REDUCING FLOOD RISK: WHICH HOMES ARE MOST SUITABLE FOR PFR?

Phase 1: National-Level Analysis

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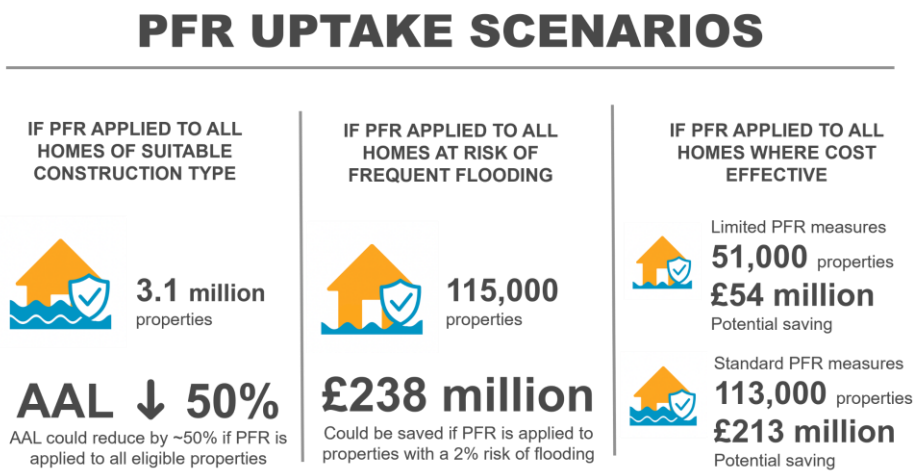
Executive Summary

Flood risk is high and widespread in the UK and is expected to increase with climate change with between **6.3 and 11 million properties** at risk to flood. Formal flood defences currently offer protection to over 4 million properties, however residual risk remains especially for properties exposed to surface water flooding where **83% of properties** remain at risk. This Phase 1 report aims to understand which home types are most suitable **for Property-level Flood Resilience (PFR)** measures and the likely cost of PFR implementation. It also explores a range of potential uptake scenarios designed to identify the potential benefit from PFR at a national scale. Finally, the report considers the influence of insurance companies and lenders in PFR uptake. For the purposes of this report, data reported considers Great Britain, England, Wales and Scotland.

Key Findings:

- Around **21.8 million homes (72%)** are suitable for PFR based on construction type and floor level.
- Of these, **3.1 million properties** are exposed to flood depths where PFR is most effective (up to 0.6 m) and could realistically benefit from PFR interventions.
- **PFR installation costs** range from:
  - £1,500–£3,000 for limited measures
  - £7,000–£15,000 for standard resistance
  - £10,000–£30,000+ for full retrofits
- Potential impact on flood losses:
  - **~50% annual loss** reduction under full national uptake
  - **£238 million/year** saving if adopted by homes at risk to frequent flooding
- For **over 50,000 homes**, the cost of PFR is lower than the expected annual cost of flooding.
- Over 30,000 PFR eligible properties have a 5% chance in any given year of flooding costing more than PFR installation.

PFR is not a substitute for large-scale flood defences, but it provides a critical layer of protection for millions of homes likely to remain unprotected by those schemes. Phase 2 will explore how these findings can be applied at a local level to maximise impact.



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1. State of flood risk in the UK

Flood risk is high and widespread in the UK and is expected to increase with climate change. In the UK, estimates of properties at risk range from **6.3 million properties (NafRA, EA, 2025) to 11 million properties, approximately one in four** (JBA, 2022a). In recent years 2013-14, 2015-16 and in 2019 there have been clusters of storm events causing significant damage, and notably, many properties to be flooded multiple times. Impacts from these events however are yet to eclipse the Summer 2007 events which caused £4.8bn in damages and affected 48,000 residential homes and 7,000 businesses nationally.

Formal flood defences offer protection to over 4 million properties. Without those formal flood defences estimated annual average losses would rise significantly. For river, surface water and coastal flooding, losses could be 360% higher without defences, for coastal alone, losses could by 1300% higher. Despite the protection offered by formal flood defences, **over 7 million homes remain unprotected.** The EA has a pipeline of over **1,500 planned flood management schemes up to 2033 expected to protect a further 215,000 residential properties** yet funding for those schemes is yet to be found.

Recent significant surface water events such as the July 2021 London event bring over 2,000 claims and estimate £100m in damages (JBA, 2021) highlight that many properties not at risk to river flooding and not formally protected by flood defence may still be at risk. Analysis indicates that **83% of homes at risk to surface water flooding remain unprotected**. Under a 1°C global warming scenario, daily rainfall rates are expected to increase by 6-7%, with sub daily rainfall rates – those causing these short sharp severe downpours as experienced during the July events – likely to increase by 12-14% increasing the probability of those properties at risk to surface water flooding being impacted.

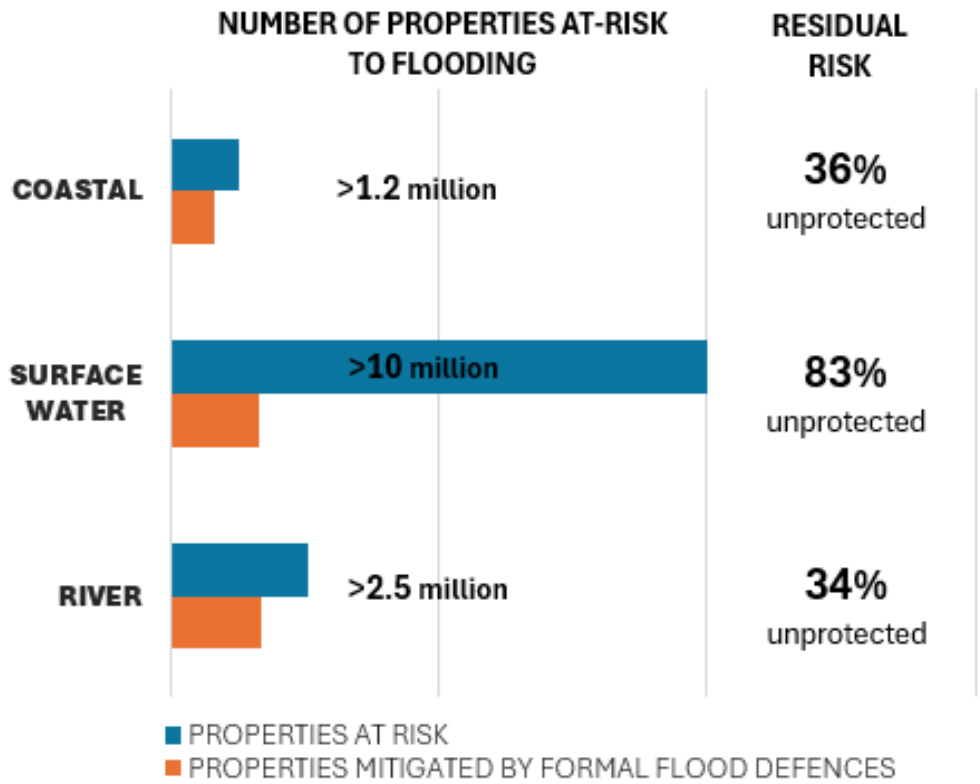


Figure 1: Residual flood risk in the UK, source JBA flood hazard data. Many properties are at risk to multiple sources of flooding.

