

This spreadsheet accompanies the report The Potential of Food Waste Disposer Units to Reduce Cost: A Literature Review. It should be read in conjunction with the Report. The tab entitled 'Literature Summary' contains the details of all 95 pieces of literature reviewed and deemed relevant for the report. A glossary of terms used can be found in the third tab.

Column Title	Explanation
Title	The title, authors and relevant journal or page numbers of the literature.
Date	The date the literature was published
Summary	A summary of the key findings or authors notes, or points of relevant interest.
Measured/ Observed Impact of FWD	Each piece of literature reviews a different set of impacts, some are measured in a laboratory or real-life trials, others are observed. Each was classed as positive, negative, neutral or N/A. For full definitions of these terms, please see the report.
Type of literature	Primary, secondary, desktop study, article, position paper or promotional literature. For definitions, please see the report.
Study Area	The geographic area covered by the literature.
Commissioning/ Funding Body	Where a funding or commissioning body is made clear, this information is included.

This report is not intended to summarise each piece of literature reviewed, but to present an overview of the evidence and opinions that are stated within the literature. It is also not intended to differentiate between the different impacts measured, but rather to summarise the conclusions of the research.

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The Potential of Food Waste Disposer Units to Reduce Cost: A Literature Review

Title	Date	Summary	Measured/Observed Impact of FWD	Type of literature	Study Area	Commissioning/ Funding Body
Atwater, R.M. (1947) The Kitchen Garbage Grinder. Editorial Amer. J. Public Health 37 573-574	1947	Reviewing the first 10 years' experience of FWD (300 municipalities) and found that engineers' apprehensions were unfounded. Will increase water use, solid and BOD content, which will increase cost, but believes these will largely be offset by reduced waste costs. Sewage with ground solids 'settles better'	Positive	Desktop study		
Poole, B. A. and Erganian G. K. (1951) Public Health Benefits from the Disposal of Garbage in Sewers. Amer. J. Public Health (1951) 41 1106-1111	1951	Reviewed experience when 800 of 1200 homes had installed FWD. "research has generally satisfied engineers that a sewer system adequately designed would not be adversely affected by ground garbage; the installation of hundreds of thousands of garbage disposal units testifies to the fact that these units can be built to meet the exacting standards demanded by America's housewives." 24 hour surveys undertaken of sewers and sewage and no adverse problems reported. BOD and suspended solids greater as expected, but not found to be a problem. "New WwTW built at same time as FWD rollout and all surveys in this report done within 12 months of FWD rollout.	Positive	Primary Research	Indiana, USA	
Ligman, K.; Hutzler, N.; Boyle, W.C. (1974) Household wastewater characterization. Journal of the Environmental Engineering Division. 201-213	1974	Small samples of no more than 40 hh, rural and urban. All apartments and 50% of urban hh had FWD. FWD had lower water use than other activities (dishwashing, toilet, shower etc.) but higher BOD and suspended solids.	Neutral	Primary Research	Wisconsin, USA	
Thackray, J.E.; Cocker, V.; Archbald, G. (1978) The Malvern and Mansfield studies of domestic water usage. Proc. Inst. Civ. Eng. (1978) 37-61 and discussion 483-502	1978	Water use. Too little water use with FWD when compared with other areas to register	Neutral	Primary Research	UK	Severn Trent Water Authority

Wicke, C. A. (1987) The effect of the household garbage disposer on the environment. 43pp	1987 Collates existing research up to that point, including Ketcham- 13 references. >80% FWD of hh in Los Angeles. 2-5% increase in BOD and suspended solids, but disadvantages negligible and outweighed by benefits. Chicago - problem is diapers, not FWD. No significant increase in cost related to sludge. Ban in NY due to combined sewers, but think that up to 25% FWD would not cause problems	Positive	Desktop study		InSinkErator
InSinkErator (1989) Understanding septic tank systems.	1989 Leaflet from InSinkErator	Positive	Promotional literature		InSinkErator
Jones, P. H. 1990 Kitchen garbage grinders (KGGs/food waste disposers) the effect on sewerage systems and refuse handling. Institute for Environmental Studies, University of Toronto.	1990 Literature review then Canadian study - 45 hh out of 180 participated (25%) - no detectable impact on water supply, sewage flow or quality. Increase in concentration, but decrease in flux of suspended solids, BOD and TKN. Phosphorus decreased in both concentration and flux.	Positive	Primary Research	Penetanguishene, Canada	InSinkErator
Nilsson, P.; Lilja, G.; Hallin, P.-O.; Petersson, B. A.; Johansson, J.; Pettersson, J.; Karlen, L. (1990) Waste management at the source utilizing food waste disposers in the home; a case study in the town of Staffanstorp. Dept. Environmental Engineering, University of Lund.	1990 CCTV, water use, number of starts for 100 apartments without and with FWD. 15 year lab simulation of FWD use and effect on pipes. No increase in water use. No fouling of pipes. 96% user satisfaction. Recommended FWD as option. Very comprehensive study. No blockage indoors. No deposits or obstructions in sewage pipes.	Positive	Primary Research	Staffanstorp, Sweden	Support from the REFORSK foundation and Sattens Energiverk (Swedish national energy agency)
Economic and Environmental Impacts of Disposal of Kitchen Organic Wastes using Traditional Landfill - Food Waste Disposer - Home Composting A Waste Management Research Unit - Griffith University Waste Management Research Unit - Griffith University Report Prepared for In-Sink-Erator - August 1994	1994 Gold Coast study comparing compost bins with FWD. FWDs do not present an unmanageable load on the existing sewage treatment facilities. 25% penetration = 4% increase in sludge volume.	Positive	Primary Research	Gold Coast, Australia	InSinkErator
Raunkjaer, K.; Hvitved-Jacobsen, T. and Nielsen, P.H. (1995) Transformation of organic matter in a gravity sewer. Water Environment Research, Volume 67, Number 2, 181-188	1995 Measured removal of easily degradable OM as wastewater flows through sewers but particulate OM is not affected. Doesn't mention FWD usage in the area.	N/A	Primary Research	Dronninglund, Denmark	C.W.Obel Foundation and the Danish Technical research Council
Ketzenberger, B.A. (1995) Effect of ground food wastes on the rates of scum and sludge accumulation, University of Wisconsin-Madison.	1995 Part 2 of thesis. Find increased suspended solids, BOD and FOG which will reduce soil absorption if septic tanks not emptied more frequently, but doesn't impact septic tank processes.	Neutral	Primary Research	Wisconsin, USA	InSinkErator

