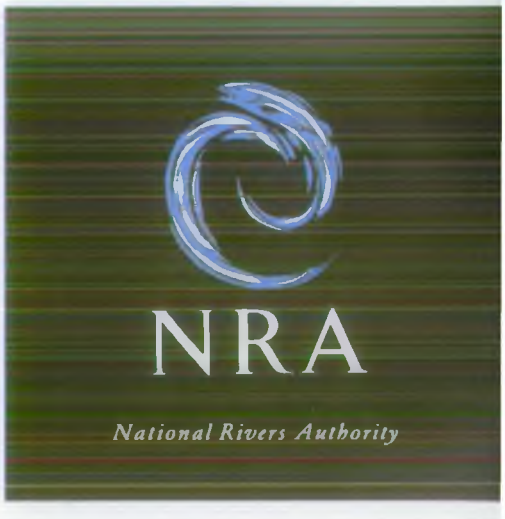
R&D Note 127



Contents

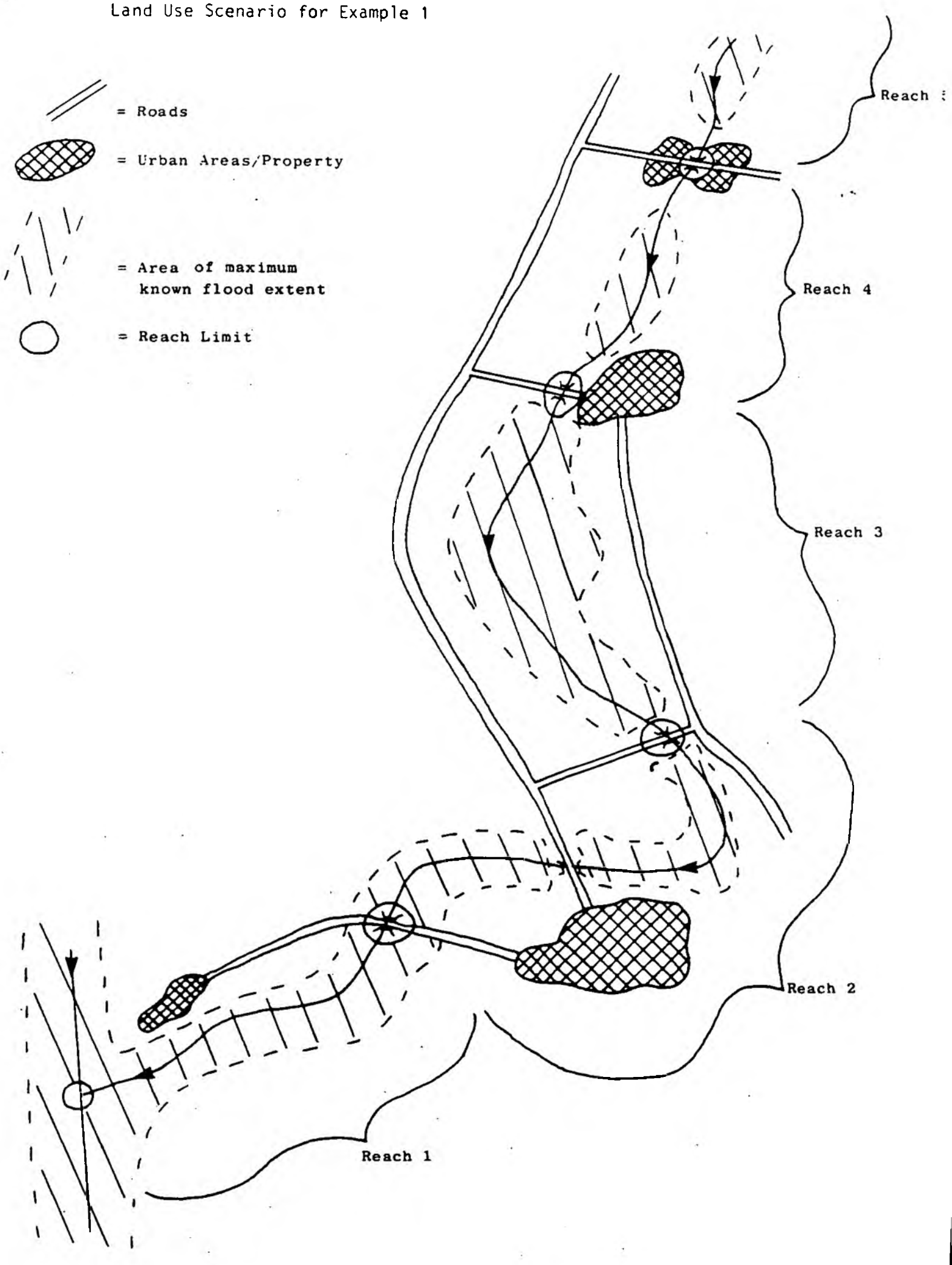
1. INTRODUCTION

This Summary Report accompanies a main report and five Annexes which together provide a description of a method for applying a flood defence levels of service strategy. This particular report is designed to provide a broad overview introduction to the main aspects of the system with reference to its application to two worked examples; the first very simple and the second more complex.

Fuller details of the overall system are described in the Main Report with consideration of alternatives given in the Annexes. Reference will be made to the relevant Sections in these documents throughout this Summary Report.

Figure 1

Land Use Scenario for Example 1



2. EXAMPLE 1.

Step 1. Reach Definition and Referencing (See Annex A)