In this context, the need for a complementary approach to flood defence becomes clear. While large-scale infrastructure will remain critical, national flood resilience will also depend on

measures taken at the property level, particularly for those millions of homes and businesses unlikely to benefit from formal flood schemes in the near term.

Property Flood Resilience (PFR) refers to a range of measures designed to reduce the damage that flooding can cause to individual buildings, such as homes or businesses. Unlike traditional flood defences that aim to prevent water from entering an area entirely, PFR accepts that some water may enter a property and focuses instead on limiting the impact and enabling faster recovery.

Resistance: Measures aiming to reduce flood damage by limiting the amount of water entering a property, including door barriers, flood doors, automatic airbricks, non-return valves and pumps.

Resilient adaption or recoverability: Measures that adapt and modify the internal fabric of a property to reduce damage if water does enter to enable quicker recovery following a flood event. Adaption measures include tiled floors, waterproof wall coverings and raised electrics, to name just a few.

Encouraging the wider use of PFR, allied to effective flood warning and raising awareness, helps inform and empower communities to take effective action themselves. With effective resistance measures, the approach aims to help build improved flood resilience, reducing damage and financial loss but also, importantly, providing welcome “peace of mind” for those at flood risk.

2. Property Flood Resilience

With millions of UK properties expected to remain outside the reach of formal flood defences for the foreseeable future, PFR offers a vital opportunity to improve national resilience to flooding from the ground up. PFR refers to measures installed at the individual property level to reduce the risk of flood damage and enable faster recovery when flooding does occur. These include both resistance measures (e.g. flood doors, automatic airbricks, non-return valves, pumps) designed to keep water out, and resilience measures (e.g. raised electrical sockets and waterproof finishes) which help limit damage when water does enter.

National flood management policy has increasingly acknowledged the importance of PFR, especially in the context of surface water flooding and repeat flood events, where conventional infrastructure often falls short. In its FCERM Strategy (2020), the Environment Agency explicitly recognised the role of property-level interventions, and Defra's PFR Pathfinder programme (2019–2021) has demonstrated PFR's value in real-world community settings.

Despite these efforts, uptake of PFR remains low, with many barriers slowing progress. Surveys and engagement with insurers suggest that PFR is considered in only a minority of flood risk assessments, often due to gaps in data, limited customer awareness, and uncertainty about performance and cost-effectiveness. Yet where PFR has been properly installed and maintained, it has been shown to significantly reduce damage and recovery costs, improve mental wellbeing post-flooding, and allow residents to return home more quickly.

Crucially, PFR also represents a more flexible and cost beneficial approach to flood protection. It offers households (including those in low-income, high-risk, or frequently overlooked areas) the means to protect themselves, even when they are not covered by strategic investment in defences. As climate change increases the frequency of short, intense rainfall events and overwhelms existing infrastructure, PFR will be a necessary component of a holistic national strategy that blends structural investment with community-level adaptation.

To unlock the full potential of PFR at scale, system-wide changes are required: better access to trusted information, incentives for installation, stronger regulatory support, and integration into insurance pricing and risk modelling. The following sections explore these opportunities in more detail, starting with the current level of PFR implementation across the UK.

Current Use and Uptake of PFR in the UK

Despite increasing recognition of its potential benefits, the use and uptake of PFR in the UK remains limited and uneven. While national policy frameworks support the integration of PFR into flood management strategies, its practical implementation across residential and commercial properties has not yet reached the scale needed to significantly reduce national flood risk.

While some flood-prone communities have benefited from PFR through government-funded recovery schemes, local council initiatives, or pilot projects, widespread and consistent deployment is rare. Research by JBA (2022b) suggests that only a small fraction of properties at risk have implemented meaningful PFR measures, and many of those at risk remain unaware of the options available. Even in areas with a history of repeat flooding, uptake is often limited to those directly supported by grants or outreach efforts.

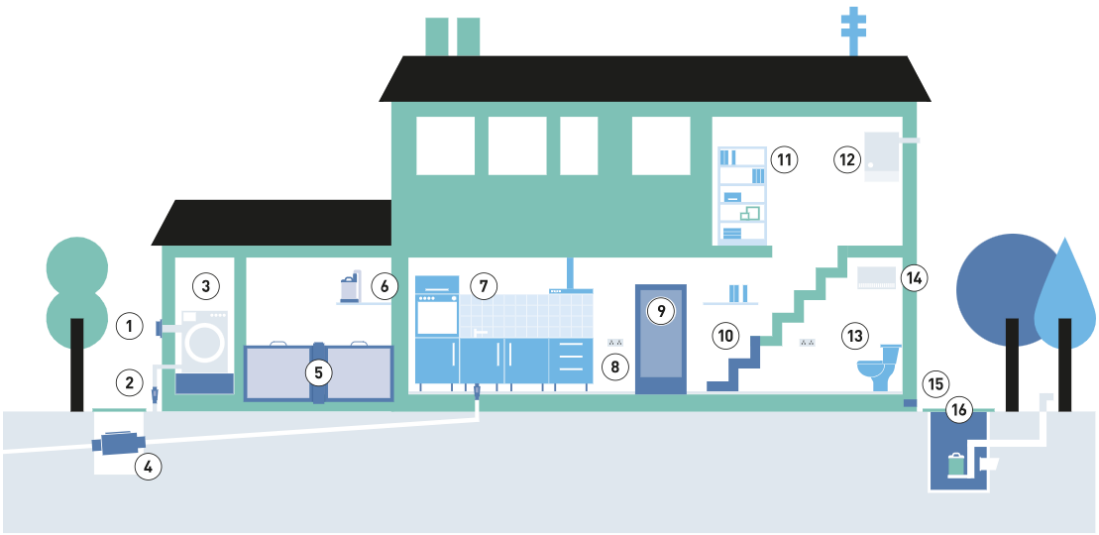
The number of properties currently benefitting from PFR is difficult to determine. However, Flood Re's 2023 'Property Flood Resilience Market Study' reported that **over 20,000 properties have received PFR measures through Defra funded schemes since their inception following the 2014/2015 flood events.** Funded schemes, predominantly led by local authorities have also seen an increase from approximately 780 properties protected via PFR schemes between 2011/2015, to 2,044 protected between October 2018 and February 2023 via 109 schemes. This shows a clear shift towards the use of PFR and the Environment Agency's National FCERM Strategy and vision for Risk Management Authorities to mainstream PFR.

