# 5 Non-Residential Properties

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## OVERVIEW

Flood damage to Non-Residential Properties (NRPs) can be a significant factor when considering major expenditure on flood risk management measures. Chapter 5 of the MCM (Penning-Rowsell et al., 2013) provides methods and data for assessing the direct flood loss potential of NRPs. Guidance on the estimation of indirect losses is also included as is guidance on evaluating the flood damage-reducing effects of property level resilience (PLR) measures and the movement of contents of properties prior to flooding and on receipt of a flood warning.

The NRP damage data are available as depth/damage and depth/damage/duration data in which short, long and extra-long flood durations are considered. The data have been selected and compiled to represent 95% of NRPs located in flood risk areas of England and Wales as indicated by the Environment Agency's National Receptor Dataset. The data includes damages from saltwater and wave impact and the damage-reducing effects of flood warnings.

The NRP depth/damage/duration data were compiled by employing an empirically informed, synthetic modelling approach in which our Building and Quantity Surveyor's (experienced in building refurbishment and replacement as well as in flood damage susceptibilities) were posed a series of 'What if?' questions. For example, what would the flood damages likely to be if a typical or representative supermarket or a warehouse was to be flooded to different depths? And what would be the likely range of damage susceptibilities (i.e. best case (low), worse case (high) and most likely case (indicative)? The method used in Chapter 5 is directly analogous to the now well-accepted synthetic approach used to compile the Residential Property depth/damage/ duration data (Chapter 4).

The categorisation of NRPs is simpler than in pre-2013 editions, as far fewer sub-categories are employed, reducing complexity for users. Using the sector and sub-sector weighted averages ensures the selection of damage data and its assignment to land use/property databases becomes relatively simple, although the user is always advised to have his/her wits about them when matching depth/damage/duration data to property databases as an incorrect assignment to properties may well lead to significant errors in damage estimation.

It is important to recognise that the NRP damage data represent an 'average' or 'typical' set of damage values for England and Wales. They therefore present users with a 'standardised' approach to damage estimation and one which aids comparability across the country. For this reason, and to the extent that users may find that they are presented with examples of NRPs which are not average, then the damage data will under or over-estimate actual damage potential. Deviation from the average is less likely to occur or be significant in the sub-sectors where multiples dominate and where properties have become more standardised over time. This is so in the Retail, Office and Warehouse sub-sectors but standardisation is least likely and therefore significant variance is most likely in the industrial sub-sector where unique factory or workshop premises are most likely to be found. Users should therefore consider the merits of undertaking site surveys in this case.

Where there is sound local evidence to suggest that properties are significantly different to the average or typical, then it is permissible to utilise the ‘high susceptibility’ or ‘low susceptibility’ depth/damage/duration data rather than the 'indicative' case data which should normally be used.

However, in these cases the use of these data in appraisals should be clearly specified and supported with evidence and sensitivity testing around these susceptibility envelopes should be incorporated into the appraisal.

The 2026/27 damages have been inflated using the appropriate indices.

## LESSONS FROM EXPERIENCE

- The range and diverse function of NRP types, their size, and the varying degrees of susceptibility for each component of damage, make it more difficult to construct these data than other loss data;
- The type and function of an NRP is not the most important determinant of potential NRP flood damage. Flood depth, property size and precautionary measures all come before the category of NRP in the influence they exert on flood losses;
- There will inevitably be errors in the data supplied with this Chapter. It is not possible to quantify all of these errors, although every attempt has been made to keep them to a minimum;
- Data on the Extra-Long Duration and coastal flooding, and on the potential reduction in losses following receipt of a flood warning need to be treated with some caution;
- Data relating to potential damage saving related to property-level protection are tentative and subject to many assumptions;
- Error is present in any flood damage data set and therefore it is wisest in any appraisal (at any scale) to subject these data to sensitivity testing.

## DIFFERENT TYPES OF APPRAISALS

The framework presented below is for appraisals of different types, scale and complexity. The framework includes (1) overview studies which are less complex and demanding in terms of damage data requirements and which may be undertaken at the meso- or micro-scales[1], (2) initial and full-scale studies, the latter of which are more detailed and demanding and more suited to the micro-scale and (3) micro-scale site surveys where site-specific damage data are collected.

