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Do surface water drainage fee rebates incentivise sustainable drainage retrofit?: a case study of households in England and Wales

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ABSTRACT

Internationally, surface water drainage fees are increasingly used to finance stormwater management. In the UK, these fees were first made transparent in 2011, so as to drive SuDS retrofit through a fee rebate available to disconnected households. However, the success of this initiative is unknown. Using Freedom of Information law, requests were made to all the Water and Sewerage companies in England and Wales, on the uptake of the rebate. Results show very low uptake nationally, at most 0.125% of all dwellings each year, and very likely much lower once bill corrections for dwellings never connected to sewer are considered. This is a concern at a time when government has introduced a new plan to combat highly problematic storm overflows. Although the rebate system has failed to incentivise household SuDS retrofit, international experience suggests it can do so if suitably restructured and supported.

Introduction

Study aim

The UK government recently published their Stormwater Overflows Discharge Reduction Plan (SODRP) to reduce, and where feasible eliminate, combined sewer overflows (CSOs), and 'sets out a mandatory £56bn investment programme to sort the problem out' (Defra 2023a:foreword). This follows unprecedented public outcry over sewage discharge into rivers and seas. This is permitted in extreme wet-weather, but increased visibility has underpinned the outcry. The debate on why seemingly more discharges occur is heated, with water and sewerage companies (W&SCs) pointing to climate change driving more extreme wet-weather events, and to enhanced event duration monitoring, whilst others blame underinvestment in drainage and treatment capacity (Giakoumis and Voulvoulis 2023), illegal discharge practices (Ford et al. 2025), and inadequate setting and enforcement of discharge consents by the regulator (Hammond et al. 2021).

The SODRP prioritises green infrastructure (GI) to reduce surface flows to sewer, supported by grey infrastructure as upgrades to storage, network and treatment capacities (Defra 2023a, 21–26). GI approaches include Sustainable Drainage Systems (SuDS, the UK practice), Water Sensitive Urban Design (WSUD), Low Impact Development (LID), Best Management Practices (BMPs), and Sponge Cities. Fletcher et al. (2015) review these approaches noting variation by focus, context and region, but common characteristics of managing peak and total stormwater runoff through distributed measures reducing surface imperviousness and increasing infiltration and retention. Gl measures can be more costeffective than grey measures (Quaranta et al. 2022) but are limited in how much increased runoff anticipated under climate change can be offset (Rodriguez et al. 2024). Therefore, grey-green infrastructure combinations attract interest (Alves et al. 2020; Wang et al. 2023), with recognition of the need for wholecatchment integrated solutions (Perry et al. 2024; Quaranta et al. 2022).

Structural SuDS range from building to neighbourhood level, including green roofs, infiltration devices, swales, detention basins and wetlands (Woods-Ballard et al. 2015). SuDS are considered at the design stage so are more common for new build yet retrofit is essential to reduce discharge from the existing built environment. UK retrofit SuDS have largely been limited to public spaces, municipal and commercial properties, and highway drainage (see >100 case studies detailed by Susdrain n.d.), with W&SC involvement via partnership with local government or other public body. A new requirement on W&SCs to develop Drainage and Wastewater Management Plans (DWMPs) is now driving a strategic approach to green-grey infrastructure (Defra

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2022; Water 2019), with generic options that include incentivising behavioural change in households, via impermeable area reduction (Water 2019: Appendix D p7).

At the household level space restricts use of some SuDS but water butts, soakaways, rain gardens, green roofs, rainwater harvesting or conveyance to river provide disconnection opportunities. However, DWMPs do not actively pursue such measures due to uncertainty over uptake, although when asked, households identify taking personal responsibility for surface runoff and installing SuDS, as a priority action for DWMPs (YW 2023, 60). Disconnecting housing is particularly important, because residential space dominates urban land in England (DLUHC 2022). Doing so is also feasible because houses are co-located with gardens, providing clear source control opportunities. To drive this domestic SuDS retrofit the SORDP commits to assess the feasibility of giving W&SCs new powers to reduce the impermeable area on private properties, using SuDS devices that can attenuate drainage from 'for example, roofs and patios' (Defra 2023a, 24). However, before considering new powers to drive domestic disconnection, it is essential to understand if W&SCs make adequate use of the disconnection incentives already available to them.

UK W&SCs have long charged households for surface water drainage (SWD). Following major floods in the mid-2000's a SWD fee rebate was offered to households not draining to sewer to drive SuDS uptake. However, the extent to which this occurred is unknown. This paper therefore aims to determine, through the experience of England and Wales, if a rebate offered on SWD fees drives household SuDS retrofit, and to consider opportunities for using the rebate to drive further adoption. The results contribute to literature where there is a lack of empirical evidence (Wilkerson, Romanenko, and Barton 2022) and have wider international relevance as municipalities increasingly finance stormwater management through fees, whilst also seeking to incentivise GI retrofit.