The benefits of PFR include reduced repair costs, quicker recovery times, and greater peace of mind for occupants. However, there are important limitations. PFR does not prevent flooding entirely; even the best resistance measures can be overwhelmed during severe events. It is not a substitute for larger-scale flood defences or strategic planning, and while it reduces the consequences of flooding, it does not lower the likelihood of a flood occurring. In areas prone to deep or frequent flooding, PFR may not be the most cost-effective solution, and alternatives such as relocation or major infrastructure projects may be more appropriate. Ultimately, PFR works best as part of a broader, layered approach to flood risk management.

3. Which types of homes are best suited to PFR?

Homes that can best benefit from PFR are typically those located in areas prone to frequent or shallow flooding. Protection by other means, such as a capital flood defence scheme is either not practical or cost-effective, but where damage can be significantly reduced through targeted measures. This includes properties situated in areas vulnerable to surface water flooding, where rainwater tends to flow after heavy storms, but flooding is not typically deep. Similarly, properties located within areas prone to fluvial flooding which is short duration and lower depth could benefit. In such cases, PFR measures can either prevent water ingress or limit the damage when water does enter.

Homes that are constructed from a standard construction method, such as solid brick, or a double skin of brick and block are generally well suited to the application of PFR measures. Those that have been previously flooded but remain structurally sound and habitable are also strong candidates for PFR, especially if they have experienced repeated, low-to-moderate level flooding. Older or traditionally built homes, particularly those with solid brick construction, are generally easier to retrofit with flood-resilient materials such as waterproof membranes, lime-based plasters, or removable fixtures. Properties with solid ground floors, like concrete slabs, are also well-suited because they are more water-resistant and easier to clean and dry compared to suspended timber floors. However, concrete floors have been known to rupture as a direct result of increased pressure as groundwater rises up through the floor during a flood event. Concrete floors can hold moisture following a flood, which can extend the drying out period, as opposed to suspended timber floors which can often dry out quickly. Figure 2 demonstrates the range of PFR measures, both resistance and resilience, that could be applied to a property to improve resilience to flooding.



1	Anti-Flood Vent Cover	9	Flood Doors
2	Backwater Valve	10	Water Resistant Stairs
3	Raised Appliances	11	Relocating Valuables
4	Non-return Valves	12	Raised Gas Boiler
5	Flood Barriers	13	Toilet Bung
6	Puddle Pump	14	Waterproofing Walls
7	Water Resistant Kitchens	15	Anti Flood Airbricks
8	Raised Electrics	16	Sump & Pumps

Figure 2: Potential Property Flood Resilience measures for residential properties (Image supplied by M3 Flood Tech).

However, some properties are less suited for PFR. These include homes in areas prone to deep, fast-flowing, or frequent flooding, where the severity of water ingress makes resilience measures less effective or economically viable. Properties with basements that flood regularly can also be problematic, as basements are inherently difficult to make flood resilient. Likewise, homes with highly insulated cavity walls may not be good candidates without extensive and costly adaptations, since water damage can be hidden and harder to address. Also, homes built from a non-standard construction, such as timber-framed structures, steel frames with some sort of cladding or prefabricated properties would not generally be considered watertight or structurally suitable for the application of PFR measures.

The full height of the British Standards Institution (BSI) Kitemark for PFR measures is 900mm above Floor Level. However, research carried out for the Department for Communities and Local Government (DCLG) and Natural Resources Wales recommends that the use of protection measures should generally be limited to a nominal protection height of 600mm above Floor Level for properties with solid floors and 600mm above ground level for those with suspended floors. This is because the structural integrity of the property may be compromised above this level, which also increases the risk of cracks and leaks.

How many homes are suitable for PFR?

To determine the number of properties potentially suitable for PFR across the UK, the residential dataset was interrogated to identify properties with a suitable construction type, primarily those of cavity wall construction and solid masonry.

Finally, the residential property dataset used for this analysis includes houses of all types (detached, semi-detached, terraced and other), as well as flats and basements. Flats located on the ground floor were identified as suitable for PFR, while those above ground were classified as Not Suitable. 9% of properties with otherwise suitable construction types (~3 million cavity wall and solid masonry properties) are not considered suitable for PFR due to being located above ground floor level. Table 1 summarises the number of residential properties suitable for PFR given their construction type and floor level. **21.8 million or 72% of homes are suitable for PFR based on these characteristics.**

Table 1: Number of residential properties suitable for PFR based on construction type and floor level

Construction Type	Suitable for PFR?	Properties Suitable for PFR	%	Properties Not Suitable for PFR	%	Total Number of Properties	Total %
Concrete Frame	No			124,303	<1%	124,303	<1%
Cavity Wall	Yes	15,534,673	51%	*1,917,288	6%	17,451,961	58%
Pre-Fabricated	No			870,165	3%	870,165	3%
Steel Frame	No			35,643	<1%	35,643	<1%
Solid Masonry	Yes	6,302,783	21%	*1,027,853	3%	7,330,636	24%
Timber Frame	No			739,286	2%	739,286	2%
Unknown type	No			3,728,344	12%	3,728,344	12%
TOTAL		**21,837,456**	**72%**	**8,442,882**	**28%**	**30,280,338**	**100%**

**Properties of suitable construction type but above ground floor and do not require PFR.*

The figures in Table 1 include Listed buildings which represent 1.89% of the total residential building stock in the UK. Whilst many Listed buildings are of suitable construction type for PFR, further heritage and conservation restrictions may limit or prohibit PFR measures being fitted.

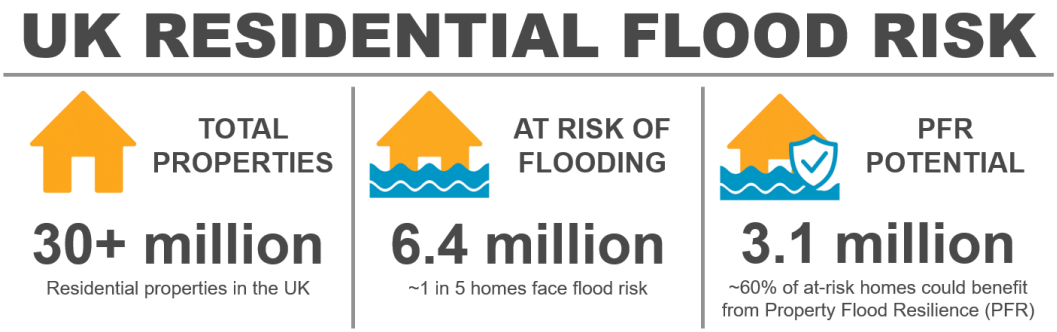


Figure 3: UK residential properties at risk to 1-in-1000-year return period and suitable for PFR.