## HOW DO MCM NRP FLOOD DAMAGE DATA COMPARE WITH REPORTS OF NRP FLOOD DAMAGE?

Since MCM flood damage data are primarily 'synthetic' data (i.e. they are constructed by building and quantity surveyors experienced in flood damage independent of actual flood damage reports) it may be considered useful to compare them with reports of actual flood damage in floods experienced in the UK in recent years. Unfortunately, insurance companies are very reluctant to release data for individual properties and post-flood property-by-property surveys of flood damage are time-consuming and costly to undertake and are often not welcomed by those who have suffered damage and have already been visited by insurance loss adjustors. In addition, property owners/managers are known to under-estimate flood damages in the period immediately following a flood because some damages only show up weeks and months later. Another problem with property-by-property surveys of flood damage is that they seldom cover the full flood depth range that is required to construct depth-damage curves: indeed, as the case in the "Non-Residential Properties: Financial or Local Economic Losses and Benefits" chapter shows, only one a very few

[1] You may use the Rapid Appraisal Tool for Economics (RATE) spreadsheet to perform simple economic benefits calculations in England (Environmental Agency, 2026a). Please check the latest guidance for its applicability.

flood depths are represented. In this 'financial losses' chapter comparisons are made, which are not repeated here, of reported flood damage values with MCM flood damage values on a £/square metre basis. Because the relationship between economic and financial flood damages values is known, the conclusions drawn about the comparison apply equally to this chapter as to the 'financial losses' chapter.

## HOW TO USE THE DATA

The potential damage data need to be related to flood probability in order to calculate annual average flood damages which is the objective (see Chapter 3). A property-by-property database is required which identifies the ground floor threshold height AOD above which flooding will start to enter the property. In the case of complex NRPs which comprise a site containing a number of buildings it will normally be necessary to treat each separate building as a separate property. The latest version of the property-by-property NRD database provides the MCM codes used here, but older versions of the NRD use the old MCM codes and these codes have been translated into the latest MCM codes in Table 5.1 (see 'Tables & Figures' spreadsheet for Chapter 5 on MCM-Online). The database should also carry other property identifiers such as grid reference and postal address information. The ground floor area in $m^2$ of the building footprint only (excluding surrounding grounds) should also be recorded as should the ground floor threshold level. Finally, this database must be linked to a hydro-dynamic model which allows flood depths for a range of floods of different probability to be assigned to each property.

The MCM data includes cellars where it is likely that property types have cellars but not in other cases. It does not include basement data. Normally, for pre-feasibility and outline appraisals only the already included cellar data will be used. However, if there is good reason to believe that properties have basements and those that have them can be easily identified, then basement threshold level could be used as the ground floor threshold level to calculate flood damage potential. Google Street View may be used to confirm existence of basements in some cases.

## OVERVIEW STUDIES

The data requirements for NRPs are as follows:

> Step One: The number of properties in each of NRP sub-sector or category

This means that the number of properties in each of the following NRP sub-sectors is required: retail, offices, warehouses, leisure, public buildings and industry; together with the number of playing fields, sports centres, marina, sports stadiums, car parks and substations. These are the NRP sub-sectors and categories for which discrete weighted mean depth/damage/duration data are provided. It will also be necessary to identify the number of non-specific, miscellaneous sub-sector 9 properties i.e. where property type is unknown without further research and/or ground-truthing. The NRP sector weighted mean depth/damage/duration data are to be used in the case of miscellaneous; 'unknown' sub-sector 9 properties.

It should be noted that a very low-resolution study may just employ the total number of NRPs and the NRP weighted sector mean flood damage data. However, this is much cruder than using the sub-sector and category weighted means indicated above.

