FLOODPLAIN COMPENSATION WORKS, CUT & FILL ON A LEVEL FOR LEVEL BASIS

The Environment Agency follows a policy of no net loss of floodplain storage and no obstruction to flood flows. **Wherever possible, natural floodplain areas should be left undisturbed**. On the extremities of a floodplain only, it may sometimes be possible to recontour the land without conflicting with this policy. Such works are subject to the Agency's Consent under its Byelaws.

Due to the complexities of such works, detailed discussions must be held with the Development Control Officer/Engineer for the area at a very early stage to check:
a) If such works are acceptable in principle at a particular location
b) What flood level is to be used to define the floodplain boundary
c) What other constraints, if any, are applicable

Theory

On certain parts of the floodplain, water will be virtually static and the volume of storage available for floodwater is the main consideration. In addition to the volume of flood water storage involved, the level (and thus the timing) at which the storage comes into operation is significant. If this volume is reduced for any stage of a flood, then the lost storage results in floodwaters being diverted elsewhere, leading to third party detriment. The detriment caused by a small encroachment may not be significant, or even measurable, when taken in isolation, but the cumulative effect of many such encroachments will be significant, and will lead to increased flood levels and/or flooding over a larger area.

For this reason, any loss of flood storage must be compensated for by the reduction in level of nearby ground, such that the **same volume** is available at **every flood level** before and after the works, and that it can freely fill and drain. It is **not** adequate compensation to:

a) Excavate holes in the floodplain
b) Create landlocked areas of lower ground, even if connected to the main floodplain by channels or culverts
c) Provide low level volumes to replace high level floodplain and vice-versa.

Example

In order to illustrate what to many is a confusing issue, the following example might be considered:

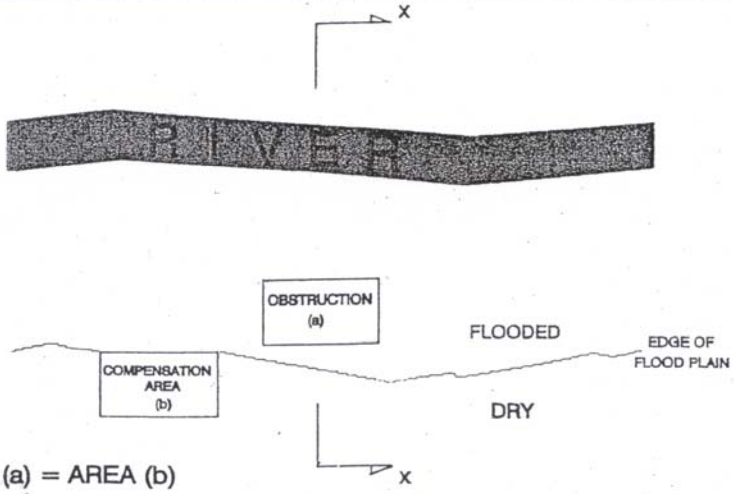
An area of land on the fringes of the floodplain is required for development. The site is partly within and partly outside the floodplain. The terrain at the edge of the floodplain is such that the floodplain boundary is very irregular and the site is not easily developable because of this. As the floodwater at this point is not flowing, it may be acceptable to realign the floodplain boundary by recontouring the ground such that no storage volume is lost. In order to mirror the existing situation so that for a particular flood each stage (or level) is provided with the same storage volume, cut and fill must equate on a level for level basis, i.e. at each level (say at O.2m vertical intervals for example) the excavated and filled volumes are equal. Calculations to show this are required.

The developer must fully understand that the level at which the cut or fill takes place is just as important as the volumes concerned if a significant change in the way in which the floodplain functions is to be avoided.

Environmental Considerations

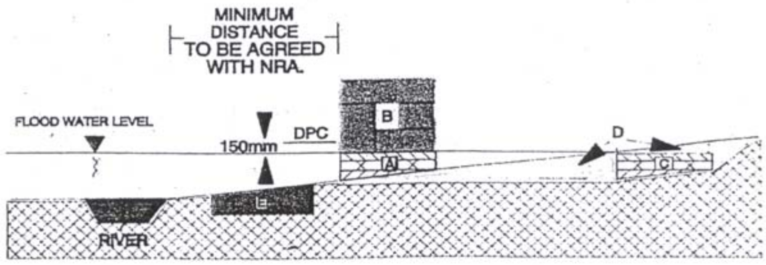
The Agency has a duty to further nature conservation. It may be possible that whilst a scheme is acceptable from a hydrology and/or hydraulics viewpoint, it is not acceptable in terms of nature conservation or some other environmental aspect. This should be borne in mind by any person wishing to carry out such works.