Of those buildings of suitable construction type for PFR, nearly 3.4 million (11%) are at risk of flooding. Practically however, the protection offered by PFR is limited to flood water depths up to 0.6m. Cross referencing those at-risk properties with JBA's 1 in 1000-year design return period flood maps indicates that **14% of PFR potential houses** are affected by depths up to 0.6m at this return period. **3.1 million properties therefore could theoretically benefit from PFR**. This total includes approximately 2.67 million at risk from surface water flooding only, 216,000 from river flooding only, 57,700 from coastal flooding only, and 170,000 exposed to more than one flood peril.

Table 2: Number of residential properties suitable for PFR considering flood depths at the 1 in 1000-year design return period for all flood types with no mitigating defences.

Flood depth	Properties suitable for PFR		Properties not suitable for PFR		Properties in a defended area or not requiring PFR		Total properties at flood risk	
	No. of properties	%	No. of properties	%	No. of properties	%	No. of properties	%
0.01-0.15m	1,267,628	4.2%	516,241	1.7%	163,193	0.5%	1,947,062	6.4%
0.15-0.3m	1,391,353	4.6%	662,606	2.2%	405,735	1.3%	2,459,694	8.1%
0.3-0.6m	454,867	1.5%	315,248	1.0%	299,780	1.0%	1,069,895	3.5%
0.6-1.0m	153,296	0.5%	133,563	0.4%	193,771	0.6%	480,630	1.6%
> 1m	87,519	0.3%	79,511	0.3%	244,785	0.8%	411,815	1.4%
TOTAL	**3,354,663**	**11.1%**	**1,707,169**	**5.6%**	**1,307,264**	**4.3%**	**6,369,096**	**21.0%**

What are the costs of PFR implementation?

The cost of implementing PFR measures varies depending on the type and scale of intervention required see Table 3. For many households, a standard resistance PFR package, typically ranging from £7,000 to £15,000, includes resistance-based measures such as flood doors, automatic airbrick replacements, non-return valves, and sump pumps, with individual components generally costing between £30 and £5,000, depending on their function and complexity.

However, where nuisance flooding, which is general shallow, lower impact flooding of up to 0.15m is the primary concern, the package of PFR resistance measures adopted might include measures limited to automatic airbrick replacements and a puddle pump. Typically, these measures might total approximately £1,500 to £3,000.

For properties at higher risk, or those less suitable to an effective resistance strategy, a full resilience retrofit may be more appropriate. These comprehensive adaptations can cost between £10,000 and £30,000 or more, combining both resistance and resilience measures. In addition to the basic elements, they may include raised electrical sockets, waterproof wall and floor finishes, tanking of internal surfaces, and design modifications that make the property quicker and easier to dry and repair following a flood.

Table 3: Cost of PFR implementation by category and measure.

PFR Category	PFR measure	Estimated Cost Range	Best Suited For
Limited Resistance PFR Package £1,500–£4,500	Property Survey	£500-£900	Homes at risk to flooding up to threshold height (0.15m)
	Air brick covers	£50-£90 each	
	Sump pumps	£1,000-£3,000	
	Sealants/coatings	£80-£120	
Standard Resistance PFR Package £7,000–£15,000	**All limited measures**	**£1,500-£4,500**	Homes at risk of shallow, occasional flooding
	Flood doors/barriers	£500-£4,000 each	
	Non-return valves	£70-£650	
Comprehensive Resilience Retrofit £10,000–£30,000+	**All limited & standard measures**	**£7,000-£15,000**	Properties with previous flooding or in medium-to-high risk zones
	Raised sockets	£500-£2,000	
	Waterproof wall treatments	£5,000-£10,000	
	Resilient flooring	£2,000-£6,000	
	Removable/raised kitchens	£3,000-£8,000	
	Flood-compatible insulation	£1,000-£3,000	

Further breakdowns by property type, floor construction, and required level of protection reveal significant variation in costs (Table 4). For example, protecting a detached property with a solid floor to a depth of 0.15 metres might cost around £1,560, whereas implementing comprehensive protection up to 0.6 metres in a semi-detached property with a suspended floor could exceed £11,600. Properties with suspended floors typically face higher implementation costs due to the added complexity of protecting underfloor voids. Similarly, costs tend to be higher for larger or detached properties, reflecting their greater surface area and complexity.

Table 4: Average cost of PFR implementation by Protection level (flood depth) and property type.

Protection level	PFR measure	Floor Type	Detached	Semi-detached	Terrace	Bungalow	Flat
Up to 0.15m	**Limited**	Solid	£1,560	£1,560	£1,490	£1,560	£1,490
		Suspended	£2,960	£2,330	£2,190	£2,960	£2,330
Up to 0.6m	**Standard**	Solid	£7,750	£6,000	£5,230	£7,500	£5,230
		Suspended	£11,150	£8,770	£7,930	£10,900	£8,070
	Comprehensive	Solid	£11,850	£8,850	£7,280	£11,950	£7,280
		Suspended	£15,250	£11,620	£9,980	£15,350	£10,120

These figures demonstrate that PFR is not a one-size-fits-all solution. Rather, it requires bespoke installation strategies tailored to individual property characteristics and flood risk exposure. Limited packages may be suitable for properties with occasional surface water flooding, while full retrofits are more appropriate for those in medium to high flood risk zones or with a history of flooding.

While the upfront investment in PFR can be substantial, with the average residential flood claim estimated at approximately £30,000, PFR can often pay for itself after a single event by reducing repair costs, limiting damage to key systems, shortening displacement periods, and enabling faster recovery. These cost savings also have wider societal value, supporting the resilience of communities and reducing the longer-term burden on insurers, emergency services, and local authorities.