Step Two: The ground floor space and threshold level for each NRP

All depth/damage/duration data for NRPs is in £m$^2$ therefore the area of the ground floor space of each NRP also needs to be entered into the property-by-property database. There are now a variety of sources of information by which property floorspace (meaning the ground floor area of the building or buildings excluding grounds and car parks) may be identified. Use the National Receptor Database (NRD) to determine each property's footprint (DQS 1). If unavailable, the following sources of information may be used depending on the resources available:

- Determine area by field measurement (DQS 1) or;
- Use GIS tools to measure the area from OS Mastermap/AddressBase or equivalent (DQS 1) or;
- For specific or unconventional properties use www.royalmail.com to determine property post code, then use https://www.tax.service.gov.uk/business-rates-find/search to determine current valuation which gives the rateable valuation for the property concerned and total ground area (DQS 1). If the specific rateable value data is not available on the VOA website then a good approximation (DQS2) is available by Country and region in the *NDR Business Floorspace Tables, 2023* at: https://www.gov.uk/government/statistics/non-domestic-rating-stock-of-properties-including-business-floorspace-2023) (values also provided in Table 5.4) or;
- Use the indicative floor sizes provided in Table 5.2 within the 'Tables & Figures' for Chapter 5 on MCM-Online (DQS 3).

Step Three: The current standard of flood protection provided for the benefit area

Step Four: The Weighted Annual Average Damages (WAAD)

The WAAD (See Chapter 4, Section 4.9.1) are then taken from the table below for each NRP sub-sector or category (or in the case of miscellaneous, 'unknown' sub-sector 9 properties - the weighted NRP sector mean) and multiplied by the appropriate ground floor area. The shading in the table represents the different subsector/category levels.

***Table 5.3: Weighted annual average damage by standard of protection (2026/27 values)***

| Standard Of Protection | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MCM Code** | **Sector Type** | **None** | **5** | **10** | **25** | **50** | **100** | **200** |
| 2 | Retail | 100.61 | 49.72 | 36.24 | 18.63 | 8.31 | 2.08 | 1.03 |
| 3 | Offices | 98.54 | 45.33 | 34.19 | 17.10 | 7.52 | 1.89 | 0.94 |
| 4 | Warehouses | 113.00 | 59.58 | 43.12 | 21.86 | 9.90 | 2.47 | 1.24 |
| 5 | Leisure and sport | NOT APPLICABLE - CONSTITUENT CATEGORIES TOO DIVERSE | | | | | | |
| 51 | Leisure | 228.04 | 78.51 | 62.50 | 28.38 | 12.17 | 3.04 | 1.52 |
| 52 | Sport | NOT APPLICABLE - CONSTITUENT CATEGORIES TOO DIVERSE | | | | | | |
| 521 | Playing Field | 4.25 | 1.70 | 1.36 | 0.65 | 0.28 | 0.07 | 0.04 |
| 523 | Sports Centre | 52.45 | 22.70 | 17.37 | 8.45 | 3.69 | 0.93 | 0.46 |
| 526 | Marina | 18.97 | 8.69 | 6.37 | 3.24 | 1.42 | 0.35 | 0.18 |
| 525 | Sports Stadium | 13.29 | 6.48 | 4.77 | 2.43 | 1.08 | 0.27 | 0.13 |
| 6 | Public Buildings | 60.76 | 27.49 | 20.73 | 10.27 | 4.53 | 1.13 | 0.56 |
| 8 | Industry | 21.34 | 10.55 | 7.68 | 3.92 | 1.75 | 0.44 | 0.22 |
| 9 | Miscellaneous | NOT APPLICABLE - CONSTITUENT CATEGORIES TOO DIVERSE | | | | | | |
| 910 | Car park | 6.55 | 2.92 | 2.17 | 1.10 | 0.47 | 0.12 | 0.06 |
| 960 | SubStation | 317.16 | 192.39 | 137.67 | 75.27 | 34.05 | 8.51 | 4.26 |
| NRP sector average | | 104.89 | 54.88 | 40.21 | 21.23 | 9.65 | 2.53 | 1.27 |

## INITIAL AND FULL-SCALE STUDIES

Step One: List the NRPs in the benefit area

For Project Appraisal Reports (PARs) and more detailed Strategy Reports a stepwise approach to data assembly is suggested here. Note that a Data Quality Score (DQS) 1-4 should be allocated for the land use sub sector or category of each NRP, ground floor area, the depth/damage/duration data assigned to the sub sector or category, as well as for property threshold.

- Determine the number by sub-sector or category of NRPs in the benefit area primarily by using the NRD (data quality score 2) and further enhanced by other data sources such as OS Mastermap/AddressBase) (DQS 2), Google Street View (DQS2) and preferably a site survey (DQS 1) for selected properties (see section 5.10.6). Also identify any miscellaneous (sub-sector 9) 'unknown' properties (i.e. the function of which is not known);

- Selective field checks are always recommended to authenticate data quality.