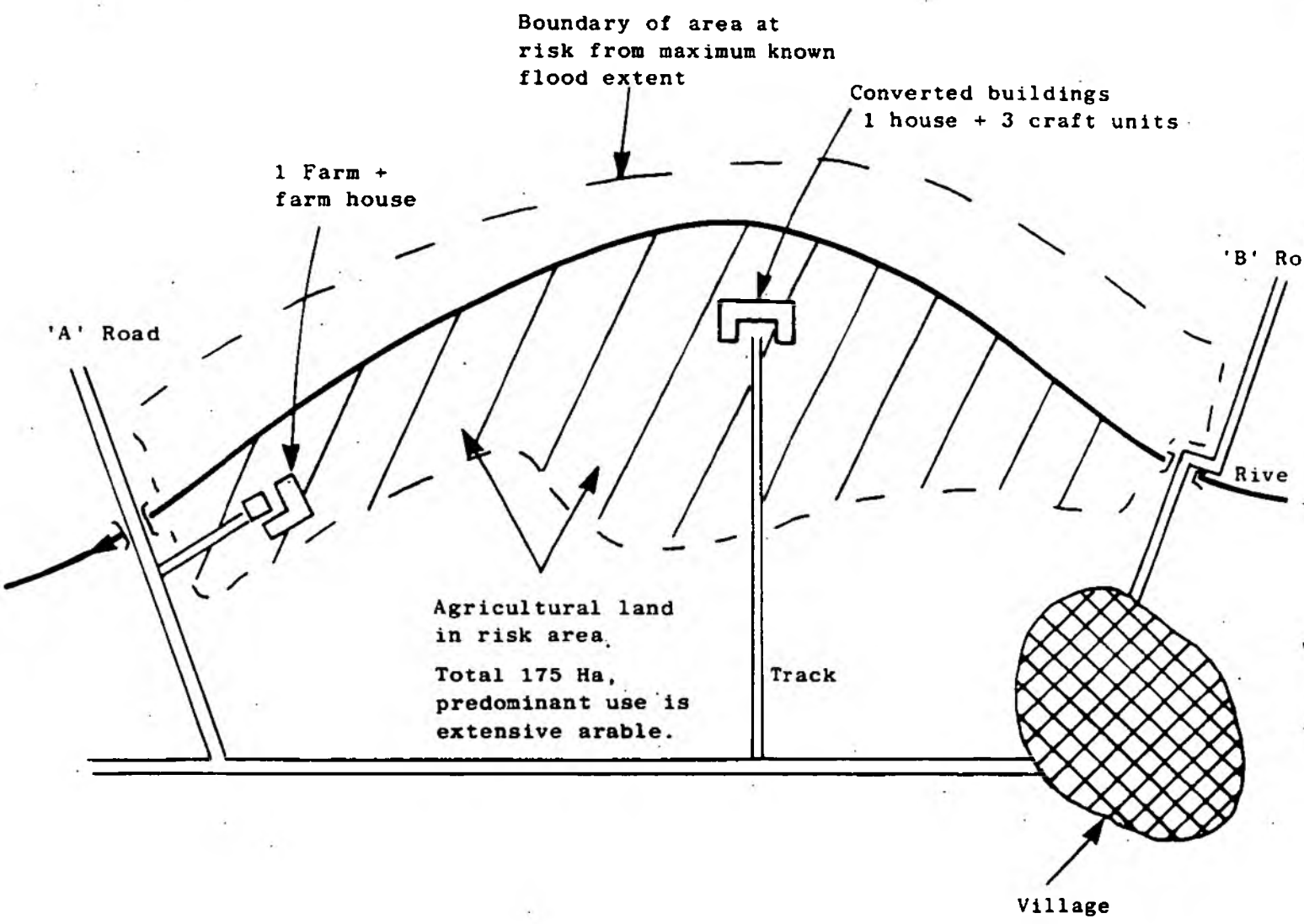
Figure 1 illustrates a typical stretch of river from its confluence with a major river, upstream past urban areas and villages. To undertake the levels of service (LOS) assessment the river is divided into LOS reaches of between 4 and 7km in length. The end points taken for reaches should wherever possible be at a clearly defined feature, such as a road or rail crossing.

It is proposed that separate assessments are completed for left and right banks. It may be necessary in unusual circumstances to use different reach limits on opposite banks.

In Figure 1 the most downstream reach limit for the river is its confluence. Other reach limits have been defined and coincide with road bridge crossings. Numbering of reaches starts with the most downstream as 1 with left or right bank specified.

The area at risk from flooding that is allocated to each reach is delineated by the reach limit and either the feature present at the limit (such as a road) or by a line drawn perpendicular to the general flow at the defined point. In Figure 1 the area at risk from flooding in each reach would be divided by the roads. The exception to this being at the confluence. The treatment of this area is indicated in Annex B accompanying this report.

Figure 2 : Detail of Reach 3, Left Bank Taken from Figure 1



Step 2. Land Use Assessment (See Annex B)

Figure 2 opposite details reach 3 left bank from the overview sketch in Figure 1.

The area at risk from flooding which is assessed for this reach is bounded by the 'A; road to the left and the 'B' road to the right, although neither of these features are affected by the maximum known flood.

Only certain of the land uses which may be present within the area at risk in the reach are included in any assessment. Those included suffer significant financial damage as a result of flooding. Table 1 below details those that are included in the assessment.

Table 1 : House Equivalents for Customers Interests

Land Use Factor	Unit	House Equivalent HE/Unit
House	Total Number	1.0
Garden/Allotments	Total Number	0.2
NRP - Distribution	Total Number	40.2
NRP - Manufacturing	Total Number	64.6
NRP - Other	Total Number	5.3
C Roads	Total Number	2.4
B Roads	Total Number	5.7
A Roads (Non Trunk)	Total Number	14.3
A Roads (Trunk)	Total Number	28.6
Motorway	Total Number	57.3
Railway	Total Number	57.3
Forestry and Scrub	100 Ha	0
Extensive Pasture	100 Ha	1.3
Intensive Pasture	100 Ha	3.0
Extensive Arable	100 Ha	6.9
Intensive Arable	100 Ha	40.2
Formal Parks	Total Number	0.6
Golf Courses	Total Number	0.6
Playing Fields	Total Number	0.1
Special Parks	Total Number	8.5

The unit of assessment is the House Equivalent (HE), one HE being the average damage to the average house when flooded. The average damage to the other interests is expressed in the same unit to facilitate the additions of all interests in one reach and comparisons with the next. In this respect 1 house scores 1 HE; whereas 1 motorway affected by flooding would score 57.3 HEs.

For each LOS reach the incidence of land use factors affected by the maximum known flood is identified and recorded on the appropriate assessment forms. The total incidence of interests is summarised on to the form shown overleaf as Table 2.

Table 2 **Assessment Summary Sheet**

Assessor's Name PR /

River Name TEST /

River Number /

LOS Reach Number, (specify left or right bank) / 3 Left

Cathment Number /

Regional Identifier (NRA region, responsible office) /

Landranger Map Number /

Floodplain extent Map Number /

From 'A' Road/ (Downstream, Name & Grid reference)

To 'B' Road/ (Upstream, Name & Grid reference

Agricultural Floodplain Area (Ha) 175

Reach length (km) 4.8km

Land Use Factor	Unit	Number (x)	House Equivalents HE/Unit (y)	Total HE (x x y)
House	Total Number	2	1.0	2.0
Garden/Allotments	Total Number	2	0.2	0.4
NRP - Distribution	Total Number		40.2	
NRP - Manufacturing	Total Number		64.6	
NRP - Other	Total Number	4	5.3	21.2
C Roads	Total Number		2.4	
B Roads	Total Number		5.7	
A Roads (Non Trunk)	Total Number		14.3	
A Roads (Trunk)	Total Number		28.6	
M. Way	Total Number		57.3	
Railway	Total Number		57.3	
Forestry and Scrub	100 Ha		0	
Extensive Pasture	100 Ha		1.3	
Intensive Pasture	100 Ha		3.0	
Extensive Arable	100 Ha	1.75	6.9	12.1
Intensive Arable	100 Ha		40.2	
Formal Parks	Total Number		0.6	
Golf / Race Courses	Total Number		0.6	
Playing Fields	Total Number		0.1	
Special Parks	Total Number		8.5	
			Total HE (a)	35.7
			Reach Length (b)	4.8
			HE/Km (a ÷ b)	7.44

Table 2 has been completed for the scenario indicated in Figure 2. Detailed guidance notes for allocating particular interests to particular categories are included in Annex B.