4. Potential Uptake of Property Flood Resilience and impact on Flood Risk

PFR uptake scenarios

To better understand the potential benefits of PFR implementation, several national-scale uptake scenarios were modelled using property-level flood risk and loss data derived from JBA's UK Flood Loss Model. This model provides high-resolution estimates of Annual Average Loss (AAL) across different flood sources and property types, enabling robust scenario testing at national scale. The scenarios presented here estimate the potential reduction in AAL that could be achieved under different assumptions about the scale and cost-effectiveness of PFR roll-out, helping to identify where interventions are likely to deliver the greatest return on investment. Figures represent potential losses to building fabric, contents and additional living expenses for all insurable residential properties across England, Wales and Scotland – 2025 values.

Detailed property-level data and rebuild costs from AddressCloud, buildings constructed since 2020, additional cost factors such as contents values, additional living expenses and inflation uplifts have been included to provide precision at the individual property level. At the aggregate portfolio level, this results in a significantly increased overall total insured value at risk to flood. For portfolio-level national estimates, we recommend referring to studies with that intended purpose, such as **JBA's previous/2023 work**. This report should be used primarily as a deep dive analysis into the suitability of property types to PFR. The precision of grouped and aggregated figures is greater for home types targeted for modelling than to the rest of the portfolio, in part due to model-level customizations applying bespoke factors impacting a wider number of properties and uplifting their AAL as well.

Maximum Potential PFR Uptake

At a national level, around 75% of modelled residential losses arise from properties considered technically eligible for PFR. Implementing Standard or Comprehensive PFR measures providing protection up to 0.6 metres across all benefitting properties could be reduced overall losses by nearly 50%.

This reduction in AAL is not uniform across all properties, and benefits to PFR owing to reduced losses more heavily concentrated in certain properties, which this study explores further below. Unsurprisingly, the impact of PFR varies significantly by property type. Table 5 outlines potential savings by property type, perhaps surprisingly though, Ground floor and Basement flats account for the highest total AAL and the largest absolute benefit from PFR, with savings of over £122 million across more than 437,000 units.

Table 5: Estimated AAL savings from PFR implementation by property type.

Property Type	Number of properties At Risk to flood	AAL assuming no PFR	AAL with PFR fitted	% saving of Total AAL
Detached House	149,506	£54.0m	£11.1m	3.1%
Semi-detached House	214,542	£58.9m	£12.0m	3.4%
Terrace House	264,033	£96.4m	£19.7m	5.6%
Other House	9,748	£4.7m	£959k	0.3%
Bungalow	75,054	£31.6m	£6.4m	1.8%
Ground Floor & Basement Flat	437,461	£159m	£36.7m	8.9%
Total	**1.15m**	**£405m**	**£87m**	**23.2%**

Basement flats are highly exposed to surface water flooding, particularly in dense urban areas, though protecting subterranean accommodation may come with its own unique set of challenges. Flats also tend to have shared infrastructure and limited flood thresholds, making them especially vulnerable to shallow pluvial events.

Terraced houses show the next highest savings, with £76.7 million in avoided losses across 264,000 properties. These homes often feature low thresholds, suspended floors, and limited front gardens, making them susceptible to overland flow. The high volume of terraced housing in older urban centres amplifies their contribution to national risk and highlights them as high-priority targets for PFR roll-out.

Semi-detached and detached houses also yield considerable savings (£46.9 million and £42.9 million, respectively) but on a per-property basis, detached homes show a higher average AAL saving. This likely reflects their larger footprint, higher insured values, and greater exposure to multi-directional overland flow.

Bungalows, while accounting for fewer properties overall, display a substantial £25.2 million in savings. Given their single-storey design, these homes often lack vertical evacuation space and therefore experience more extensive damage during flood events. This makes them strong candidates for resilience-focused PFR, including raised electrical systems, resilient finishes, and sump and pump systems.

These findings reinforce the value of a housing-type-sensitive approach to PFR policy and funding, where different property forms are matched with appropriate interventions. Flats and terraced houses emerge as high-impact priorities, both in terms of the number of properties at risk and the magnitude of potential savings. Targeting these groups, especially where clustered in flood-prone urban areas, could yield large reductions in national flood losses for a relatively modest investment.

Realistic PFR Uptake: Risk-Based Scenario

While a 100% uptake of PFR is theoretically possible, it is highly unlikely in practice. A more realistic scenario assumes that PFR is most likely to be adopted in homes facing the greatest flood risk, particularly those with a history of frequent flooding. In this scenario, attention is focused on the subset of PFR-eligible properties exposed to a 1-in-50-year loss event, representing a minimum 2% annual probability of flooding. Based on analysis using JBA's UK Flood Loss Model, **approximately 115,000 properties fall into this high-risk category.**

If only PFR measures were implemented to properties at risk of frequent flooding (1-in-50-year loss event, 2% chance of flooding in any year) the number of benefitting properties would be smaller, **with a total AAL saving of £238 million.**

The modelled results show a wide range of outcomes in terms of potential AAL reduction:

- 50,000 properties (43%) could achieve AAL reductions greater than 75%.
- 30,000 (26%) show reductions between 50–75%.
- 20,000 (17%) fall in the 25–50% range.
- 16,000 (13%) see modest reductions between 1–25%.
- Around 500 properties (<1%) have no measurable AAL benefit under the modelled assumptions.

Table 6: Estimated reduction in AAL for PFR-eligible properties under a national implementation scenario.

AAL Reduction	Number of properties frequently flooded	AAL assuming no PFR	AAL with PFR fitted	% saving of Total AAL
75%+	50,590	£168.0m	£35.0m	9.7%
50-75%	29,787	£99.5m	£35.8m	4.6%
25-50%	20,047	£80.5m	£52.1m	2.1%
1-25%	15,649	£81.2m	£67.6m	1.0%
Total	**116,073**	**£429m**	**£191m**	**17.4%**

The total AAL assuming no PFR for frequent flood risk properties is £429 million, which could be reduced to £190 million following PFR implementation, **a total saving of £238 million, or approximately 56%.** These results suggest that encouraging PFR update towards properties affected by frequent flooding would yield high levels of benefit.

Figure 4: Realistic reduction in flood risk through national PFR implementation.

Realistic PFR Uptake: Cost-Effectiveness Scenario

PFR is more likely to be taken up by private homeowners where there is clear financial benefit, i.e the cost of PFR is less than the expected cost of flooding over the projected lifespan of the products. Here we consider property type, rebuild cost, PFR installation for limited and standard measures, together with AAL before and after PFR implementation for the following scenarios:

- Where PFR cost is less than the AAL: representing a payback period within theoretically average year.
- Where PFR cost is less than the AAL × 3: representing a payback over three theoretically average years.

Table 7: Cost-effectiveness of PFR implementation based on return-on-investment thresholds.