Financing surface water disposal

Faced with growing urban drainage challenges, authorities increasingly seek financial support for stormwater management. Funding often comes from fees, set at a variable rate (frequently linked to impermeable area drained) or a flat rate, which may be seen as unfair. Reviews reveal strong growth in publications on stormwater fees after 2015 (Arik 2024) but that programmes have been operating in North America since the 1970s (Campbell and Davis (2023) identify 2179 municipalities charging stormwater fees in the US and Canada), in

Germany from the 1980s and later in Australia, Canada, Ecuador, and at least seven other European countries (Tasca, Assunção, and Finotti 2018). Fees have also been proposed in Brazil and South Africa (Tasca, Assunção, and Finotti 2018) and to support China's sponge city programme (Shi et al. 2024). In some places, fee reductions are offered to incentivise disconnection (e.g. Philadelphia Waters 'Green City-Clean Water' programme), but the effectiveness of this practice is not well known. Some argue that stormwater fees are usually too low, making disconnection efforts uneconomic (Tasca, Assunção, and Finotti 2018), but others argue that incentives can be effective if discounts are available for partial disconnection (Godyń, Muszyński, and Grela 2022) or if applied with other incentives (Wilkerson, Romanenko, and Barton 2022).

In England and Wales, household surface water disposal (SWD) fees are fixed, or based on a property's value (the rateable value, £RV). Fees vary between W&SCs reflecting that conveyance and treatment costs vary, in part due to differences in network infrastructure; for example, 55% of the Northumbrian region (NE England) is drained by combined sewers, compared to just 10% in the Thames (London) region (Ofwat 2009, 19). For all the W&SCs in England and Wales, Table 1 details the SWD fees, which range from £25-75 per year. For context, average water bills for 2023/24 range from £391–526 per year (with an average price increase of 36% 2025-30 to be applied in 25/26). A further fee is charged for highway drainage. This is paid by all households, as all are assumed to benefit from the highway network, and more precise fee allocation is too complex to administer.

The water industry of England and Wales was privatised in 1989, and a common practice in terms of the SWD fee emerged. In a 1999 parliamentary debate, it was noted that W&SCs did not identify foul, surface and highway drainage fees separately, and that few companies volunteered a SWD rebate for eligible customers (Hansard 1999). Reflecting the 'polluter pays' principle, a rebate was available to customers who could demonstrate their property had no SWD to sewer, and they were not using any W&SC drainage services. However, the onus was placed on households to apply for the rebate because the industry regulator (Ofwat) agreed it would not be cost-effective for W&SCs to survey millions of properties to obtain individual connection details. Consequently, many households were left paying for a service they did not use. Customers general lack of awareness that they were paying for SWD, and the lack of water bill transparency, meant few households applied for the rebate. The lack of bill transparency concerned Ofwat who asked W&SCs to itemise drainage

Table 1. Surface water drainage fees for England and Wales water and sewerage companies.

Company	Drainage charge basis	Surface water drainage (SWD) and Highway drainage (HD) fees, 2023/24
Anglian	Fixed fee	All households - £45 year for SWD, £24 year for HD
Dwr Cwmru/ Welsh Water	Fixed fee	Individual charges are not explicit in tariff guide; by inference, the SWD/HD combined charge is £52.59 year, of which the SWD is £34.60 year
Northumbrian	Fixed fee	Individual charges are not explicit in tariff guide. Sewage fee reduction with SWD disconnection implies a charge of £58.80. (HD is not stated and is included in sewage charge after SWD rebate applied).
Severn Trent	Fixed & variable According to property: type, rateable value, and location	Metered households pay annual SWD fee based on property type: Detached house £71.36; Semi- detached house £47.57; Other £23.79. Unmetered households pay £26.47 year SWD fixed fee plus 19–32 p per RV £ (depending on which of 10 geographical charge zones the customer is in). HD fee is £16.41 year.
Southern	Fixed fee	All households - £23 year for SWD, £11.50 year for HD
South West	Variable (RV & volumetric) plus fixed fee	Metered properties pay SWD as fixed fee (£21.79 per year) plus variable fee (52p per m ³ water used). Unmetered properties pay SWD as fixed fee (£21.79 per year) plus variable fee (52p per £RV).
Thames	Variable (RV & volumetric) plus fixed fee	SWD rebate for single occupancy household specified as £32.46. For housing blocks (flats etc) SWD rebate depends on water supply pipe size. HD fee not specifically identified.
United Utilities	Fixed and Variable (RV)	SWD fee for metered properties is £75.33 per year. SWD fee is 50.3p per £RV (zero if disconnected) for unmetered properties. HD fee is £34.96
Wessex	Fixed and Variable (RV)	For metered properties the SWD rebate is 48–60% of full drainage fee, which varies by supply pipe diameter, starting at £25 per year for 25 mm supply pipe. For unmetered properties the combined SWD/HD fee is £54 per year.
Yorkshire	Fixed fee	For metered properties the SWD fee is £54.89 (HD fee 17.9p m ³ water used), and £54.89 for unmetered properties (HD is 18.82p per £RV).

1. Source: Statutory information on charges on W&SC websites. Severn Trent includes Hafren Dyfrdwy incorporated from 2018. 2. About 60% of homes have a water meter, the others have their bill assessed according to the value of the property assessed for local tax purposes ('Rateable value' in 1990). 3. There is no explicit SWD charge for households on a social tariff, such as 'WaterSure'.

fees on bills, or at the very least explain their fees (Hansard 1999). However, this recommendation did not feature in later water legislation (Water Industry Act 1999), and lack of transparency on water bills persisted.