For this example the following general assumptions are used:

- each house is assumed to have a garden that is also affected by flooding;
- non residential properties (NRP) are allocated to one of three categories. Craft centres would fall within the NRP other category which includes general retail outlets, hotels, garages etc:
- categorisation of agricultural land is made on the basis of the predominant land use. The use in specific fields is not important

When all qualifying interests are identified and recorded the total HEs within a reach is calculated and expressed in terms of HE/km for the reach. In this way comparisons can be made between reaches.

In this example, neither of the roads which form the reach limits are at risk from flooding and are not included in the assessment.

If a road or railway which forms a reach limit is at risk from flooding it is included in the land use assessment of the upstream reach only.

Table 4 : Land Use Band Descriptions

BAND A

A reach containing the urban elements of housing and non-residential property distributed over a significant proportion of its length, or densely populated or developed areas over some of its length. Any agricultural influence is likely to be over-ridden by the urban interests. Amenity use such as parks and sports fields may be prominent in view of the floodplain's proximity to areas of population density.

BAND B

Band B category reaches will contain either housing or non-residential property distributed over or concentrated in part on its length but not of the same density as band A. Agricultural use could be more intensive in the less populated areas of band B reaches.

BAND C

Isolated rural communities at risk from flooding, with both residential and commercial interests, will be found in band C reaches but in limited numbers. Consequently, farming interests will be more apparent than band A and B reaches.

BAND D

Isolated properties at risk from flooding, both residential and commercial, will be found in band D reaches but in limited numbers. Agricultural use will probably be the main customer interest with arable farming being a feature. Where band D reaches are found in undeveloped pockets of largely urban use, amenity interest may be prominent.

BAND E

There are likely to be very few properties and roads at risk from flooding in these reaches. Agricultural use will be the main customer interest with extensive grassland the most common land use in the floodplain. Amenity interests are likely to be limited to public footpaths along or across the river.

As suggested in the earlier report, caveats may need to accompany these descriptions as a wide range of combinations of interest can be arrived at - the very reason for adopting the matrix approach.

CATEGORY X

This is identified for those reaches where no area at risk from flooding is defined. This may be due to topographic features or that no flooding has actually be observed in these areas.

Step 3. Land Use Bands (See Annex B)

On the basis of the assessment score reaches can be allocated to one of five land use bands as follows:

Table 3

HE/km of Bank	Land Use Band
50 +	A
25 to 49.99	B
5 to 24.99	C
1.25 to 4.99	D
0.01 to 1.24	E
0	Category X

These land use bands represent the continuum from heavily urbanised, band A, through to rural, band E, reaches.

An indication of the typical nature of the land use bands is given in Table 4 opposite.

In addition, a sixth category band X is identified to distinguish those reaches where there may not be an identified area at risk from flooding.

Example 1, the reach shown in Figure 2 and assessed as 7.4 HE/km in Table 2 would thus fall in land use band C.

Table 5

Land Use Band	Target range of average * HE's affected /Km per year		Approximate standard of protection from flooding (Fluvial Floods) *	Approximate standard of protection from flooding (Tidal Floods)
	Max	Min		
A	1	0.5	1 in 50 - 1 in 100	1 in 100 - 1 in 200
B	1	0.5	1 in 25 - 1 in 100	1 in 50 - 1 in 200
C	1	0.5	1 in 5 - 1 in 50	1 in 10 - 1 in 100
D	1	0.5	1 in 1.25 - 1 in 10	1 in 2.5 - 1 in 20
E	1	0.5	< 1 in 2.5	< 1 in 5

Note: These are for reaches which comprise one bank only.

Step 4. Target Levels of Service (See Main Report)

For each land use band a target level of service is defined in terms of an acceptable degree of flooding occurrence, ie: a required standard of protection from flooding. The flooding occurrence is monitored and targets set in terms of HEs per km that have been or may be affected per year by flooding events. A target range of scores is defined with the maximum score reflecting the maximum degree of flooding considered acceptable and the minimum score reflecting the concept that not all flooding is unacceptable.

Table 5 opposite details the target range of scores recommended for each land use band with the target standard of protection this gives.

For the example given in Figure 2 the following targets would be applicable:

HE/km = 7.4

Land Use band = C

Target Range HEs/km/year = 0.5 to 1.0

Approximate Range of Return Period = 1 in 5 to 1 in 50
of Protection from Flooding

Table 6 : Severity Weighting Factors

6a - Reactive Method

Flood Event Component	Category for Severity of Event				Weighting
	0	1	2	3	
Timing	Nov-Feb	Mar or Oct	Apr or Sep	May-Aug	0.25
Duration	≤ 1 day	> 1 < 5 days	5-7 days	>7 days	0.25

For each component of the flood event, timing or duration, the category of severity is identified as 1, 1, 2 or 3. This category score is then multiplied by the weighting for the particular component. Summing these scores for timing and duration of event gives the overall severity weighting for the event. This approach is illustrated in the following examples.

Example (1)

Flood event in March for 4 days

Timing	March (1) x weighting (0.25)	= 0.25
Duration	4 days (1) x weighting (0.25)	= 0.25
	Severity weighting	= 0.5

Example (2)

Flood event in June for 6 days

Timing	June (3) x weighting (0.25)	= 0.75
Duration	6 days (2) x weighting (0.25)	= 0.5
	Severity weighting	= 1.25

6b Predictive Method

In order to account for average timing and duration at flood events under this method, a weighted average value has been derived, see appendix 1 of Annex B.
This gives an average vaule of severity weighting for predictive methods of **0.5**. This same figure is applied to all agricultural HE's when undertaking the assessment, no matter where the particular reach is located.

Step 5. Assessment of Flood Events (See Annex C and Main Report)

The actual LOS being provided is a function of both the flooding occurrence, actual or probable, and a measure of the condition and integrity of any flood defence assets that may be present.

This step 5 will detail the methods for scoring actual or likely future flood occurrence.

Step 6 details the method for assessing any flood defence assets that may be present with step 7 describing how these measures are brought to a single measure of LOS adequacy.

A dual monitoring technique is recommended which provides a 'reactive' assessment based on the interests that have been affected by floods over the preceding five years, and a 'predictive' assessment which reflects the probability of interests being affected by all events including the infrequent occurrence of the large events.

In summary the methods of scoring flood occurrences are as follows:

1. Reactive

Those interests affected by flooding are identified and the total HEs affected by each event is calculated using the formula

urban HEs affected plus (agricultural HEs affected x severity weighting).

The severity weighting is the means by which the differential effects of timing and duration of flood events on agricultural land are taken into account. Table 6a opposite indicates the calculation of the severity weighting.

The scores for each event in each reach can be calculated and averaged over a 5 year rolling period to give an annual average score of HEs affected/km/year. This score can then be compared with the target.