	Limited PFR measures costing £1,500 to £3,000		Standard PFR measures costing £9,500 to £12,500	
	Number of Properties	Potential AAL saving	Number of Properties	Potential AAL saving
PFR cost < AAL	51,030	£54.3m	112,946	£213m
PFR cost < AAL x3	103,247	£175m	116,503	£238m

For limited measures (costed at £1,500 for solid floors and £3,000 for suspended floors), **approximately 51,000 properties are cost-effective under the one-year payback threshold, rising to 103,000 under the three-year threshold**, with AAL savings increasing from £54 million to £175 million.

The benefits are more significant for comprehensive PFR (assumed at £9,500 for solid floors and £12,500 for solid floors). Just under **113,000 properties meet the one-year threshold, with a potential AAL reduction of £213 million**. This rises marginally to £238 million under the three-year threshold.

These findings show that for a significant share of properties, especially those at higher risk, PFR is financially viable, this is supported by several detailed studies have shown that PFR measures offer good value for money, particularly manually deployed flood resistance measures. A 2012 Defra report (JBA, 2012) found these to be more than twice as cost-effective as automatic systems, especially for moderate flood risks (e.g., 1 in 40 year events). Automatic measures are cost-effective in certain conditions but generally offer lower benefit-cost ratios due to higher costs. Resilient adaptation measures, while helpful are often significantly more expensive, making them less cost-beneficial and generally not covered by government funding. This was reinforced by a 2018 Flood Re report, which also found manually deployed systems to be the most cost-beneficial. However, rising costs of materials and labour since 2021 suggest that updated economic evaluations are needed to maintain confidence in these findings.

An alternative way to consider cost-effectiveness might be to consider the probability of a flooding costing more than the PFR implementation cost. Figure 5 indicates the number of properties likely to see flood events which cost more than PFR costs of £1,500, £10,000 and £30,000 by probability.

- Over 30,000 PFR eligible properties have a 1 in 20-year likelihood or 5% chance in any given year of flooding costing more than PFR installation.
- ~180,000 PFR eligible properties have a 1 in 65-year likelihood or a 1.5% chance in any given year of flooding costing more than PFR installation
- ~350,000 PFR eligible properties have a 1 in 100-year likelihood or 1.0% chance in any given year of flooding costing more than PFR installation

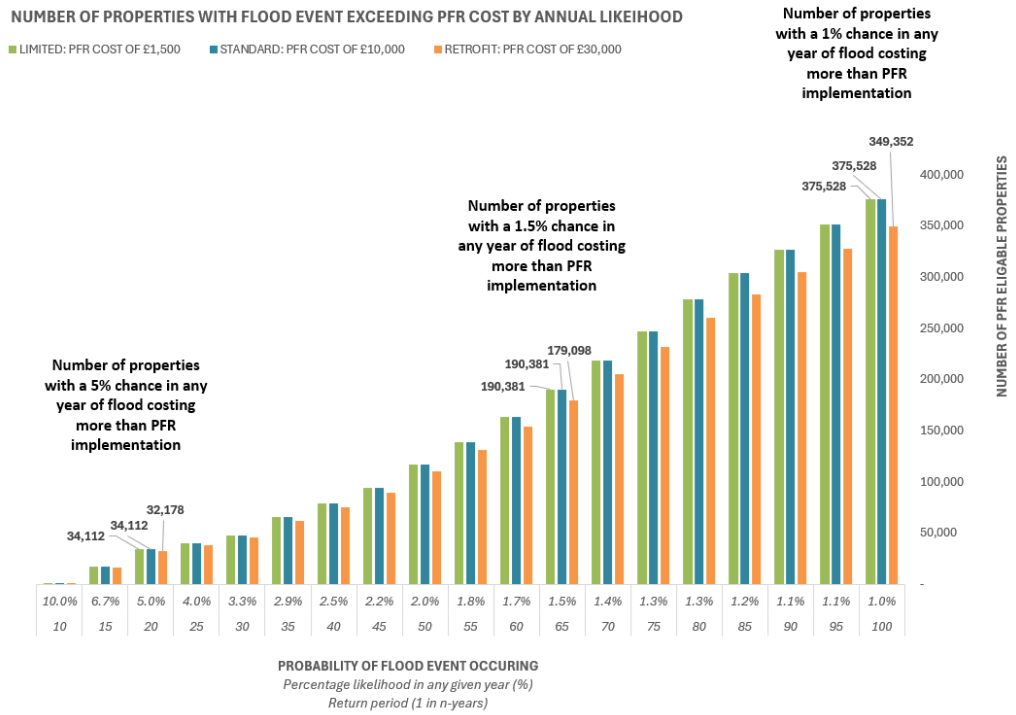


Figure 5: The number of properties likely to experience a flood event costing more than PFR installation cost by annual likelihood. Number of properties is cumulative as the probability decreases left to right.

Scenario summary

Together, these scenarios demonstrate the transformational potential of PFR in reducing the financial impacts of flooding across the UK. Whether assessed through universal application, risk-informed targeting, or cost-benefit analysis, PFR emerges as a practical and scalable solution, particularly when aligned with property characteristics and risk levels. While behavioural, logistical, and financial barriers remain, the evidence strongly supports the case for strategic national investment in PFR as part of the UK's broader flood resilience strategy.

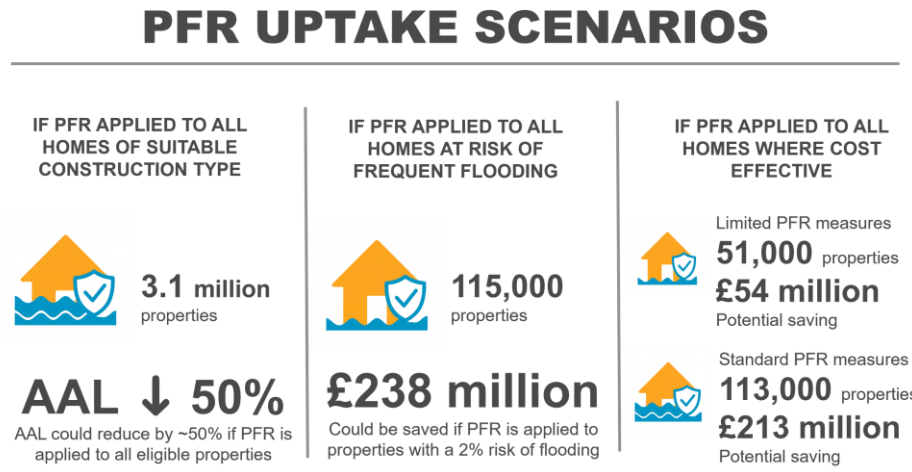


Figure 6: Summary of PFR uptake scenarios in terms of number of properties benefitting and potential saving in combined Annual Average Cost of Flooding