Step Two: Determine each property's ground floor area and property threshold level

Determine ground floor area by using the NRD (DQS 1). If unavailable, use one of the following sources (each with differing DQS). Selection will depend upon available budget and timescale:

- Determine area by field measurement (DQS 1) or;
- Use GIS tools to measure the area from OS Mastermap/AddressBase or equivalent (DQS 1) or;
- For specific or unconventional properties use www.royalmail.com to determine property post code, then use https://www.tax.service.gov.uk/business-rates-find/search to determine current valuation which gives the rateable valuation for the property concerned and total ground area (DQS 1). If the specific rateable value data is not available on the VOA website then a good approximation (DQS2) is available by Country and region in the *NDR Business Floorspace Tables, 2023* at: https://www.gov.uk/government/statistics/non-domestic-rating-stock-of-properties-including-business-floorspace-2023) (values also provided in Table 5.4) or;
- Use the indicative floor sizes provided on MCM-Online (DQS 3);
- Determine property ground floor threshold level through the use of a site survey. In some cases it may also be possible to do this using a tool such as Google Street View.

Step Three: Linking NRD (MCM) codes to the MCM data

- Link the NRD (MCM) codes to the weighted sub-sector or category means on MCM-Online. For some categories (most notably sport (52) and miscellaneous (9)) it will be necessary to use the corresponding 3-digit NRP category code instead. Use the NRP sector weighted mean data for any miscellaneous sub-sector 9 'unknown' properties.

Step Four: Allocate depth/damage/duration data

- Within Chapter 5 of the MCM-Online, the preferred depth/damage/duration data for each NRP (MCM) code with appropriate data quality are available;
- Basement data misuse can inappropriately bolster estimates of damage potential and the present value of damage (PVd). The MCM-Online therefore does not provide data for properties with basements. However, data are provided for selected properties which are likely to include a cellar, such as a public house or restaurant. Here we assume that a cellar is a room below ground with no functional use and limited storage. For functional basements that fill completely once ground floor threshold levels have been exceeded by flooding, it is likely that all contents and equipment would be written-off or would need cleaning and repairing, and that refurbishment and redecorating would be necessary. It is therefore recommended that damage data are not assigned to basements unless field-based land use checks clearly confirm that basements are present. We recommend in such cases that the basement threshold level is used as the property threshold level in calculating damage potential;

- The *Additional Data* for Chapter 5 section of the MCM-Online provides further depth/damage/duration data for low and high susceptibilities and flood warnings where the data takes into account the potential percentage reductions in damage to moveable equipment and stock only - see MCM, Chapter 5 (Penning-Rowsell et al., 2013). These should be employed wherever there is a functioning formal flood warning system in place which affords a minimum of 4 hours flood warning lead-time to NRPs in the benefit area. The additional data section also provides salt and wave damage date. Where NRPs are likely to be subjected to wave impacts (seafront properties, for example) the wave data should be used, which also accounts for saltwater inundation. If the property is likely to be protected from the force of waves but still inundated by seawater, the 'salt data' should be used.

Step Five: Undertake present value of damages calculation

- Use proprietary software to calculate estimated property present value of damages (PVd).

Step Six: Apply evidence-based damage-reduction factors to Annual Average Damages for frequently flooded properties.

- Under the new guidance on *frequently flooded properties and write-off* (Environmental Agency, 2026b), Annual Average Damages for frequently property damages should be reduced by damage-reduction factors. Rationale, approach and damages limiting tables are available at: Methods for calculating economic benefits - GOV.UK

Step Seven: Filtering

- Rank each property in the benefit area by its PVd or capped value (see Chapter 3). Check the data quality of at least the top 10 contributing NRPs as these from experience contribute a significant proportion of Total PVd representing the potential for significant uncertainty.
- Work to reduce the number of sub-sector 9 'unknowns' by undertaking further Google Street View and/or field checking. A large number of these 'unknowns' can lead to significant inaccuracies (i.e. under or overestimates) in damage estimation.
- If after the filtering process and improvement of data quality any NRP contributes more than 10% of PVd or capped PVd then a site survey should be undertaken to confirm these damages.