2. Predictive

A number of options for collecting data for the predictive assessment are detailed in Annex C. These options have varying complexities and resource requirement. The option providing the minimum appropriate level of detail within a reasonable resource level is Option 2 involving local operations personnel identifying return periods at which particular interests are affected by flooding. By applying the probability of particular interests being affected to the HE value of the interest the HEs/km that are likely to be affected per year can be identified even though the particular events may not occur until some time in the future. Agricultural interests have their HE value multiplied by the standard severity weighting of 0.5, see 6b opposite, before the probability of the event is applied.

For this method it must be assumed that any flood defence assets that are present provide protection from flooding to their design standard.

Application to Example 1.

Flood History

Reactive data:-

In the previous 5 years two separate flooding events have been recorded.
Flood a) March 1988 for 4 days, affecting 100ha of agricultural land (extensive arable from Table 2) and two gardens.
Flood b) December 1987 for <1 day, 30ha of agricultural land affected, no urban interest affected.

Reactive Score

Applying formula to each event.

Urban HEs affected plus (agricultural HEs affected x severity weighting)

Flood a) Two gardens + (100 Ha of extensive arable land x severity weighting)

From Table 1:- One garden = 0.2 HE per unit
Extensive arable = 6.9 HE per 100 Ha unit

From Table 6a March for 4 days = 0.5 severity weighting.

Therefore Flood a) = 2 x 0.2 plus (6.9 x 0.5)
= 3.85 HE's

Flood b) 30 Ha extensive arable x severity weighting.
Again referring to tables 1 and 6a.
Flood b) = 6.9 x 0.3 x 0
= 0

Total score over 5 years	=	3.85 HE's
Reach Length	=	4.8 km
Average HE's/km/year	=	0.16

Predictive data:

Interviews with local staff identified that:-

a) No flooding occurs in events occurring more frequently that 1 in 5 years.
(Note however that the reactive assessment includes two flood events in the previous 5 years. It is coincidence that two events occurring less frequently than 1 in 5 years have occurred twice in the previous 5 year period).

b) Gardens are affected in events of or less frequent that 1 in 10 years.

c) No other urban interests are affected until the 1 in 33 year event when all property becomes affected.

Table 7. Data for predictive graph interpreted from predictive data on flood occurrence.

Point	Notes	Probability Axis	HE Axis	
a)	Overtopping commences	1/5 = 0.2	0	
b)	Progressive agricultural flooding from point a) upto 1 in 10 year event	1/10 = 0.1	$\frac{12.1}{95} \times 0.5 \times 5 = 0.32$	$\frac{12.1}{95}$ = Agric HE's affected per year. 0.5 = severity weighting factor. 5 = no of years from overtopping.
c)	Commence Garden flooding at 1 in 10 year events	1/10 = 0.1	0 + 0.32= 0.32	
d)	Flooding upto 1 in 10 years	1/10 = 0.1	(2x0.2)+c = 0.72	Two gardens of 0.2 HE's per garden
e)	Marginal extra agricultural flooding from point d) upto 1 in 33 years event	1/33 = 0.03	$\frac{12.1}{95} \times 0.5 \times 23 = 1.46$	23 years from 1 in 10 year event to 1 in 33 year. Assumed progressive increase
f)	Agric flooding upto 1 in 33 year event + gardens	1/33 = 0.03	e)+d) = 2.18	
g)	Property flooding at 1 in 33 year event	1/33 = 0.03	2 + 21.2 = 23.2	2 houses plus 4 NRP (other)
h)	Flooding to 1 in 33 years	1/33 = 0.03	f) + g) = 25.38	
i)	Marginal extra Agricultural contribution at max extent, ie 1 in 100 year event	1/100 = 0.01	$\frac{12.1}{95} \times 0.5 \times 67 = 4.27$	67 years from 1 in 33 year event to max known. Assumed progressive severity
j)	Total HE's affected by 1 in 100 year event	1/100 = 0.01	h) + i) = 29.65	

d) Agricultural HE's are progressively affected with increasing severity of event.

e) Maximum known flood equates to a 1 in 100 year event.

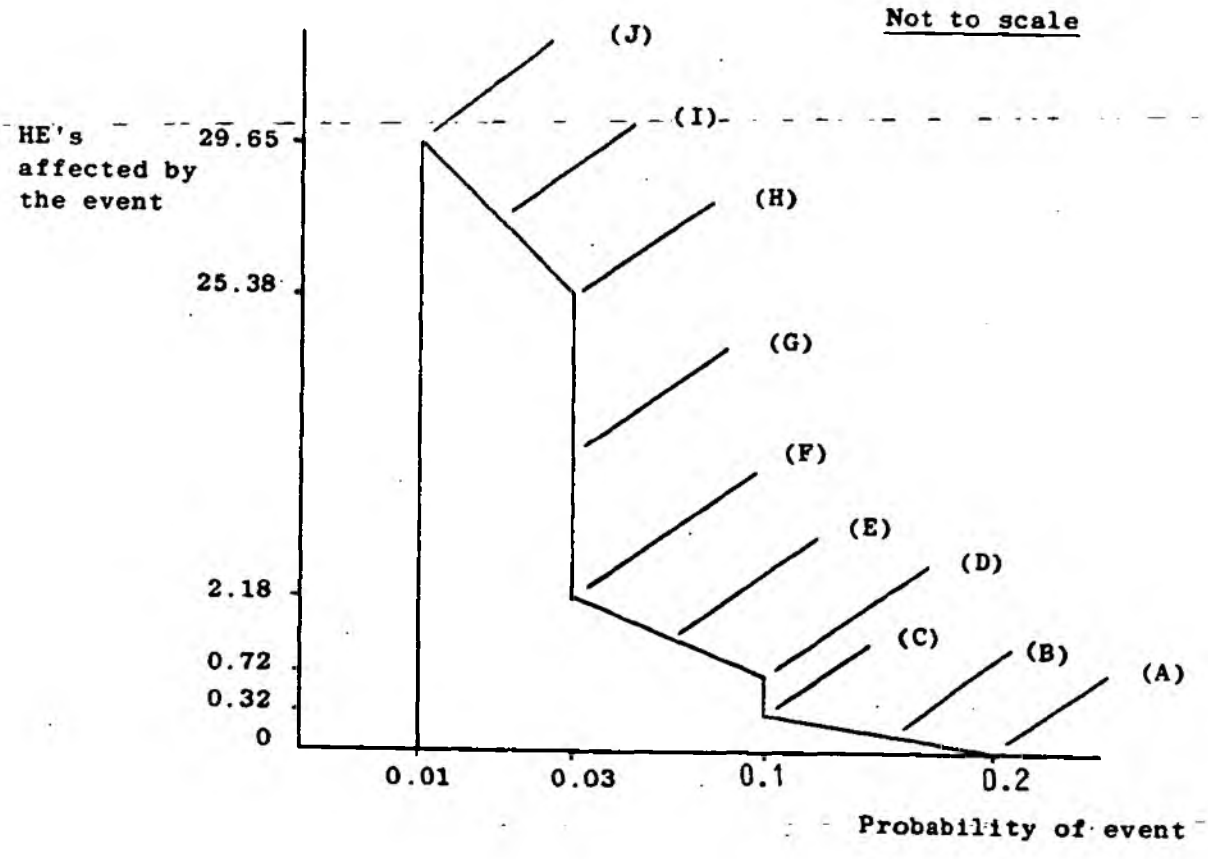
f) There are no flood defence assets in this reach.