EXPLANATION OF LEVEL FOR LEVEL FLOOD COMPENSATION



AREA (a) = AREA (b)

PLAN



CROSS SECTION X - X

KEY:

A: VOLUME OF OBSTRUCTION OCCUPYING THE FLOOD PLAIN.

B: VOLUME OF OBSTRUCTION ABOVE WATER LEVEL.

C: LEVEL FOR LEVEL COMPENSATION AREA (VOL C = VOL A).

D: MATERIAL REQUIRED TO BE REMOVED BUT NOT IN COMPENSATION AREA. THIS WILL NECESSITATE RE-CONTOURING GROUND LEVELS TO ACHIEVE THE COMPENSATION AREA.

E: UNACCEPTABLE COMPENSATION SCHEME - NOT LEVEL FOR LEVEL.

NOTE:

LEVEL FOR LEVEL FLOOD COMPENSATION APPLICABLE WHERE FLOOD ROUTES AND RIVER CORRIDOR INTERESTS ARE PROTECTED AND THE NRA ARE PREPARED TO ACCEPT SOME FORM OF COMPENSATION FOR LOSS OF FLOOD STORAGE.

A BRIEF EXPLANATION OF FLOOD PLAIN STORAGE AND 'LEVEL FOR LEVEL' FLOOD PLAIN COMPENSATION.

1. When it rains, water finds it's way off roofs and roads, into drains, thence through surface water sewers and into watercourses. Water also runs off the land but at a slower rate.

2. If one considers a point, X, in the watercourse just downstream of the surface water sewer outfall, water falling just upstream of that point will arrive before that falling further away from the watercourse, and so on, until the rain falling furthest away arrives last. Thus, eventually rain is reaching X from the whole area drained. At this stage the whole area is contributing and the flow has reached it's maximum. This is why, following rain, a watercourse can take some time to rise to a peak (sometimes after the rain has stopped) and following this, the flow declines. This rise and fall is called a flood wave or, more technically, ***a flood hydrograph***.

3. It is at this ***peak flow***, i.e. when levels are highest, that properties are most likely to be affected; but it is also at this stage that nature takes a hand to reduce the problem. Consider a plot of rate of flow against time (fig. 1) Or flood hydrograph, as we know it and assume that the channel banks are very high (fig. I a). The flow will rise to a peak and fall, unmodified by storage; it will leave the site as it arrives, being contained throughout within the channel.

4. If a flood plain exists and the banks are not too high (fig.2a), the hydrograph (fig.2) is rather different. Once the flow rises to a rate which exceeds the channel capacity it starts to overflow into the flood plain. Immediately the rate of increase in flow passing downstream levels off as a certain proportion of the flow passes into storage in the flood plain and stays there until the flow rate reaches it's maximum and begins to drop, allowing water in the flood plain to flow back into the channel. Fig.2 demonstrates the resulting, altered, hydrograph. The onward flow is modified along the dotted line, the peak reached being lower; the volume stored on site is shown vertically hatched. This volume is discharged after the peak as the diagonally hatched area a11d both are equal.

5. ***In summary, flood plain storage reduces the peak of the flow passed on downstream by cutting the top off the hydrograph. Without the storage, as shown in Figs I & la, the flow to be dealt with downstream would be higher and the flood risk greater.***

6. Because the Stage at which storage takes place is critical, it is important that compensation is designed on a ***level for level*** basis. The following example (fig.3a) shows compensation provided at a lower level than the fill in the flood plain; one side of the flood plain is excavated below existing ground level to 'provide compensation' for the filling above ground level elsewhere in the flood plain, the arguement being that the storage volume is still the same. Looking at the hydrograph (fig.3), the rate of flow is as before, but now storage can take place earlier, as on one side the bank is lower. The rate of increased flow follows the chain dotted line, at first it is flatter but as the flow rate gets higher it steepens because the volume of storage at the higher level is less although the total storage available is the same. Finally, the peak rate reached is greater.

7. In summary, the effect of providing storage at the wrong level, too early in the flood, is to allow a higher peak flow to pass on downstream, whereas the provision of full level for level flood plain compensation will ensure that the performance of the flood plain and the flood hydrograph will remain unaltered and flood risk will not be worsened.