## SITE SURVEYS

The variety of NRPs is considerable, and average/standard depth/damage data given may be considered inappropriate for one of the following reasons:

1. A property may contribute more than 10% of the PVd; and/or;

2. A property may be so unusual or unique that it warrants the replacement of mean standard damage data by damage data that would be considered to be more reliable.

In such cases a site survey of the property is probably required depending upon the type or scale of appraisal (a standard NRP site survey proforma may be downloaded from the *Additional Resources* section of Chapter 5 on MCM-Online). However, site surveys are time-consuming and require the willing cooperation of the company concerned which might itself take time to acquire. This means that site surveys, where required, are usually reserved for the largest NRPs with high flood frequencies and therefore potentially average annual damage.

For a site survey, the following is a guide as to whom to approach within the business organisation to help complete the site survey questionnaire:

- Small firms - the owner;
- Medium size firms - the plant or company manager;
- Large complex firms - the Managing Director or Financial Director, senior accountant, insurance claims Officer, estates manager or emergency planning officer.

A simplified approach will focus on the following questions making sure that damage or cost estimates exclude VAT:

1. What is the cost of re-build (I.e. the building structure and fabric)?
   Note that this is for the footprint of the building(s) and not the Footprint of the property.
2. What is the value of services installed?
3. What is the value of moveable equipment?
4. What is the value of fixtures and fittings including static machinery and equipment?
5. What is the value of stock, raw materials and work-in-progress?
6. Are losses of trade to overseas competitors likely to be significant (see below)? If so, what are they likely to be?
7. What are the likely costs of clean up after the flood?

Realistic rounded estimates of damage and loss potential are required (e.g. to the nearest £1,000 for smaller firms, or the nearest £10,000 for larger organisations), where indicative values of equipment (moveable and static) and stock etc. may run into £millions.

The values for each damage component are converted to values per square metre of the buildings in question and can these be entered into a spreadsheet (provided in the *Additional Resources* section for Chapter 5 on MCM-Online) for the nearest MCM code of the property in question to obtain correct susceptibility levels. The susceptibility to damage for each component is assumed unchanged from the previous research and depth/damage/duration data are automatically generated based on the revised component values derived from the site survey. In short, valuation of component damages is revised with respect to a specific property and applied to existing susceptibility curves.

## INDIRECT FLOOD LOSSES

Obtaining accurate data on indirect flood losses is difficult. Users must decide whether or not to include an estimate of indirect losses. Indirect losses are of two kinds:

- Losses of business to overseas competitors, and;
- The additional costs of seeking to respond to the threat of disruption or to disruption itself which fall upon firms when flooded.

The first of these losses is unusual and is limited to highly specialised companies which are unable to transfer their productive activities to a branch site in this country, and which therefore lose to

overseas competitors. The second type of loss is likely to be incurred by most NRPs which are flooded. They exclude post-flood clean-up costs but include the cost of additional work and other costs associated with inevitable efforts to minimise or avoid disruption. These costs include costs of moving inventories, hiring vehicles and costs of overtime working. These costs also include the costs of moving operations to an alternative site or branch and may include additional transport costs.

Chapter 5, Section 5.7 of the MCM (Penning-Rowsell *et al*., 2013) provides a relatively crude method for estimating and including potential indirect costs where these are the additional costs associated with trying to minimise indirect losses. This is by calculating total indirect losses as an uplift factor of 3% of estimated total direct NRP losses at each return period included within the damage estimation process. This uplift factor of 3% remains as the best estimate of economic indirect flood losses to NRPs even though the uplift factor for financial indirect flood losses has now been revised significantly upwards as a result of new evidence (see Non-Residential Properties: Financial or Local Economic Benefits and Losses).

If an NRP is likely to contribute over 10% of the overall PVd, then it may well be worth seeking to ascertain indirect costs through asking the questions on disruption and indirect losses included in the site survey questionnaire which is recommended in this case. Also, if a business appears to be highly specialised and may not have competitors in this country, it may also be worth pursuing an estimate of indirect cost of flooding in the same way.

The site survey questionnaire can be found in the *Additional Resources* section for Chapter 5 on MCM-Online.