Impetus for change came in 2007, following widespread and intense floods across the UK. An independent government review was conducted by Sir Michael Pitt, who made 92 recommendations to build flood resilience. Pitt noted that water bill transparency incentivised SuDS installation in other European countries, but not in the UK where customers were unaware of the various fees on their water bill, and where fewer than 5% of households received a SWD fee rebate (Pitt 2008, 101). Pitt also supported a conclusion of the Parliamentary committee scrutinising the draft national 'Future Water' strategy (Defra 2008). The committee recommended: 'Ofwat should insist that water and wastewater companies state the proportions of customers' bills made up of foul water drainage, surface water drainage and highways drainage. Property owners who have, or retrofit, SuDS should receive a rebate on the surface water component of their water company bill' (Environment Food and Rural Affairs Committee 2008, 21). The 'Future Water' strategy did not commit to water bill transparency, but the Government agreed to: 'consider whether funding for surface water drainage should be changed to better reflect the polluter pays principle ... which may involve strengthening requirements by Ofwat for water companies to vary their fees to reflect more accurately the true cost of surface water drainage' (Defra 2008, 82).

That further consideration came with the independent review of Anna Walker, a senior civil servant. The Walker review examined the effectiveness, affordability, and fairness of systems for charging households for water and sewerage services. The concern over flooding was such that a major conclusion was that households should be incentivised to minimise their surface drainage (Walker 2009:foreword), via two key recommendations. First, the cost of surface water and highway drainage services should be stated separately on water bills (Walker 2009, 106). Second, households should be incentivised to reduce impermeable area connected to sewer through SuDS installation. This retrofit was viewed as preferable to increasing sewer capacities, given the potential to reduce investment needs and bills.

Walker considered whether a polluter pays charge based on surface area drained, rather than water supplied, would better incentivise disconnection. This was Ofwat's preferred approach, and accepted in principle, but was not ultimately recommended, because drainage area based charging being introduced in the non-household sector was proving difficult. Some nonhousehold customers with low value properties (e.g. churches, community premises) relative to extensive drainage areas were suddenly faced with large bill increases, requiring concessions in the Flood and Water Management Act 2010 that implemented the 'Future Water' strategy. Walker also concluded that measuring drainage area for all households would be costly, so not justified given that differences in household drained areas were much less than for nonhousehold properties. She did, however, recommend a sliding scale for the SWD rebate, with the rebate proportionate to newly disconnected area, so as to incentivise SuDS retrofit (Walker 2009, 106). Respondents to the review supported this approach (102), which was recommended to government, regulators, and the water industry.

Neither of Walker's recommendations on SWD fees became law in the Flood and Water Management Act 2010. The recommendation on a sliding SWD fee was rejected by Ofwat (2009, 38–39) who viewed it as a disincentive to full disconnection. As such, the SWD rebate continued to be offered as all or nothing, with no reward for partial disconnection. The recommendation on bill transparency was accepted, with itemised drainage fees becoming standard industry practice from 2011.

Data and method

Pitt stated that 2–5% of households in England received a SWD rebate (but no source is given), which was considered low relative to Europe (Pitt 2008, 101). Following Pitt and Walker's reviews, the expectation was that disconnections would be accelerated by the transparency over SWD fees and the rebate. However, whether disconnections did increase, and the current national extent of household disconnection is unknown. To address this, disconnection data could be obtained via a household survey, but this would be a sample, lack temporal accuracy, and risk responder bias. Therefore, all W&SCs in England and Wales that have provided drainage services since 2011 were approached directly. Collectively, these companies serve 61 million people in 26.2 million dwellings (see Ofwat (no date) for a map of company areas).

Data was obtained using freedom of information (Fol) law (Environmental Information Regulations, 2004) which requires public authorities to provide environmental data upon request. W&SCs were asked: (Q1) how many applications for a SWD fee rebate they had received annually since 2011; (Q2) how many SWD fee rebates they had granted; and (Q3) for data indicating why applicants applied for a rebate, including the number of years rebate claimed. Q3 was asked to differentiate those who actively disconnected their property from those who had never been connected and were seeking a bill correction. An assumption was that if no reason for the application was recorded, data on the rebate period claimed for would be informative, as rebates can be backdated for six years, so a multi-year claim probably indicates a property was never connected to sewer.

Seven of the eleven W&SCs provided data within the statutory twenty working day limit. Two more provided data after requesting extra time, one only in aggregate, as the company claimed it would take too long to provide annual data; an offer to process anonymised data on their behalf was refused. Two further companies declined to provide any data, stating it was financial not environmental, hence they need not answer. A request to reconsider was made noting that a SWD fee rebate is an 'administrative measure' so covered under regulation 2(1)(c), and that a rebate would affect factors in regulation 2(1)(b) - 'substances ... discharges ... likely to affect elements in regulation 2(1) (a)' which include 'elements of the environment, such as....water'. One company then provided data; the other refused to provide data on SWD requests, but provided data on SWD rebates, accepting this fell under the scope of the EIR law. Clarification requests were made (e.g. unexplained internal codes, likely errors in the data), from which, after four months, an industry-wide data set emerged.