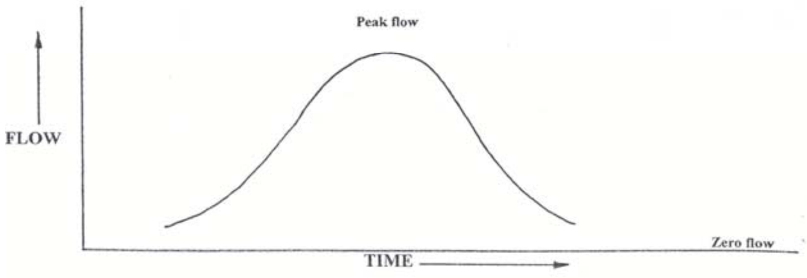


Fig. I **Flood Hydrograph**

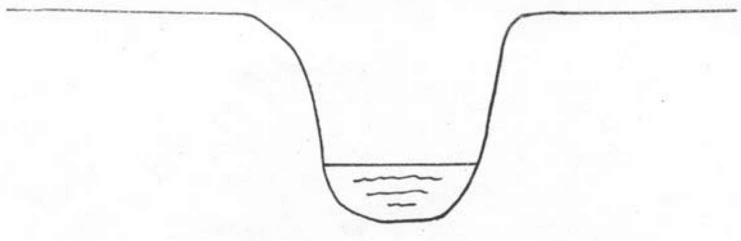


Fig.1a **Channel without flood plain**

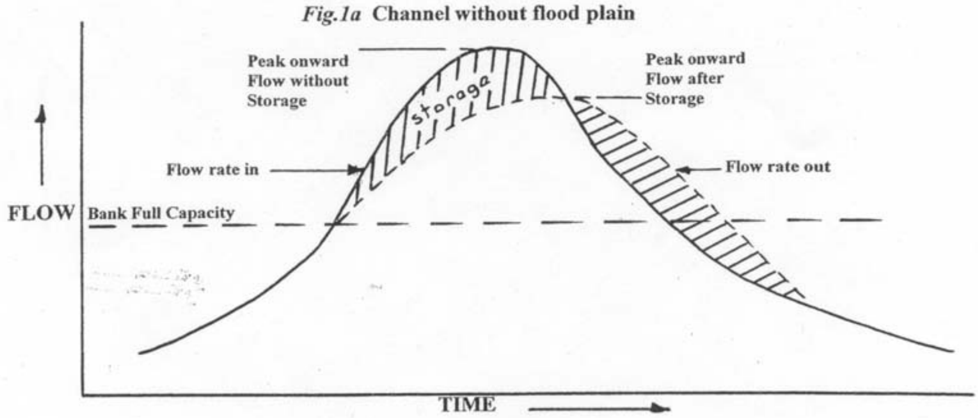


Fig. 2 **Hydrograph altered by flood plain storage**

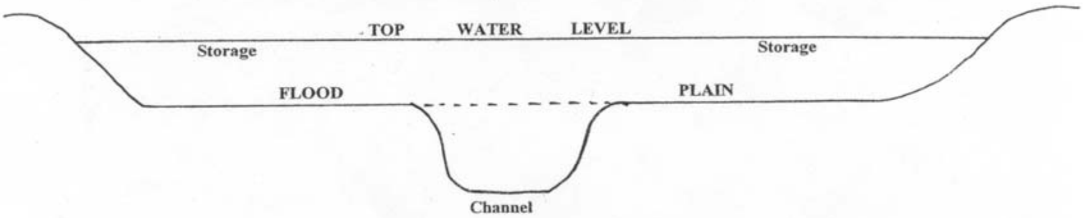


Fig. 2a **Channel with flood plain**

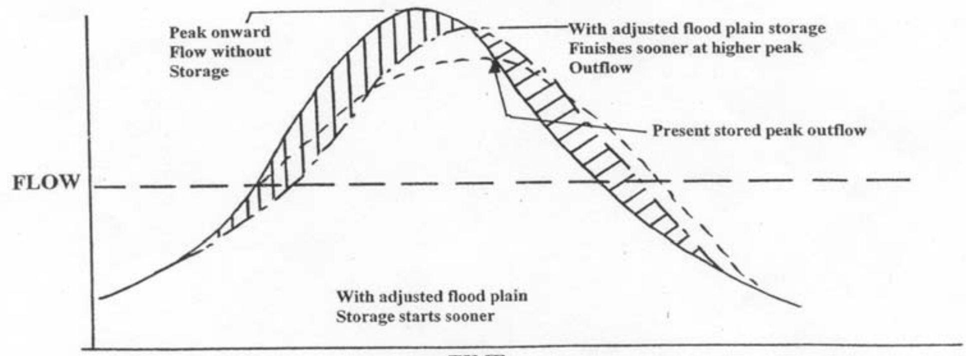


Fig. 3 **Hydrograph altered by below ground flood plain compensation**

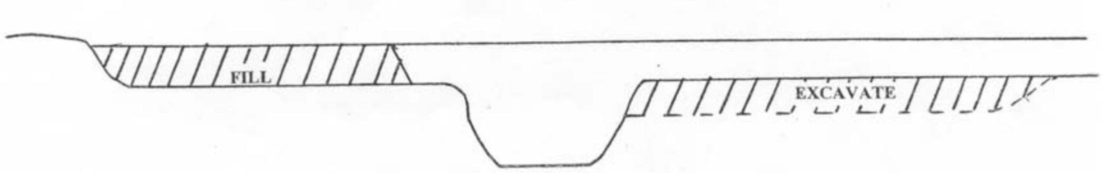


Fig 3a Channel with fill above and 'compensation' excavation below ground

Level for level flood plain compensation

Storage and river levels in a non-flood situation

Imagine, as a hypothetical case, a river where a compartment has been excavated in the bank, going down as deep as the river itself and separated from the river by a sealable gate located in the riverbank. The compartment starts empty, then the gate is opened. Because some of the flow reaching that point is diverted into filling the compartment, there is a temporary lowering of levels immediately downstream of the gate. Then the compartment becomes full, and the river resumes its previous level. The compartment does not from that point influence the river level (though it may have a minuscule impact on the timing of any changes in flow as those changes move downstream).

Loss of storage and river levels in a non-flood situation

Equally, the placing of a volume of material in the river, assuming that this is done in a way which does not alter the pattern of flow appreciably (a lining to a length of bank, for example, or spreading gravel across the bed), would give rise to a temporary raising of levers immediately downstream, as a volume of water is displaced and forced into the next section of river. Original levels would then be resumed.

The storage requirement in a flood event

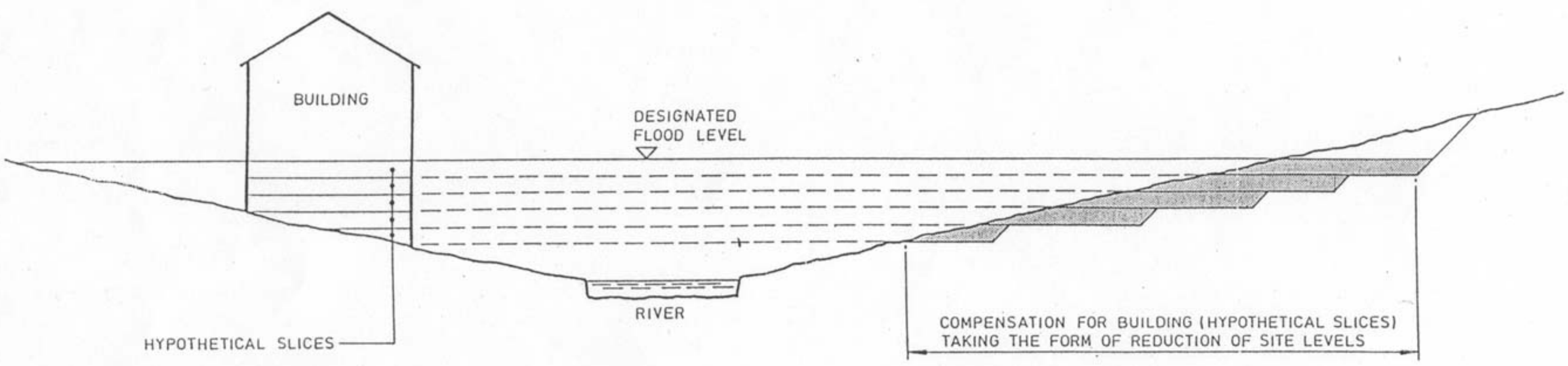