## ESTIMATING THE DAMAGE-REDUCING EFFECTS OF PROPERTY LEVEL RESILIENCE MEASURES

Currently there is significantly less use of property-level resilience (PLR) measures in the NRP sector than in the residential sector where much of the emphasis in national policy has focused (Haskoning UK Ltd, 2012; Merritt, 2012). PLR survey and installation is being increasingly professionalised to ensure effectiveness (May et al. 2015) and small and medium sized enterprises (SMEs) are now being targeted for PLR measures. However, in general, take-up is currently significantly lower than in the residential sector. In Britain, businesses are likely to use various generic coping strategies that support business continuity, rather than property-level protection measures against flooding. Confirming this, Ingirige and Wedawatta (2011) found that SMEs tend to mostly rely on general business continuity and/or risk management strategies, although the uptake of those strategies was also found to be minimal. Generally, the level of up-take was higher among the SMEs with previous flood-related hazard experience, and such businesses were more likely to implement PLR measures than the SMEs without such experience. Obtaining property insurance, having a business continuity plan, using a business data backup system, and obtaining business interruption insurance were the commonly implemented business continuity measures by SMEs (Wedawatta and Ingirige, 2012). Further confirmation of the current low uptake of PLR measures by businesses in Britain, as well as in other parts of Europe is provided by Parker *et al*. (2012).

In the NRP sector, PLR are only likely to be relevant for small and some medium sized business properties (i.e. generally those of SMEs). Larger business premises are likely to be more complex, possibly with a number of buildings, and generally other approaches rather than PLR will be more relevant here.

An assessment of flood damage potential may or may not therefore warrant inclusion of the damage-reducing effects of property-level resilience measures: it depends on the purpose of the assessment,

the user's objectives in undertaking the assessment and the size of business premises. If the decision is made to assess and include the estimated impact of these measures, then they are to be entered into any working spreadsheet as deductions of damage potential once damage potential has been estimated using one of the procedures above.

Where it is known that if PLR measures have been installed, their potential impact should be reflected in damage calculations otherwise damage potential will be over-estimated. However, if the number of NRPs protected in this way is small (say 5% of properties or less) it may well not be worth taking account of the impact of these measures in an appraisal. If the objective is to assess the potential for installing PLR measures then a with-and-without appraisal needs to be undertaken, and the method below will only provide a very crude estimation of damage-savings which will need to be taken further. Identifying those properties which have already installed PLR measures can be difficult and time-consuming if there is no adequate record already in existence. A field survey designed to identify these properties will be necessary and to identify resilience measures in particular, contact may well need to be made with property occupants. These measures are most likely to be found in the 1:75-year flood extent envelope where the 100-year flood is no deeper than 1 metre.

## RESISTANCE MEASURES

If flood resistance measures are identified as installed in NRPs or are being considered, then the damage-reducing effects of these measures may be estimated. A **first method** by which an estimation may be achieved is by raising the ground floor threshold level assigned to the properties in question by 0.6 metres within the land use/property database constructed for the appraisal. The 0.6 metres above property threshold level is considered by May and Chatterton (2012) to be the maximum level at which resistance measures can work effectively. This is, however, likely to lead to some overestimation of damage reduction because other factors such as the effectiveness of resistance measures needs to be taken into account.

A **second method** is to use formulae 5.1 and 5.2 below, although this method also has limitations. When using these formulae locally derived and appropriate parameter values should be used. Only where these do not exist should the default values below (which approximate average values for the nation) be used.

Surveys of the performance of predominantly residential PLR measures in four locations following the 2012 floods revealed that where PLR measures were deployed and actually required, these measures have helped to reduce the impact of flooding in 84% of properties (although performance varied considerably between locations) (May *et al*., 2014). There was also evidence that water will still seep into properties through brickwork generating flooding of up to one inch. For this reason, the damage-reducing effects of resistance measures must be factored by 0.84 if a more appropriate locally relevant value is unavailable. This only applies to properties which have a ground floor size of 320m$^2$ or less. NRPs of more than 320m$^2$ are much less likely to be protected by PLR measures because of the complexity and cost. Instead, they may be protected by demountable defences close to properties or more remotely from them. The damage-reducing effects of demountable – if there are firm plans to deploy them – should also be taken into account by raising the ground floor property threshold of the protected property (as in the first method explained above). However, for PLR measures, damage savings at each return period should be factored by 0.84 to take account of reliability issues.