Other factors influencing PFR uptake

PFR is most effective when delivered by Risk Management Authorities (RMAs) through well-funded, coordinated community schemes. These programs rely on expert flood risk assessments and use accredited contractors and quality products. However, poor or unregulated delivery can result in inadequate protection, ongoing damage, and loss of trust in PFR. The market is still vulnerable to exploitation, with risks of mis-selling and substandard installations. Clear communication about residual flood risk and the need for emergency planning is essential. In order to address some of these concerns, and building on the 2016 Bonfield Action Plan, the Environment Agency has commissioned Dr. Peter Bonfield to review property flood resilience (PFR), identify gaps and opportunities in the PFR market, and develop a new action plan for stakeholders. The intent is to improve flood preparedness and understanding and to future-proof the built environment by improving design and construction methods in anticipation of climate change. To date, successful PFR cases show that community engagement, best practices, and multi-agency coordination lead to better outcomes. These successes are driving more government support and insurance recognition, improving affordability and resilience.

CASE STUDY: BEWDLEY PFR SCHEME AND POST INSTALLATION EFFECTIVENESS STUDY

Bewdley is an area prone to extensive fluvial flooding from the River Severn. Flooding is reported to have impacted residential and commercial properties in Bewdley throughout history. Permanent works and demountable flood barriers offering a 1 in 100-year standard of protection have been implemented along the right bank, with a temporary barrier deployed along the left bank offering a lower 1 in 10-year Standard of Protection 19 properties. As a result, property flood resilience measures were also offered to properties on the left bank to enhance their resilience to flooding, increase the Standard of Protection offered and also increase the number of properties offered protection from 19 to 44.

44 properties in Bewdley had PFR measures installed following surveys conducted by JBA Consulting in 2014.

Engagement with the community over the implementation of the Bewdley PFR scheme began in 2013, with independent PFR surveys carried out by JBA Consulting in 2014 and 2015. Due to the significantly historic nature of a high proportion of properties, extensive discussion and collaboration was required between the Environment Agency, Historic England, local Conservation Officers at Wyre Forest, JBA Consulting, the appointed installation contractor, Watertight International and the homeowners. As a result of this extensive engagement, 100% uptake for the scheme was achieved.

Following flooding in 2022, a post installation effectiveness study was carried out to understand the effectiveness of PFR measures during the flood event. 23 properties out of the 44 properties that received PFR participated in the post installation effectiveness study. Further information for an additional 10 properties was provided by Wyre Forest District Council.

Findings from the study included the following:

- 29 property owners identified that their PFR measures were required during the February 2022 flood event.
- **Where the PFR measures were required and deployed during the February 2022 event, 28 of the properties (97%) reported a positive response when asked is the PFR measures helped to reduce the impact of flooding to the property.** 8 properties reported that they didn't have any water enter the property, 14 reported a reduction in the amount of water that entered their property and 5 reported that their measures were eventually overtopped.

Figure 7: Images of resilient adaptation including raised appliances and water resilient floor coverings

Figure 8: Images of flood wall adaptation

- Out of 17 property owners who responded, 11 property owners said they had made changes to the PFR measures they received since the EA scheme, 9 of which reported that this change had been purchasing and/or installing additional pumps.
- 11 properties are reported to have installed resilient measures or adapted their property internally to improve recoverability. Measures included tanking, stainless steel flood resistant kitchens, raising electric sockets and appliances, installing flood resilient flooring, flood resilient plasterboard and flood wall adaptation.
- Issues around the handover of products were identified, with only 15 out of 23 property owners reported that they were shown how to operate their PFR measures.
- 11 out of 18 property owners were unaware of any maintenance requirements and only 3 out of 11 had tested their products outside of a flood event.
- 15 residents answered questions relating to insurance and 5 of these (33%) stated that they found it difficult to access flood insurance and 11 out of 15 (73%) reported that the installation of PFR measures had had no impact on the availability and affordability of insurance.

5. Role of Insurance in PFR Uptake

Homeowners adopting PFR may not directly see the benefit of their investment for a number of years if not affected by flooding. A tangible early return and likely key factor increasing the uptake of PFR is where homeowners see a saving in their annual insurance premium.

A survey of the top UK primary insurers explored perceptions and practices around the integration of PFR into flood risk assessment and pricing. 1 in 5 of those surveyed currently consider PFR in their flood risk assessment or pricing. The remaining 4 of 5 do not yet incorporate PFR into their pricing or risk models, citing a range of challenges that hinder broader adoption.

The most frequently stated challenge or limitation to utilizing PFR information was:

1. Lack of reliable data on PFR measures at property level (33%)
2. Uncertainty about the effectiveness of PFR in reducing claims (27%)
3. Concerns around ongoing maintenance or compliance (20%)

A smaller proportion of respondents also noted difficulties integrating PFR into existing underwriting and pricing tools, and the lack of data being captured at the point of quote.

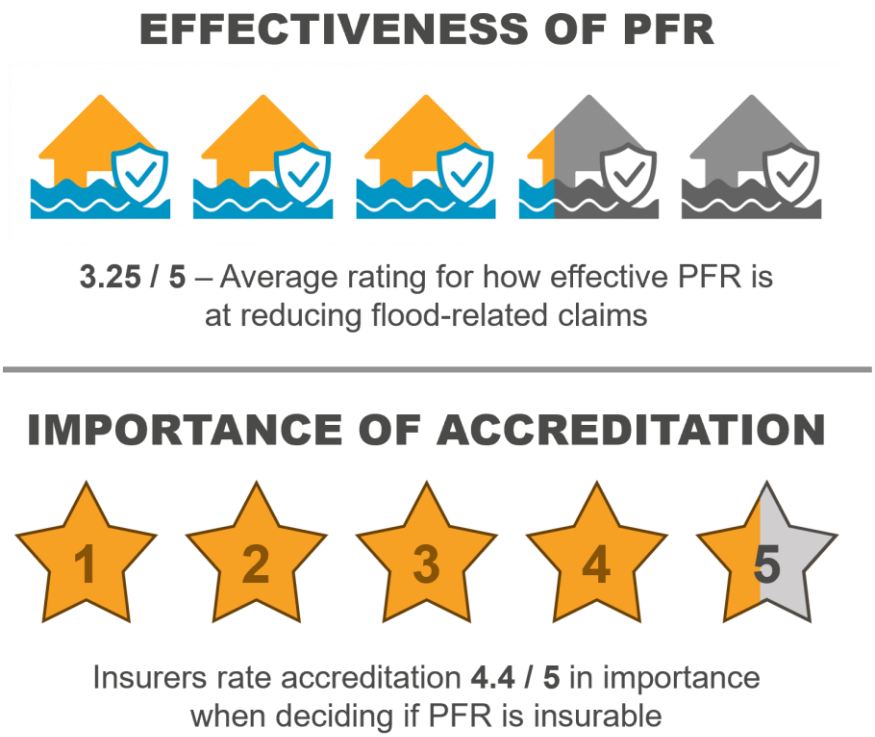


Figure 9: Summary of survey results from UK insurers when asked about the effectiveness and importance of accreditation of PFR.