Predictive Score

From this data it is possible to identity the HE's that are likely to be affected, by reach, at different probabilities of event. This is shown opposite in table 7 with the information expressed in a graphical format below.

The area under the graph represents the HE/km/year likely to be affected by flooding in this reach. In the example shown above this area equals 0.67 HE/km/year.

Note that the severity weighting factor applied to agricultural flooding results in the total HE's affected by events being less than the total HE's within the reach as indicated in table 2.



Step 6. Asset Condition Assessment (See Annex E and Main Report)

In step 5, the predictive scoring method was described, in this it is assumed that any flood defence assets that are present are assumed to provide protection from floods to their design standard. In reality a proportion of these assets will not be effective upto this design standard.

Step 6 accounts for this by incorporating into a repeated predictive method any perceived reduction in the performance of an asset compared with its design standard.

In those reaches where flood defence assets are present and perceived to be providing protection to their design standard the modified asset predictive score in step 6 will be equal to the predictive score from step 5.

In reaches where there are no flood defence assets present as in example 1 again the modified asset predictive score will be equal to the predictive score from step 5.

Example 1, no flood defence assets present.

Modified Asset Predictive Score= step 5 predictive score
= 0.67 HE/km/year

In example 2 the effect on the predictive score of a perceived poor asset performance is described.

Table 8 Adequacy of Service Provision

Actual HE's/km/year	Adequacy of Service Provision	Interpretation
> 1.0	Inadequate	HE's affected is greater than the target and is considered unacceptable. More resources may need to be directed at this reach to correct inadequate LOS
0.5-1.0	Adequate Category A	HE's affected falls within the acceptable range. Continue current management strategy
< 0.5	Adequate Category B	HE's affected is less than the target range. Consider scope to reduce resource input

Step 7. Adequacy of Service (See Main Report)

Table 8 opposite indicates the determination of adequacy of service provision based on the comparison of the actual level of service being provided with the target level of service thought appropriate for the reach.

For each reach, no matter the land use band, it is necessary to complete each of the scoring methods. Whilst the main determinant of adequacy of service provision is that defined by step 6 the other two methods give valuable additional information. This can explain why the particular level of service is being provided and if necessary give guidance on what particular remedial action may be necessary.

From example 1 the following scores have been calculated.

Step 5 - Reactive method. = 0.16 HE/km/year
Step 5 - Predictive method. = 0.67 HE/km/year
Step 6 - Modified method. = 0.67 HE/km/year

Comparing the score from step 6 with the range appropriate for the reach (Table 8) indicates that the current level of service is Adequate.

In this example, a reach classified as land use band C, it is perhaps not surprising that the reactive score indicated a very low occurrence of flooding equating to an adequate (B) LOS provision. The target range for band C reaches equates to standards of flood protection, in terms of return period of flood occurrence, generally in excess of a 1 year in 5 standard. The 5 year monitoring period of the reactive method is then too short to fairly reflect the overall actual incidence of flooding.

Step 8. Growth Index (See Annex D)

It is recommended that the policy of opposing development in the floodplain unless the developer pays for the necessary flood protection or compensatory works be pursued rather than incorporating the potential for development of the flood risk area into the LOS system.

Step 9. Summary and Interpretation

For example 1, reach 3 left bank as defined by step 1.

Land Use Assessment (step 2)	Total HE	=	35.7
	Reach length	=	4.8km
	HE/Km	=	7.44
Land Use Band (step 3)	Band	=	C
Target LOS range (step 4)	HE/km/year	=	0.5 to 1.0
Reactive Score (step 5)	HE/km/year	=	0.16
Predictive Score (step 5)	HE/km/year	=	0.67
Modified Asset predictive score (step 6)	HE/km/year	=	0.67
Adequacy of Service (step 7)			Adequate
Growth Index (step 8)			Not applicable

Interpretation

Current maintenance practices are providing an appropriate level of service for the interests present within the reach. The very low reactive score may indicate some scope to reduce resource input and accept marginally increased flooding provided that the predictive scores are not adversely affected.

Figure 3. Example 2.