Assume now that the river is in flood and out of banks. Exactly the same principles apply, but a quantity of flood plain storage volume provided as flood plain compensation would only offset the loss of storage as a result of displacement by the building if the compensation came into play at the same time as the loss by displacement occasioned by the building. This can normally be achieved only if the volume lost is at the same level or levels as the volume gained.

The basis of flood plain compensation

The protection of the storage capacity of flood plains through planning policies is intended to ensure that works are kept to a minimum, which would increase the extent of the flood plain. The crucial factor in determining the extent of flooding in a given event is the storage capacity available immediately before the peak of the flood. Up to that point, the availability of flood plain storage capacity may affect the timing and build up of flooding, but it is as the peak is approached that storage becomes critical.

Maintaining storage for all return periods

Clearly, the seriousness (related to the probability of recurrence or "return period") of a flood is not known in advance, so the objective of planning policies is normally to protect river flood plains affected by events up to and including the I in 100 year event, assuming that the necessary information on flooding is available. The I in 100 year event is specified as the criterion in DoE circular 10/92. In order not to risk reducing storage available for a range of possible flood events up to the I in 100 year event, it is necessary for compensation to provide equivalent volume at each level for which the building is displacing storage, up to the level of the 1 in 100 year event. To achieve this, part of the site has to be outside the flood plain.


BUILDING
DESIGNATED
FLOOD LEVEL
RIVER
HYPOTHETICAL SLICES
COMPENSATION FOR BUILDING (HYPOTHETICAL SLICES)
TAKING THE FORM OF REDUCTION OF SITE LEVELS

SECTION