Results

Incentivising household surface water disconnection

Ultimately, an irregular set of data emerged (Table 2). Two W&SCs responded in full, with definitive annualised data from 2011. For rebate applications (Q1), only three W&SCs could provide full or partial data, with others providing none, or data on applications was lumped with that on customer contacts regarding general SWD queries; these might be to ask why a SWD fee was being levied, whether a water butt made a customer eligible for a rebate, or simply a request to explain what SWD was. With respect to SWD rebates granted (Q2), three companies provided no data, two provided full annualised data, with others having only partial rebate records, several citing changes in customer relations/billing software five years previously. One W&SC (Yorkshire) provided monthly data, but rebates awarded in response to customer applications could not be differentiated from new build properties where SWD fees were not levied (probably developments of 10+ dwellings where SuDS are mandatory, and which comprise an estimated 22% of all new builds in the region over the period).

The Thames Water data is notable, as the number of rebates granted far exceeds applications. This occurs because when a customer successfully applies for a rebate, Thames Water conducts desk checks for adjacent properties that qualify and automatically applies the rebate. This include neighbours on a street identified

Table 2.	Overview o	f data	provided i	in response to	freed	om of	f in	formati	on r	equests
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	Applications for SWD rebate since 2011		Reasons cited for SWD rebate applications
Company	(Q1)	SWD rebates granted since 2011 (Q2)	(Q3)
Anglian	Data provided	Data provided	Anecdotal
Dwr Cwmru/Welsh	Data provided	No data	Not recorded
Water	(2015–2023)		
Northumbrian	Aggregate data ² (2018–2023)	No data	Unable to answer
Severn Trent ¹	Data provided (2012–2022) ³	Data provided (2012–2022)	Unable to answer
Southern	No data	Data provided	Not recorded
South West	Data provided (2014–2022) ^{2, 3}	Data provided (2018–2022)	Not recorded
Thames	Data provided (2018–2023) ^{2, 3}	Data provided (2018–2022) ⁵	Not recorded
United Utilities	No data	Data provided (2016–2023)	Not required to answer
Wessex	Data provided	Data provided	Anecdotal
Yorkshire	Data provided ^{2, 4}	Data provided but lumped with new build	Anecdotal
	(2016–2023)	data	

¹Includes Hafren Dyfrdwy/Dee Valley Water incorporated into Severn Trent from 2018. ²Company provided data on SWD charge customer contacts, where applications for a rebate are lumped with more general enquiries about the SWD charge (e.g. request for explanation); ³Advised may include duplicate contacts from same household; ⁴Data included some SWD queries and rebate applications from some STW customers where SWD is billed via YW; ⁵Includes households automatically granted a SWD rebate in response to a successful application by a neighbour (e.g. a block of flats).

as unconnected to a surface water sewer, and those in a block of flats or maisonette ('bulk customers'). It is not recorded whether households who automatically receive a rebate in this way have qualified on the basis of a bill correction or a recent disconnection. However, the Thames data on applications (rather than rebates granted) is considered more representative of disconnections arising from SuDS retrofit, as for bulk customers a single retrofit system can serve multiple households; in practice many of the original application may still be for bill corrections.

Figure 1 illustrates these data by W&SC, as SWD applications and rebates granted. Table 3 presents directional trends. For the industry as a whole, data quality is not high, because of refusal to provide data, data not collected, or differences in reporting metrics by W&SC, such as lumping rebate applications in with SWD queries, treatment of multiple contacts per customer, and rebate extensions to bulk customers. The reporting period covers the COVID-19 lockdowns (2020-21), and whilst Anglian Water saw a big drop in rebate applications, this pattern is not observed for other W&SCs so no general pandemic effect can be inferred. For W&SCs with a long run of data that most closely meets the Fol request (Anglian, Severn Trent, Wessex) the pattern of rebates awarded closely follows that of applications, with a high chance of an application being successful. For these W&SCs, and the industry as a whole (Table 3), there is an overall downward trend in SWD rebate applications and awards. Overall, these data provide no evidence that the SWD rebate is driving household stormwater disconnection and SuDS retrofit, as intended by Pitt and Walker. Rather, the downward trends suggest the requirement to itemise SWD on water bills has driven bill corrections for households never connected to a stormwater sewer, and that bill corrections made since 2011 have reduced the pool of households wrongly charged for SWD, with fewer new rebate applications coming forward.

Table 4 presents rebates by W&SC, as a share of all dwellings per W&SC area. Results are presented post 2011 (when SWD fees were first explicit on bills) but as this period is impacted by missing data, results are also presented for the last five years, where there is complete data. Results are presented according to whether dwellings are occupied or not, as it is assumed that rebate applications would mostly come from occupied dwellings (although over time unoccupied dwellings can become occupied and vice versa). A national estimate of rebates awarded is presented for all dwellings, and with the exclusion of flats, maisonettes and apartments which may be unable to install SuDS. With respect to SuDS retrofit the final estimates presented are conservative (a likely overestimate), as for four W&SCs, data on rebate applications are used due to missing rebate awards data, and because no allowance is made for why a rebate is granted (i.e. SuDS retrofit or bill correction).

The W&SCs were largely unable to evidence why applicants requested a SWD rebate (Q3). Several explained this was not recorded (Dwr Cymru, Northumbrian, Southern, Thames, Wessex), others declined to answer stating the data were not environmental (United Utilities) or that it was personal data which, citing EIR regulation 12(4)(b), would take too long to anonymise (Severn Trent, Southwest Water). Some W&SCs provided anecdotal evidence on why households apply for a rebate. SWD rebates for new









Figure 1. (Continued).