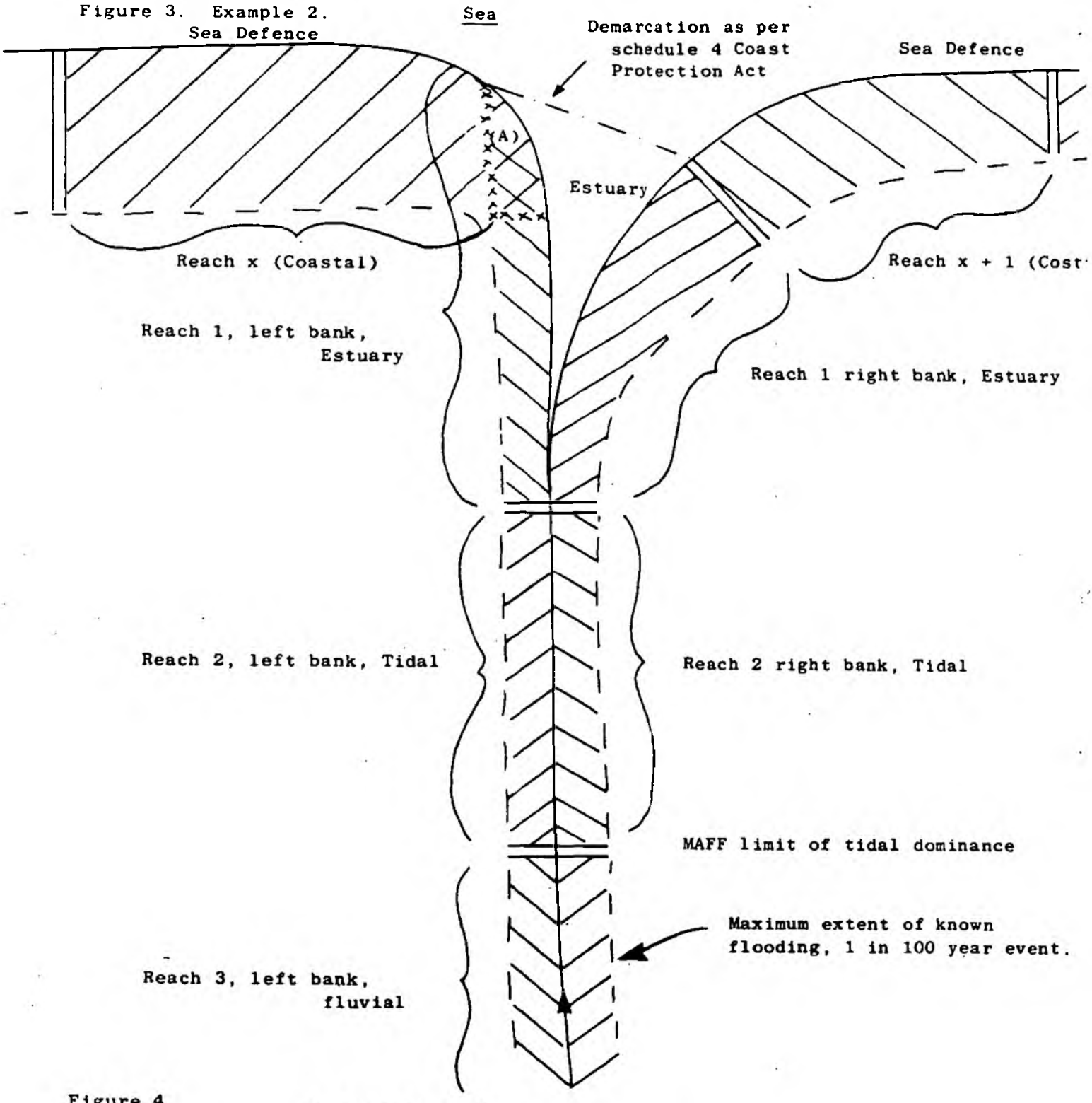
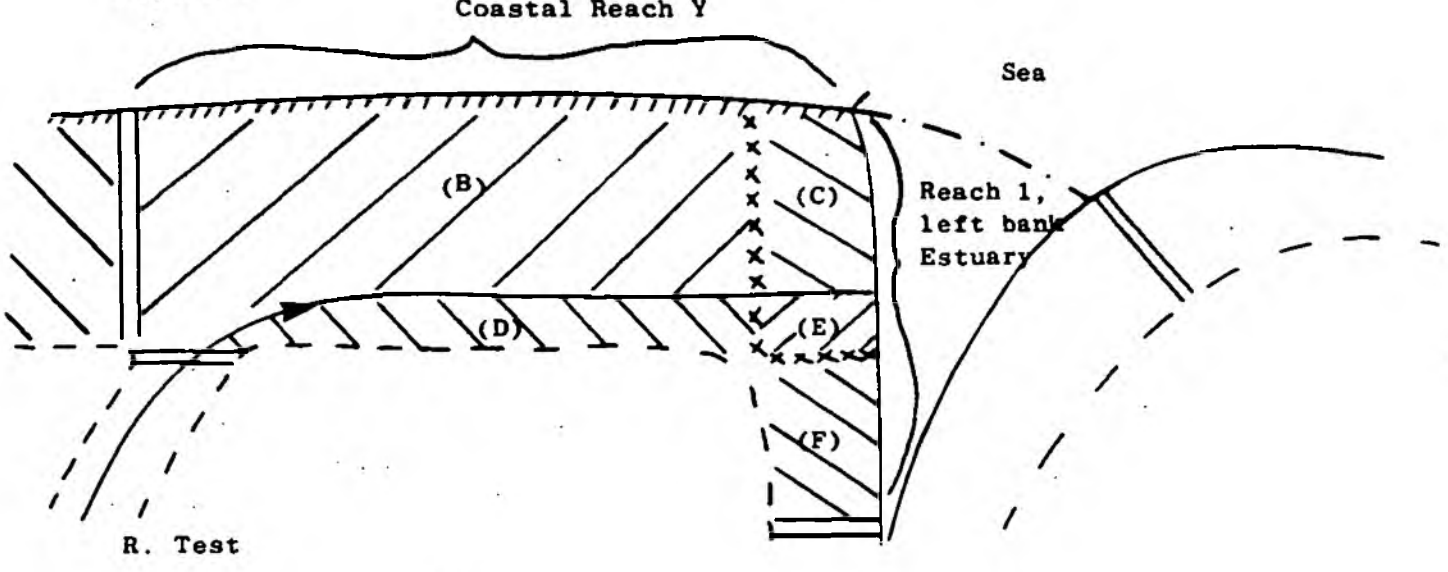


Figure 4



3. EXAMPLE 2

In this second example a number of additional factors and more complicated situations are presented. However with reference to the additional detail available in the accompanying annexes and by following the system through logically the assessment can be completed.

Step 1. Reach definition and referencing (Annex A)

In figure 3 opposite a scenario which may be encountered around estuaries is described. Key points to note concerning definition of reaches are:-

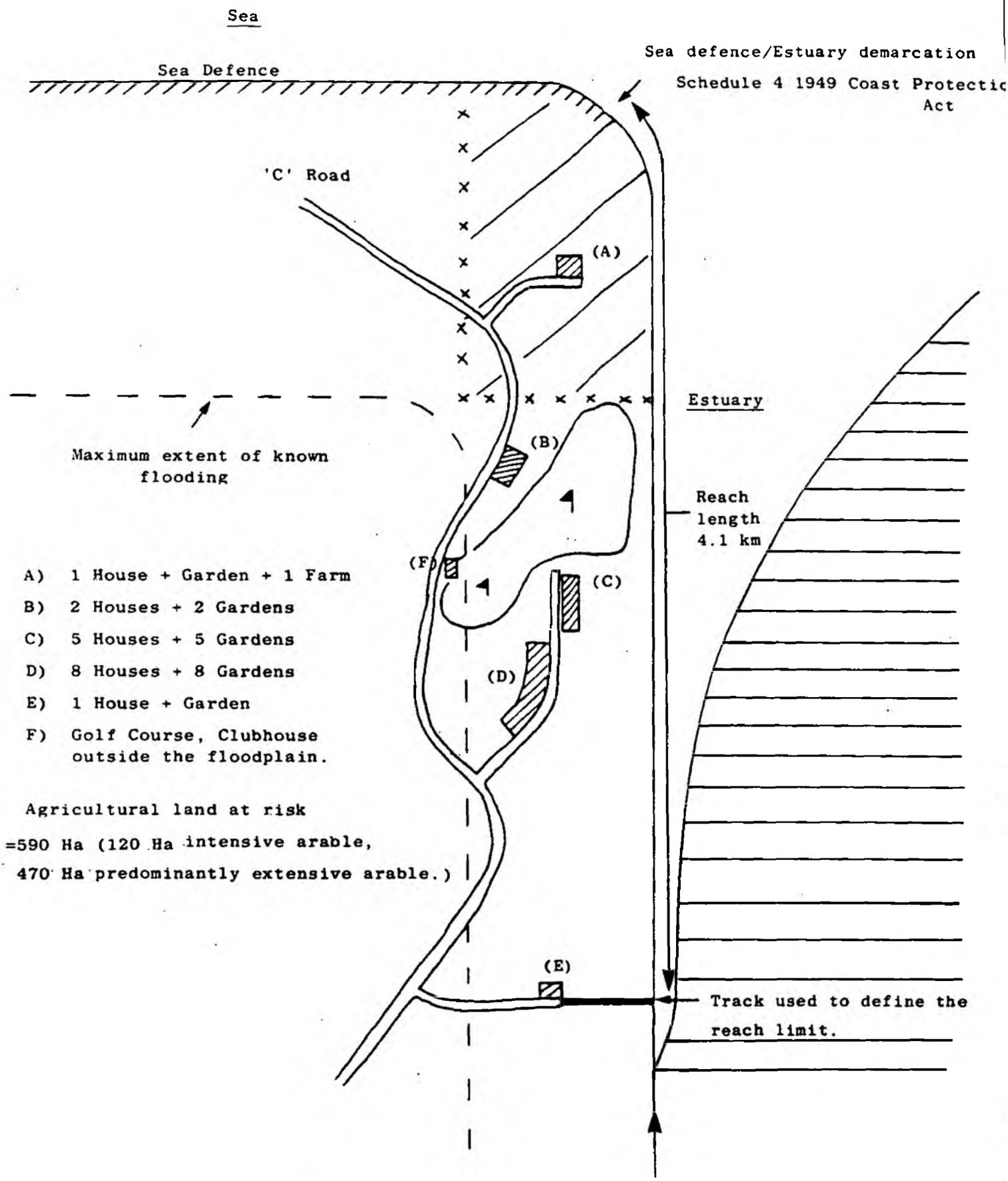
1) Reach limits are defined to coincide both with the sea defence/estuary demarcation as per schedule 4 of the 1949 Coast Protection Act and with the MAFF defined limit of tidal dominance.