Uptake values (UP) are the proportion of NRPs within the 1:75-year flood envelope which are expected to have PLR measures installed (e.g. 10% = 0.1). Because take-up of PLR is currently

significantly less for NRPs than for residential properties, the national uptake factors are reduced here to 0.016 for warning-dependent resistance measures (WDRM) and 0.024 for warning-independent resistance measures (WIRM) (i.e. the values given in Penning-Rowsell *et al*. (2013) have been adjusted downwards to reflect lower take-up in the NRP sector). Damage reduction (DR) values are derived using economic costing rather than financial costing principles and are intended for use as broad average values. Not all property owners can be expected to operate their warning dependent measures and so an OP variable is included in Equation 5.2 to reflect this.

Step One: Calculate the number and then the total ground floor size ($m^2$) of NRPs at risk at each return period in the benefit area up to the 1 in 75-year flood probability threshold where flooding is not expected to be greater than 1m. Include only those NRPs with a ground floor size of 320$m^2$ or less.

Step Two: The following formulae may then be used to estimate the total £ damage reduction owing to NRP warning-independent measures (WIR):

**Equation 5.1**

WIRB (£) = TGA * DR * UP * EF

where:
**WIRB** (£) is Estimated damage reduction (i.e. Benefit) by employing WIR measures;
**TGA** is Total ground floor area of NRPs located in benefit area within 1:75 flood risk area and where flooding is not likely to be greater than 1m (for each return period in the appraisal);
**DR** is Damage reduction: (national default value = £97.55 per $m^2$ at 2026/27 values);
**UP** is Uptake of WIR measures factor: (national default value = 0.016);
**EF** is Effectiveness factor: (national default value = 0.84).

The resultant £ value result must then be converted to annual average damages saved.

Step Three: For NRP warning-dependent resistance measures (WDR) the equivalent formula is:

**Equation 5.2**

WDRB (£) = TGA * RA * DR * UP * OP * EF

where:
**WDRB** (£) is Estimated damage reduction (i.e. Benefit) by employing WDR measures
**TGA** is Total ground floor area of NRPs located in benefit area within 1:75 flood risk area and where flooding is not likely to be greater than 1m (for each return period in the appraisal.) Include only those NRPs with a ground floor size of 320$m^2$ or less;
**RA** is Reliability and Availability: (national default value = 0.30);
**DR** is Damage reduction: (national default value = £97.55 per $m^2$ at 2026/27 values);
**UP** is Uptake of WDR measures factor: (national default value = 0.024);
**OP** is Operated: (national default value = 0.63);
**EF** is Effectiveness factor: (national default value = 0.84).

The resultant £ value result must then be converted to annual average damages saved.

To summarise, the above formulae are only a rough guide to the value of NRP damage reduction through use of resistance measures for the following principal reasons:

- The uptake factor (UP) applies to the number of properties although here we apply it to TGA which is a surrogate measure for property numbers;
- The effectiveness of PLR measures varies between locations;
- DR in £m$^2$ is derived from research into detached houses; and
- Only reduction in direct damage is included whereas in practice reduction of stress and anxiety may also be relevant.

A **third method** may only be relevant where local data on the existence of PLR measures are unavailable or the scale and objective of the appraisal does not warrant a more penetrating appraisal, but where the effect of these measures is still considered to be important to include. Here, the average annual damage potential can be factored in some suitable way to take account of the damage-reducing effect of these measures - see Chapter 5 of the MCM (Penning-Rowsell *et al*., 2013) for further guidance.

## RECOVERABILITY MEASURES

For England and Wales, the estimated uptake (UP) of recoverability measures for properties in benefit areas up to the 1:75 flood probability England and Wales is 2% (Clarke *et al*., 2015) although this value applies more to residential than to NRP properties. For this reason, this value has now been adjusted downwards below to reflect significantly lower uptake (0.01). The effectiveness (EF) of these measures is known to be lower than for resistance measures and this is reflected in a value of 0.50 for EF. Again, damage reduction (DR) values are derived using economic costing rather than financial costing principles and are intended for use as broad average values.