Figure 1. Surface water drainage fee rebate applications and awards, 2011–2023. 1. N.B. Y axis range varies; 2. Nil values denote missing data (records not kept or not supplied); 3. Applications may include SWD queries and/or duplicate records; 4. Thames Water rebates awarded exceeds rebate applications due to automatic awards for neighbours (see text); 5. Northumbrian Water reported 744 rebates awarded 2018–23 (no annual breakdown).

Table 5. Trends in 5WD result applications and awards, 2011 2025.						
Company	Applications for SWD rebate	SWD rebates granted				
Anglian	\searrow	\searrow				
Dwr Cwmru/Welsh	\searrow	N.d.				
Northumbrian	N.d.	N.d.				
Severn Trent	\searrow	\searrow				
Southern	N.d.	\searrow				
South West	\rightarrow	1				
Thames	\searrow	× 2				
United Utilities	\rightarrow	1				
Wessex	\searrow	\searrow				
Yorkshire	\searrow	N.d.				

Table 3. Trends in SWD rebate applications and awards, 2011–2023.

1. N.d. is no data; 2. Includes automatic bulk enrolments (see text).

disconnections were recognised (Wessex Water), as were rebates applied to new properties following a SWD disconnection check that occurs when a water meter is fitted (Yorkshire Water). Rebates for long standing SWD disconnections were widely cited including, for example, 'moved in and applied for a bill correction' (Yorkshire Water), 'previous owners had not applied for legacy disconnection' (Wessex Water), and 'the vast majority of surface water rebates are applied because the property was never connected to the surface water' (Anglian

Table 4. SWD rebates awarded, as a share of all dwellings.

Company	Dwellings in 2021 ¹	SWD re 20	bates awarded 11–2023 ²	SWD rebates awarded 2018–2022 ²		
	5	% All dwellings % Occupied dwellings ³		% All dwellings	% Occupied dwellings ³	
Anglian	2,938,762	2.89	3.07	1.35	1.44	
Dwr Cwmru/Welsh Water ⁴	1,497,923	0.62	0.66	0.22	0.23	
Northumbrian ⁴	1,320,290	0.06	0.06	0.05	0.05	
Severn Trent	4,269,383	0.74	0.78	0.28	0.30	
Southern	2,070,659	4.18	4.45	0.37	0.40	
South West	782,220	0.57	0.60	0.57	0.60	
Thames⁵	6,194,588	1.09	1.15	1.09	1.15	
United Utilities	3,461,387	0.52	0.55	0.27	0.28	
Wessex	1,297,967	0.87	0.92	0.24	0.26	
Yorkshire ⁴	2,380,536	0.22	0.23	0.07	0.07	
England/Wales	26,213,715	1.22	1.29	0.56	0.60	
England/Wales (exc. Flats)	20,152,355	1.58	1.68	0.73	0.78	

1. Company household count in 2020 from CCW (2021, 37) scaled to 2021 total census count by 1.1% uplift; 2 Missing data in 2011–2023 data; no missing data for 2018–2022; 3. Occupied dwelling count from 2021 census; 4. No rebates data, applications data used as substitute; 5. Applications data used in place of rebates data due to automatic rebate grant to bulk customers; 6. Flats, maisonettes and apartments excluded (may face constraints on SuDS retrofit) so includes detached, semi-detached, bungalows and terraces (ONS 2023).

Water; South West Water). Southern Water provided data on the backdating of rebates: for 2011–23 26% of properties granted a SWD rebate received a multi-year rebate (rising to 45% post 2020). As it can take over a year for applications to be investigated and a bill correction applied, this is inconclusive as to the cause for disconnection (new vs legacy). Rebates can be claimed for up to six past years, and data on backdating for three or more years would be more informative.

Discussion

Why are disconnection rates so low?

Table 4 shows that since 2011, when SWD fees became transparent, up to 1.68% of dwellings may have received a SWD fee rebate, c. 0.125% of dwellings per year. This is however very likely an overestimate, as many rebates, perhaps most, are probably legacy bill corrections, and not the result of new SuDS retrofit. As such, making the SWD fee explicit on the W&SC bill has raised customer awareness of stormwater, and improved fairness in SWD charging, but has not incentivised households to disconnect from sewer, as envisaged by Pitt and Walker.

It is difficult to put these figures in an international context, because household disconnection rates are rarely reported, with major institutional stormwater programmes (e.g. Philadelphia, Portland, China Sponge Cities) reporting against aggregate targets of reduction in impermeable area or stormwater discharge (Badger 2018; Chikhi et al. 2023). Khan et al. (2021) report that 34% of Australian households achieve some disconnection via rain water harvesting, but the context here is very different (water scarcity motivating conservation). On an absolute basis, it is reasonable to view a disconnection rate that (generously) implies 80 years to disconnect 10% more homes is very low.

Understanding this lack of SuDS retrofit requires investigation, informed by prior work on barriers (Ortega, Rodríguez, and Bharati 2023) and framed around behaviour models (see Brown, Venkatesh, and Hoehle 2015 for a comparative review) or diffusion innovation theories (O'Callaghan, Adapa, and Buisman 2020). However, in the meantime, we can hypothesise that customer awareness of the rebate, eligibility, and retrofit cost are likely to be relevant factors in disconnection.