2) To the right hand side of the diagram the river opens out to the sea in a broad sweeping estuary. In this situation the reach limits between reaches are generally marked perpendicular to the general coastline.

3) To the left hand side of the diagram a more abrupt change in direction of land occurs. This has the result that there is an area of land marked (A) that can be flooded from either the sea defence or estuary defence sides of the schedule 4 demarcation. To ensure that this is adequately accounted for, the interests within the area (A) are allocated to both reach 1, left bank estuary, and to reach-x coastal. A more extreme form of this situation is illustrated in figure 4 where a river outfalls into the estuary. Over part of it's length it is in the area at risk of flooding from either the sea defence or from the estuary. In this situation the allocation of land use areas to reaches is made as follows.

	Areas contributing to land use Assessment
Coastal Reach Y	B + C + D + E
Estuary Reach 1 left bank	C + E + F
R. Test reach 1 left bank	B + C
R. Test reach 1 right bank	D + E

Figure 5 Example 2, Reach 1, left bank, Estuary.



This assumes that the topography is such that the R. Test could flood area B. Local knowledge may be able to indicate a smaller area at risk from flooding for the R. Test, in which case the land use assessment would be based on that.

Step 2 Land Use Assessment (Annex B)

Figure 5 opposite details the interests within Reach 1, leftbank estuary from figure 3. As before, the eligible interests within the flood risk area are identified and the total incidence of them recorded. A completed form for this reach is included as table 9 overleaf.

Key points to note.

1) The house and farm at (A) in figure 5 is included in the assessment of the estuary reach and also the assessment of the coastal reach, as are any other interests within this area, eg agricultural land, roads etc.

2) The golf clubhouse is outside the risk area. The course is thus entered as an amenity only (golf course). If the clubhouse had been within the risk area the whole enterprise would have been entered as one Non Residential Property (other).

3) The 'C' road is included in the assessment only once even though it veers into the flood risk area at two separate points.

4) The calculation of agricultural HE's within the risk area separately identifies intensive arable land when it represents more than 10% of the total agricultural area.

Summing the totals for each factor identified within the reach gives a HE total = 109.37,
HE/km = 26.67

Step 3 Land use bands (Annex B)

Referring to table 3, earlier in this report, identifies this reach, 26.67 HE/km as within the range of values for land use band B.

Step 4 Target level of service (Main Report)

Referring to table 5, earlier in this report identifies for band B reaches the appropriate target range of acceptable flood incidence at between 0.5 and 1.0 HE/km/year. This equates to a possible range of acceptable flood return periods of between 1 in 25years and 1 in 100 years for fluvial reaches and 1 in 50 to 1 in 200 years for tidal flooding.

This reach is downstream of the MAFF limit of tidal dominance and thus all flooding is assumed to be tidal in nature. The target return period of flooding is 1 in 50 to 1 in 200 years.

Table 9

Assessment Summary Sheet

Assessor's Name .....

River Name .....

River Number .....

LOS Reach Number, (specify left or right bank) .....

Cathment Number .....

Regional Identifier (NRA region, responsible office) .....

Landranger Map Number .....

Floodplain extent Map Number .....

From .....
(Downstream, Name & Grid reference) .....

To .....
(Upstream, Name & Grid reference .....

Agricultural Floodplain Area (Ha) 590

Reach length (km) 4.1

Land Use Factor	Unit	Number (x)	House Equivalents HE/Unit (y)	Total HE (x x y)
House	Total Number	17	1.0	17.0
Garden/Allotments	Total Number	17	0.2	3.4
NRP - Distribution	Total Number		40.2	
NRP - Manufacturing	Total Number		64.6	
NRP - Other	Total Number	1	5.3	5.3
C Roads	Total Number	1	2.4	2.4
B Roads	Total Number		5.7	
A Roads (Non Trunk)	Total Number		14.3	
A Roads (Trunk)	Total Number		28.6	
M. Way	Total Number		57.3	
Railway	Total Number		57.3	
Forestry and Scrub	100 Ha		0	
Extensive Pasture	100 Ha		1.3	
Intensive Pasture	100 Ha		3.0	
Extensive Arable	100 Ha	4.7	6.9	32.43
Intensive Arable	100 Ha	1.2	40.2	48.24
Formal Parks	Total Number		0.6	
Golf /Race Courses	Total Number	1	0.6	0.6
Playing Fields	Total Number		0.1	
Special Parks	Total Number		8.5	
			Total HE (a)	109.37
			Reach Length (b)	4.1
			HE/Km (a ÷ b)	26.67

Step 5 Assessment of Flood Events (Annex C)

This particular reach contains a flood defence asset along it's entire length which has a design standard such that it provides protection upto events of return periods 1 year in 40. However it is believed that in reality this asset will only provide protection to flood events of 1 year in 20 return period or more frequent.

Reactive score

No flood events have occurred in the 5 year monitoring period.

Reactive score = 0 HE/km/year.

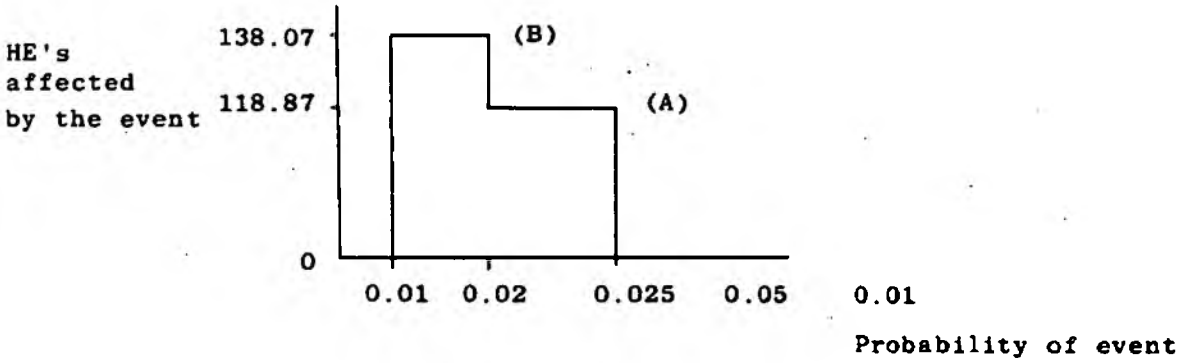
Predictive score

The predictive score is calculated under the assumption that any flood defence assets that are present will provide protection from flooding to the design standard.