Step One: A rough estimate of the value of the damage reducing effects of recoverability measures on NRPs may be made by applying the following formula and deducting the resultant £ average annual damage value from the potential average annual damage value at each return period used in the appraisal:

**Equation 5.3**

RISDR (£) = TGA * DR * UP * EF

where:
**RISDR** (£) is Estimated damage reduction by employing recoverability measures;
**TGA** is Total ground floor area of NRPs located in benefit area within 1:75 flood risk area and where flooding is not likely to be greater than 1m (at each return period);
**DR** is Damage reduction: (national default value = £79.43 per m$^2$ at 2026/27 values);
**UP** is Uptake factor: (national default value = 0.01);
**EF** is Effectiveness factor: (national default value = 0.50).

The resultant £ value result must then be converted to annual average damages saved.

Very similar simplifying assumptions to those applicable to the procedure for estimating the damage reducing effects of resistance measures are also applicable to recoverability measures. A further simplifying assumption which can affect the reliability of these estimates is that in some cases resistance and recoverability measures may be used in combination. The uptake factor may improve in the future and/or local evidence of uptake of resistance and recoverability measures in which case the uptake value can be altered to more closely match with evidence.

## SUBSTITUTING LOCAL VALUES INTO EQUATIONS

The national default values which appear in the above formulae (i.e. for calculating WIRB and WDRB) are derived from the best available data within England and Wales and represent mean national level values. Each value should be substituted by local values where there is evidence to support a more customised local appraisal. For example, if it is known that in a particular benefit area that, say 10% of properties have WIR measures, then the UP parameter value may be altered from 0.032 to 0.10 and so on with other parameter values.

## REFERENCES

Clarke, J., McConkey, A., Samuel, C., Wicks, J. (2015) Quantifying the benefits of flood risk management actions and advice: flood incident management and property level responses. Report SC0900039/R stage 3, Environment Agency, Bristol, ISBN: 978-1-84911-360-1, accessible from https://assets.publishing.service.gov.uk/media/603545b7e90e0740b33891bd/The_benefits_of_flood_risk_management_actions_and_advice_report.pdf. , accessed 07 May 2026.

Environmental Agency (2026a) Methods for calculating economic benefits, (published 3 March 2026), Methods for calculating economic benefits - GOV.UK, accessed 07 May 2026.

Haskoning UK Ltd (2012) Assessing the Economic Case for Property Level Measures in England Draft Final Report, Project Economics of flood risk adaptation measures, No. 9X1055 Committee on Climate Change, Haskoning, Peterborough.

Ingirige, B and Wedawatta, G. (2011), in J Lamond, C Booth, F Hammond & D Proverbs (eds), Flood hazards: impacts and responses for the built environment. CRC press, Boca Raton, FL, 269-280.

May, P.G, and Chatterton, J.B. (2012) Report title: Establishing the Cost effectiveness of Property Flood Protection: FD2657, JBA Consulting. Defra, London.

May, P., Emonson, P., Jones, B. and Davies. A. (2014) Post-Installation Effectiveness of Property Level Flood Protection, Final report FD2668, report to Defra, JBA Consulting, Defra, London.

May, P., Emonson, P., O'Hare, P., Cobbing, P., Connelly, A., Lawson, N. and Burchard, H. (2015) Surveying for Flood Resilience in Individual Properties – FD268, report to Defra, JBA Consulting, Defra, London.

Merrett, S. (2012) Evaluation of the Defra Property-level Flood Protection Scheme: 25918, Environment Agency, JBA Newport.

Parker, D. J., Penning-Rowsell, E. C. and McFadden, L (2012) Business Disruption and Recovery Planning in relation to Flood and Coastal Erosion Risks: Theoretical Dimensions and Field Survey Evidence, Research Report IDWT4.3, THESEUS Research Project.

Penning-Rowsell, E.C, Priest, S., Parker, D., Morris, J., Tunstall, S., Viavattene, C., Chatterton, J., Owen, D. (2013) Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, London and New York, Routledge.

Wedawatta, G. and Ingirige, B. (2012), "Resilience and adaptation of small and medium-sized enterprises to flood risk", Disaster Prevention and Management, Vol. 21 No. 4, pp. 474-488. https://doi.org/10.1108/09653561211256170 accessed 7 May 2026.