Following Walker recommendations, raising customer awareness of SWD and associated fees became a task of Ofwat, who provide SWD guidance to customers, and advise that rebate applications must be made direct to W&SCs (Ofwat, n.d.). After 2011 W&SCs were more explicit about SWD fees on customer bills, although scrutiny of bills posted online by customers indicates that for several years some W&SCs did not differentiate wastewater and surface water fees. Today, bills clearly itemise the SWD fee, and some advertise the rebate on the bill. All W&SCs provide online guidance on the rebate application process. Overall, clear information is given to bill payers on the rebate, although the industry approach is passive with few attempts using other media (e.g. Eastern Daily Press 2018) to drive rebate uptake.

Table 5 details the rebate application process. Nearly all W&SCs provide clear guidance: a simple online or postal application, with a follow up site visit by the company. Qualifying criteria are clear, and (un)acceptable disconnection devices explained. The key criteria to qualify for a rebate are full disconnection, with no SWD to public sewer, directly or indirectly. Devices such as stormwater planters, water butts and most rainwater harvesting, which act only to attenuate or reduce flow to sewer, are unacceptable. Although Walker recommended a sliding scale for SWD rebates, full

<i>.</i>			Disconnection
Company	Process & evidence required	Disconnection technique cited	required
Anglian	Online, simple description ¹ . Possible further information required or site visit.	Soakaway. Water course, pond or other property ² . Water butt ineligible ³	Full
Dwr Cwmru/ Welsh Water	Postal application ¹ with probable follow up site visit.	Soakaway, water course, or private sewer. Water butt ineligible ³	Full
Northumbrian	Postal application of questionnaire and flow map	Soakaway, water course, pond and Other.	Full
Severn Trent	Not stated online. Required to contact the company ⁴ .	Soakaway, or private sewer.	Full
Southern	Simple online form.	Soakaway.	Full
South West	No information provided online		
Thames	Online application ¹ . Possible further evidence request.	Drains to a river, stream, or soakaway (for instance)	Full
United Utilities	Postal application ¹ with flow map. Follow up site visit.	Watercourse, soak-away or third party. Water butts and RWH ⁵ ineligible.	Full
Wessex	Postal application ¹ with flow map. Follow up site visit.	Soakaway/ground, watercourse or RWH ⁵ only used for garden irrigation. Water butts ineligible.	Majority ⁶
Yorkshire	Postal application ¹ with flow map. Possible follow up site visit.	Soakaway, watercourse, grassed area, water butts ⁷ . RWH ⁵ ineligible.	Full

 Table 5. SWD rebate application process and requirements.

1. Description of how SWD is disconnected from sewer, including flow paths. 2. Disconnection/rebate opportunity only cited on starting the application process. 3. As can only hold a fixed amount, does not collect the rainwater landing on curtilage, overflows to sewer when full or deemed impermanent. 4. SWD fee varies by property type – detached houses pay more but should have more scope to disconnect. 5. Rainwater harvesting system – ineligible if used for toilet flushing or other internal use draining to foul sewer. 6. This is not further qualified on the website but the response to the EIR request cited more than 50% as the threshold. 7. Ambiguous if water butts are eligible, as YW only ask if water drains to any of these options – it is explicit that indirect connection to sewer disqualifies for a rebate.

disconnection was required from 2011 as Ofwat deemed partial or area based fees too costly to assess for housing. Wessex Water is an exception, as a rebate is granted if 'the majority' of SWD is disconnected – this is not qualified in the public information, but the response to the FoI request stated >50%.

In 2023/4 W&SC average bills were £473/yr of which SWD fees averaged £46/yr (Table 1). In comparison, costs for installation of a soakaway start from £750-1000 for a basic installation (easy access, no paving to lift etc) (Checkatrade 2023; Diygardening 2023; Homehow 2023; Myjobquote 2023). Although bills are rising steeply following the 2024 Ofwat Price Review (averaging 36% over five years), the payback period for a soakaway is likely to be a decade or more. Costs could be much reduced via a do-it-yourself install, but for properties with both front and rear elevations, two soakaways may be needed to meet the full disconnection requirement, increasing cost. Metered customers trying to reduce their bills may thus find water conservation measures (e.g. tap aerators costing just a few pounds) an easier and more attractive option than attempting 100% SWD disconnection.

Incentivising SuDS retrofit

The need to incentivise retrofit

Against a background of creeping urbanisation and climate change, there is high confidence the UK will experience growing risk of pluvial flooding (Miller and Hutchins 2017). This, and high public interest in CSOs, has added to the imperative to reduce urban stormwater runoff, resulting in the national SODRP. With respect to housing, W&SCs offer a discount (of £25-£598) on the drainage infrastructure fee to developers not connecting to sewer (Ofwat 2022), whilst the implementation of Schedule 3 of the Flood and Water Act 2010, expected in 2025, will require all new housing of two or more dwellings to use SuDS. These are welcome initiatives, yet only address new build and not the drainage problems associated with existing buildings, where SuDS retrofit is needed.