For example 2, once this standard is exceeded the following flooding scenario is assumed.

1) All interests are affected by flooding as soon as flooding commences except for the houses and gardens at (D) on figure 5 which are unaffected until a 1 in 50 year event occurs.

This can be expressed on a graph.



The Area under the graph = 1.974 HE/year
Reach length = 4.1 km
HE/km/year = 0.48

The values at A and B above are calculated by summing the HE values of all interests affected, remembering to multiply the agricultural HE's by the severity weighting, and then multiplying the total volume by a factor of 2 to reflect the increased damage caused by saline flooding.

That is for A the HE's affected equals.

A = 9 (Houses) + 1.8 (Gardens) + 2.4 ('C' road) + 0.6 (Golf Course) + 5.3 (NRP other) plus (80.67 agricultural land) x 0.5 (severity weighting)

= 19.1 + 40.335

= 59.435 x 2 (Factor for effects of saline flooding)

= 118.87 HE's affected.

For B the additional contribution is from 8 houses and 8 gardens affected by flooding = 8 + 1.6 = 9.6 x 2 (saline factor) = 19.2 HE's.

Step 6 Asset Condition Assessment (Annex E and Main Report)

The flood defence asset present along the length of this reach is believed by local staff to be providing a standard of protection below its design standard of 1 in 40 years such that events of 1 in 20 years magnitude or greater would result in flooding due to asset failure.

Taking this into account local staff revised the flooding scenario given at step 5 predictive score as follows.

1) At 1 in 20 years event all agricultural interests are affected as are the properties at point A, C and E, the 'C' road and golf course.

2) Properties at B would be affected by events of magnitude 1 in 33 years.

3) Properties at D would be by the 1 in 50 year event.

The HE's affected at different return periods can be calculated exactly as before with the following graph produced.

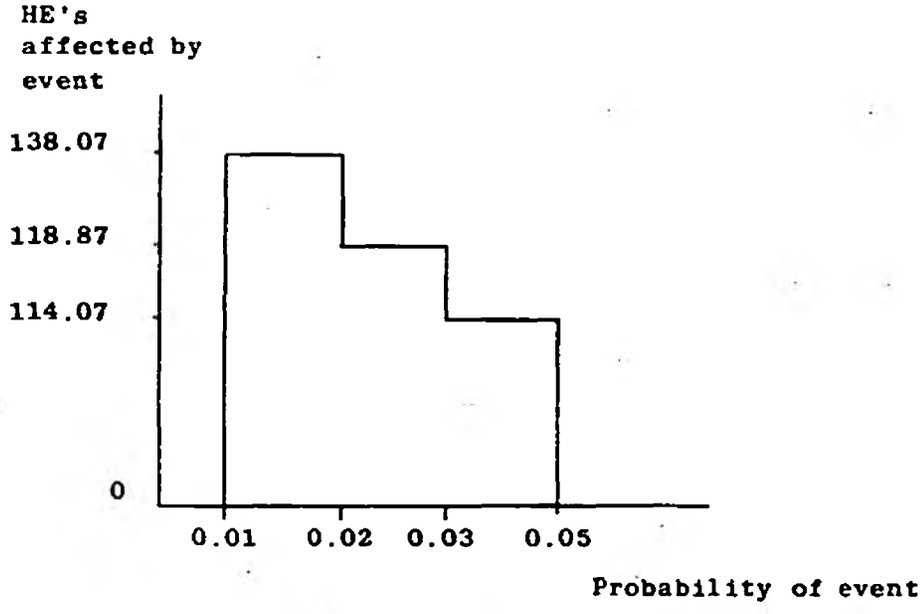


Table 8 Adequacy of Service Provision

Actual HE's/km/year	Adequacy of Service Provision	Interpretation
> 1.0	Inadequate	HE's affected is greater than the target and is considered unacceptable. More resources may need to be directed at this reach to correct inadequate LOS
0.5-1.0	Adequate Category A	HE's affected falls within the acceptable range. Continue current management strategy
< 0.5	Adequate Category B	HE's affected is less than the target range. Consider scope to reduce resource input

The area under the graph	= 4.87 HE/year
Reach length	= 4.1 km
HE/km/year	= 1.19

Step 7 Adequacy of Service (Main Report)

The main determinant of the level of service provision is the score from step 6 which takes account of any perceived reduction in the performance of flood defence assets that may be present. Comparing the score from this of 1.19 HE/km/year with the target range indicates from table 8 that an inadequate level of service is being provided, ie the incidence of flooding is too great for the interests present within the reach.

Consideration of the score from the predictive method of step 5 indicates that it is the poor asset performance, below design standard, that is leading to the inadequacy of service provision. The predictive score from step 5 on it's own indicates that marginally too high a standard of protection would be afforded if the asset was providing protection upto it's design standard of 1 year in 40.

Step 8 Growth Index (Annex D)

Comments as for example 1.

Step 9 Summary and Interpretation

For example 2.

Land Use Assessment (step 2)	Total HE	= 109.37
Reach length		= 4.1
HE/km		= 26.67
Land Use band (step 3)		= B
Target LOS range (step 4) HE/km/year		= 0.5 to 1.0
Reactive score (step 5) HE/km/year		= 0
Predictive score (step 5) HE/km/year		= 0.48
Modified Asset predictive score (step 6) HE/km/year		= 1.19
Adequacy of service (step 7)		= Inadequate
Growth Index (step 8)		= Not applicable

Interpretation

Incidence of flooding occurrences is likely to be too high for the interests that are present. The main contributing factor to this appears to be the poor condition of the asset. If performing to it's design standard the asset would be providing an adequate level of service, though being classified in category B, there may be some scope to reduce resource input and accept a slightly higher incidence of flooding.

Remedial actions to improve the standard of service provision should be investigated.

4. CONCLUSION

It is impossible to address all the issues and alternative scenarios that will be encountered in two worked examples in this Summary Report. Additional details to approach particular situations are given in the accompanying Final Report and Annexes. The two examples do however serve to illustrate the logical procedure for completing a LOS assessment for any reach. Even as the land use scenario and flooding scenarios become more complex, the assessment can be readily completed by following through the ordered sequence of stages forming the system.

It is of course essential that any individual undertaking the assessment is fully familiar with the principles and detailed approaches which are described in the accompanying Report and Annexes.