When asked about the importance of accreditation (such as adherence to British Standards) in determining whether PFR measures are insurable, respondents gave a score of 4.4 out of 5. This reflects a general consensus that accreditation is important, with 60% rating it as "very important" (5 out of 5).

Respondents also offered insights into what could support the broader integration of PFR into insurance product design and pricing. The most frequently mentioned enablers were the availability of standardised, accessible data on PFR installations, and stronger evidence of effectiveness in reducing claims or improving recoverability. Increased customer demand and public awareness were also noted as potential drivers of change, alongside improved tools for integrating PFR into existing underwriting platforms.

In terms of specific PFR measures, flood doors and barriers were the most frequently cited as reliable or viable, mentioned by 60% of respondents. Other commonly mentioned

interventions included non-return valves, raised electrical sockets and wiring, and landscaping or external ground works.

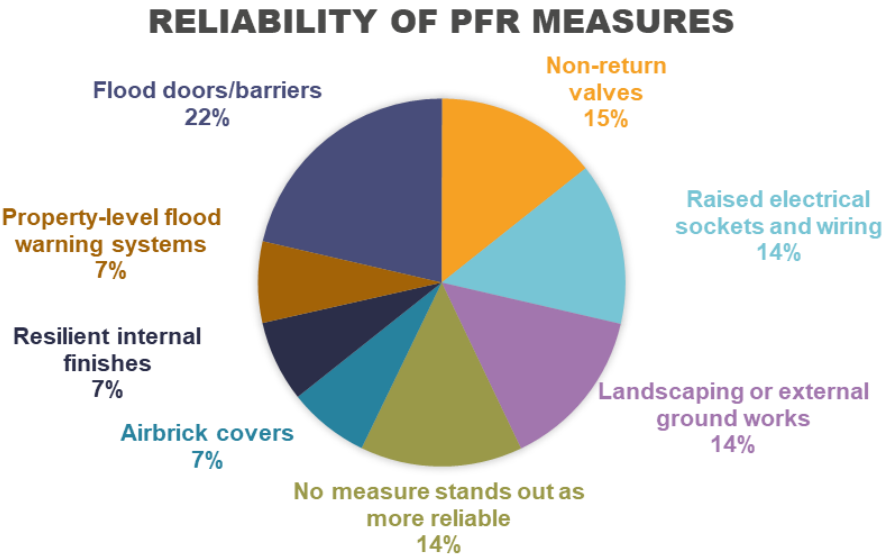


Figure 10: Summary of insurers perception of the most reliable or viable PFR measures.

To support wider adoption of PFR across the industry, several policy and collaborative initiatives were proposed. These included financial incentives or subsidies, potentially delivered through Flood Re or government schemes, and the development of industry-wide standards and registries of installed PFR measures. Improved sharing of case studies, particularly those that demonstrate PFR success in commercial properties, and clear regulatory guidance were also seen as important. One respondent proposed that Flood Re take a leading role by differentiating ceding costs to reward properties with lower residual risk due to PFR, and by creating a central register of where PFR measures have been implemented.

Overall, the survey highlights both a strong interest in the concept of PFR and a set of practical and systemic barriers that need to be addressed to enable its more consistent use across the insurance sector.

A key factor in increasing the uptake of PFR may be the understanding of the percentage discount in premium offered for adopting such measures. However, just as nobody knows the discount for fitting burglar alarms, or for achieving a Pass Plus Driving status, insurers are unlikely to divulge this information in a transparent manner.

Insurance availability is also critical to securing a mortgage, with lenders insisting homeowners have buildings cover as a condition of the loan to protect their investment and to protect the homeowner from financial shock. Discussion with some of the UK's biggest lenders highlights that even with insurance in place, properties at the highest flood risk may not be offered a mortgage as:

1. High insurance premiums will influence Affordability decreasing the amount of capital the lender is prepared to offer
2. Flood Risk and a potential flood event, may significantly devalue the asset

Data disclosed by Barclays indicates that over 90% of the properties in its UK mortgage portfolio were judged to be either in a "negligible," "very low" or "low" flood-risk band, with 1.6% judged to be in the moderate risk band, and 2.6% and 1.2% in the high-risk and very-high-risk bands (Guardian, 2024).

There is however a willingness from lenders to consider PFR in their risk appraisal and this may be the means to allow mortgages to be secured for the most at-risk properties.

6. Summary

Flood risk in the UK is both extensive and growing, with over 6 million residential properties at risk. Despite the presence of formal defences for over 4 million properties, residual risk remains high. Property Flood Resilience (PFR) offers a vital, scalable solution to mitigate these risks, especially for properties not covered by planned or existing flood schemes.

This Phase 1 report assesses the suitability of UK homes for PFR implementation and evaluates the economic and practical benefits of various uptake scenarios. Key findings include:

- **PFR Suitability:** Approximately 21.8 million UK homes (72%) are suitable for PFR based on construction type and floor level. Around 3.4 million of these are exposed to flood depths up to 0.6m at a 1000-year flood, where PFR is most effective.
- **Cost of Implementation:** Limited resistance measures cost £1,500–£3,000; standard resistance measures range from £7,000–£15,000; and full retrofit solutions may exceed £30,000.
- **Economic Impact:** Full implementation across all suitable properties could reduce the annual average cost of flooding (AAL) by up to 50%. A more realistic risk-based scenario targeting high-frequency flood areas could yield savings of £238 million.
- **Cost-Effectiveness:** For over 50,000 properties, the cost of limited PFR is lower than the AAL, offering a potential return on investment within a single year. This number doubles under a three-year payback model.
- **Insurance and Lending:** Although insurer interest in PFR is growing, only 1 of 5 insurers currently integrate it into pricing models, citing data gaps and maintenance concerns. However, accreditation and standardisation are widely recognised as essential to greater adoption.

The report demonstrates that strategic investment in PFR, guided by property characteristics, flood exposure, and economic viability, can significantly reduce national flood losses, protect vulnerable households, and support more equitable flood resilience.

Phase 2 will build on these findings through local-scale analysis of four case study areas to explore community-specific pathways for effective PFR deployment.

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