In England, 8.7% of land is developed (mostly buildings, transport, and utilities) with another 4.9% as residential gardens (the commonest use after agriculture, and forestry/open land); residential buildings comprise 1.3% of all land nationally (DLUHC 2022). These figures reveal the significance of domestic gardens and indicate significant potential to disconnect stormwater from sewers through domestic scale SuDS retrofit. However, loss of garden space is common, particularly through paving for off-street car parking. Kelly (2018) cites a 2006 RHS study that found that nationally 28% of front gardens had at least 75% of the area replaced with impermeable paving. Following Pitt's review, planning permission was required for new or replacement paving of $\geq 5 \text{ m}^2$ not draining to a permeable area, but this regulation is difficult to enforce and does not address garden space already lost.

Partial disconnection

There is then, a need to incentivise domestic scale SuDS retrofit. Pitt and Walker both intended to drive retrofit by making the SWD fee transparent on utility bills, but in

practice, SWD rebates are uncommon, with most probably awarded for bill corrections. A better incentive would be to drop the requirement for 100% SWD disconnection to qualify for the rebate. Area-based charging is consistent with the polluter pays and 'rectification at source' environmental principles, recently reaffirmed by government (Defra 2023b), and operates in the non-household sector. It is also a widespread practice in other countries that charge household stormwater fees, so it is feasible (Tasca et al., 2018). The sliding fee scale recommended by Walker (Walker 2009, 106) may be more costly to administer for households, but it is notable that one W&SC (servicing c. 1.3 million households) does offer a rebate for partial disconnection (Table 5). Thus, a dwelling that can disconnect all roof runoff, but not an area of hardstanding can still qualify for the rebate, and so may disconnect what they can.

'Slow the flow' devices

The SODRP emphasises 'we all have a role to play' in reducing storm discharges and that householders should be incentivised to install SuDS; it even suggests (Defra 2023a, 26) W&SCs be given rights to install SuDS on private land. W&SCs accept disconnection via any means, but in communication with householders on the rebate, emphasise the soakaway and conveyance to a watercourse (Table 5). Conveyance may be inferior to onsite infiltration (if it adds to fluvial flood risk) and is disconnection more likely to be associated with bill correction than new SuDS retrofit. For retrofit, the soakaway is the main SuDS device advocated by W&SCs. However, if partial disconnection is allowed for the SWD rebate, a wider range of 'slow the flow' devices become viable, and which may give added benefits to householders. For example, stormwater planters offer visual and amenity value, but are currently unacceptable in SWD rebate terms, as small returns to sewer may occur for large storms. Similarly, disallowed are smart water butts; these empty in advance of a forecast storm to create detention capacity and benefit householders by reducing potable water use in garden watering (Devenish 2022; Sefton et al. 2022). W&SCs are trialling smart butts with customers (Southern water 2023; United Utilities 2023), but there is no indication that adopting customers will qualify for a SWD rebate.

W&SCs could also actively explain that different types of soakaway are possible in a domestic setting. For example, no current guidance identifies disconnection of driveway runoff via a peripheral infiltration strip, or that infiltration can be achieved via a 'rain garden' which has amenity value not offered with a conventional soakaway. It is ironic that the SODRP (Defra 2023a, 48) models domestic SuDS retrofit scenarios based around storm planters, raingardens, and water butts, yet none of these devices are eligible for a SWD rebate, hence rebates will not incentivise their adoption. W&SCs could also promote SuDS retrofit opportunities to householders when they are undertaking other works, such as garden remodelling or building an extension.

Where W&SCs actively promote environmental measures, as they do in water demand management, businesses develop supporting services and products (e.g. tap inserts to grey-water recycling systems). There has been considerable innovation in SWD control, yet the domestic SuDS retrofit market is immature, receiving little promotion from W&SCs. Rather, commercial SuDS retrofit services (e.g. H20 Building Services, n.d.) focus on the non-household sector where substantial SWD fee reductions from SuDS retrofit are possible. Overall, there is a need for active promotion of household SWD disconnection opportunities and the multiple benefits of retrofit. The range of benefits possible means a wider range of institutions have a role to play in retrofit (e.g. Environment Agency, Local Authorities, Consumer Council for Water), but the SWD rebate means that W&SCs are best placed to take a central role in promoting SuDS retrofit to households.

W&SC revenue

W&SCs provide sufficient information to enable households to reclaim the SWD fee where the property is disconnected and will apply a rebate where they learn a fee is not due (e.g. to all flats in a block, following a successful rebate application from a flat in that block). Nevertheless, W&SCs do not actively promote the rebate, probably over concerns of revenue loss. Post privatisation, water industry borrowing to finance investment is £60Bn, whilst the industry also carries a burden of unpaid bills (c.3.2% of revenue; PWC 2017) as customer water supply cannot be cut off. Thus, W&SCs will be reluctant to lose SWD fees, which given industry averages (Table 1) represent about 10% of annual revenue or over £1Bn per year.

W&SCs have been permitted to raise prices by an average 36% over the next five years, but most are appealing, claiming still higher fee increases are necessary to fund required investments (Guardian 2025). Companies will then be cautious about measures that erode revenue without compensatory benefits. Because problems of SWD are geographically localised, companywide promotion of SuDS retrofit via the rebate could reduce revenue with little flood/CSO reduction benefit. Water companies invest in companywide water efficiency schemes (e.g. providing free/ subsidised water efficiency devices) but the networked nature of water supply means the benefits of water conservation are companywide and immediate. This is not the case with SWD, so W&SCs could promote the rebate where SuDS retrofit is most needed, in return for Ofwat's permission to raise the SWD fee by a compensatory amount (the SODRP identifies priority areas such as designated bathing waters and ecological conservation sites). Higher SWD fees, and more active promotion of disconnection, might also have a spill-over benefit of incentivising disconnection more widely.

Conclusion and recommendations

As with many countries, the UK experiences problems from stormwater discharges that could be mitigated by disconnecting existing built surfaces from sewer. UK government reviews of flooding (Pitt 2008) and household water service charges (Walker 2009) recommended making SWD fees explicit and rebating them on a sliding scale proportionate to disconnection, to incentivise SuDS retrofit. Bills did become transparent, but the sliding scale was rejected by the industry regulator fearing it would deter households from fully disconnecting, hence all but one W&SC in England and Wales requires 100% disconnection from sewer to qualify for the rebate. Data obtained from W&SCs using freedom of information laws provides no evidence that this approach has incentivised disconnection, with rebates going to households seeking a bill correction (as their SWD was never connected to sewer). Even if it were generously assumed that all such rebates were granted for SuDS retrofit, the very low rate (0.12–0.15% households per year) means it would take until 2100 to disconnect another 10% of the existing housing stock.

Via bill corrections, the SWD rebate applies the polluter pays principle, and so supports the important principle of fairness in stormwater drainage (Arik 2024; Baghersad et al. 2024). However, the rebate has failed to incentivise SuDS retrofit as intended. W&SCs do provide clear, accessible guidance on applying for a SWD rebate, but do not actively promote it, probably fearing revenue loss. Furthermore, the soakaway is the only qualifying device to feature in guidance (excepting conveyance to a watercourse, a retrofit option available to few dwellings). The installation cost for a soakaway is high relative to the SWD rebate, and households aiming to reduce water bills will likely find water conservation measures easier.

To better incentivise household stormwater disconnection through the SWD rebate, it is recommended to:

- Reward partial disconnection. The requirement to eliminate all SWD to sewer to qualify for a rebate is too demanding and should be relaxed to incentivise disconnection. One W&SC does reward partial (>50%) disconnection, whilst charging based on percentage impermeable area is feasible and common practice in other countries charging for SWD (Tasca *et al.*, 2018).
- (2) Accept and promote a wider range of SuDS devices. The expectation to install soakaways to qualify for the rebate is too restrictive. Stormwater planters, rain gardens, smart water butts and other 'slow the flow' devices should be accepted too, as should filter strips peripheral to driveways and patios. Rebates should be actively promoted alongside supporting measures such as grants and education (Godyn *et al.*, 2022).
- (3) Focus SWD rebate promotion geographically. Promoting the SWD rebate in priority areas (e.g. with bathing waters or ecologically sensitive sites) will help achieve required critical mass in disconnection. Assessments are needed so that W&SCs know tipping points where SWD revenue loss is offset by reduced SWD costs (e.g. CSO incidence).
- (4) Compensate W&SCs for net revenue losses. Through the regulatory Price Review higher SWD fees overall can compensate W&SCs for any net (noting 3 above) losses arising from awarding SWD rebates. Promotion of SuDS/fee rebate and a higher SWD fee that accepts partial disconnection can act as further incentivise beyond priority areas.
- (5) Report SWD rebate statistics to the industry regulator. These should comprise customer contacts re SWD, completed rebate applications, and rebates awarded. Statistics should differentiate bill corrections from new retrofit to support 3 and 4 above.

The practice of charging fees for stormwater drainage is growing internationally as municipalities increasingly seek to finance stormwater management programmes in an efficient and equitable manner (Tasca et al., 2018; Arik 2024). In some municipalities (notably in the USA) fee reductions are available, but the effect on SWD disconnection is not generally reported. In England and Wales, where explicit stormwater fees have been charged since 2011, the fee rebate has promoted fairness by removing charges for households with no drainage to storm sewer but has failed to incentivise disconnection.

Research is needed to understand this lack of household disconnection, but cost is very likely to be a barrier, as it has been for public buildings when the intangible benefits of GI are overlooked (Oladunjoye,

Proverbs, and Xiao 2022). Fee rebates should therefore be awarded for partial disconnection, making installation more economically viable (Godyń 2022). Drainage service providers should also apply rebates in conjunction with other measures that encourage disconnection (Wilkerson, Romanenko, and Barton 2022). These may include awards for GI installation (which have been shown to increase property values), and particularly cost sharing via grants and reimbursements (Godyń, Muszyński, and Grela 2022; Newburn and Alberini 2016; WEF (2013)). Focussing incentives in priority disconnection areas is also suggested to tackle stormwater problems more cost-effectively. Evidence from Norway and the USA (Shuster et al. 2013; Thurston et al. 2010; Wilkerson, Romanenko, and Barton 2022) indicates that doing this via reverse stormwater auctions, where households bid to participate in disconnection programmes, can deliver higher adoption at lower overall cost to the drainage authority, whilst also growing broader householder awareness of SuDS retrofit needs and opportunities.

The study of England and Wales reveals that a SWD fee rebate that is low in value, hard to qualify for (100% disconnection required) and not actively promoted, will not motivate household SuDS retrofit. However, whilst further experimentation is needed, international experience suggests that SWD fee rebates applied within a more sophisticated incentive structure, and actively promoted, do have the potential to motivate household disconnection.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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