<p>Uitdenboger, D. E. (1995) Kitchen waste disposal treatment: an evaluation. Agricultural University, Wageningen. 27pp</p>	<p>1995 AD best option, followed by composting then FWD. Fewer pollutants released through FWD than composting, but they end up in the sludge, so problem shifts to sludge treatment. Costs for FWD will be in sewage treatment and drying of sludge. 10% of food waste being disposed of through FWD would increase sewage sludge volume by 5%.</p>	<p>Neutral</p>	<p>Secondary research</p>	<p>Netherlands</p>	<p>InSinkErator 'Principle' for the report</p>
<p>Ketzenberger, B.A. (1995) Water use by kitchen food waste disposers in households. MS thesis, University of Wisconsin-Madison.</p>	<p>1995 MSc thesis, Part1. Metered kitchens in staff members' housing to measure water use, starts etc.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>Wisconsin, USA</p>	<p>InSinkErator</p>
<p>Koning, J. de and Graaf, J.H.J.M. van der (1996) Kitchen food waste disposers, effects on sewer system and wastewater treatment. Technical University Delft.</p>	<p>1996 No evidence of clogging indoor or outdoor pipes even at very shallow gradients. No increase in hydraulic load and negligible effect on biological load. Increased cost per person of treatment and sludge = 0.05% of current WwTW cost. 1995 5% penetration in UK; 10% max expected penetration in Netherlands; 1995 50% penetration in US (90 areas made mandatory). No evidence in literature of any sewer blockage. Cold water in FWD congeals FOG so sewers will not be coated with grease. 5% penetration will increase average waste water flow by 0.07%. 100% penetration= 1.35% increase. Biogas increase of 17.4l/per/day. Final sludge increase of 0.13 l/per/day</p>	<p>Positive</p>	<p>Secondary research</p>	<p>Netherlands</p>	<p>InSinkErator</p>

Strutz, William.F. (1998) A brief summary and interpretation of key points, facts and conclusions of Diggelmann, Carol and Ham, Robert K. (1998) "Life-Cycle Comparison of Five Engineered Systems for Managing Food Waste." Department of Civil and Environmental Engineering, University of Wisconsin. January 1998.

1998 Summary by InSinkErator Staff Engineer of 4 year research project. "Of the five alternative food waste systems measured, a food waste disposer processing food waste through a publicly owned treatment works has the lowest cost to the municipality; the least air emissions especially greenhouse gases; converts the food WASTE to a RESOURCE which may be recycled; and as a result overall is the most environmentally friendly and sustainable option for recycling non-edible food RESOURCES.

Positive

Article

InSinkErator

The food waste disposer is also the most convenient method of disposing food waste and is most likely to be used as the vehicle for source separation of food waste from the solid waste stream."

Sludge the biggest impact. Not good for septic tanks, due to clogging of soak away. Processing cost = \$0.50/100kg food waste. FWD best option when sludge is spread on land and AD at WwTW. 50%-75% of MSW cost is in the collection. FWD would be most sustainable if non-potable water used.

<p>Karlberg, Tina and Norin, Erik, (1999) Food Waste Disposers – Effects on Wastewater Treatment Plants. A Study from the Town of Surahammar. VBB VIAK AB. Köksavfallskvarnar – effekter på avloppsreningsverk, En studie från Surahammar. VA-FORSK RAPPORT 1999-9.</p>	<p>1999 Results of first trial of FWD in apartment buildings then launch of different waste charges and Fwd. installation going from 0% to 30%. No effect on CCTV of sewers. No effect on activated sludge electricity use. Increase in biogas. Small increase in screened material. No increase in aeration of sewage. FWD energy requirement=3-4KWh/hh/yr. 2 sites, control and 32/39 FWD. Reduction in residual collections from 6 bins twice a week to 3 bins once a week (but larger sorting project across both sites). 22% claimed had some problem with FWD, mostly because of internal blockages (rectified by pipe changes e.g. elbows) and materials caught in FWD. 96% satisfaction. No difference in sewers after Yr1. WwTW no noticeable impact apart from increased gas. Concludes that case was picked because of capacity at WwTW and suitability of network, so not representative of Sweden.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>Surahammar, Sweden</p>	<p>VA - FORSK, an R&D program funded by the municipalities within Sweden</p>
<p>New York City DEP (1999) The impact of food waste disposers in combined sewer areas of New York City. http://www.nyc.gov/html/dep/html/grinders.html</p>	<p>1999 Largest field controlled study of FWD – 573 apartments with FWD in 3 locations. Ban rescinded in 1997. No adverse effect on sewers. Minimal impact on water consumption. Assumed 1% penetration a year and that after a decade there would be a relatively small (\$4.1m out of \$1.5bn current spend (1997 rates)) increase in wastewater treatment and sludge handling costs. Increase cost increase of less than 1% in water rates. If reached max penetration of 38%, waste savings of \$4m a year.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>New York, USA</p>	<p>DEP, in conjunction with the plumbing industry, representatives of FWD manufacturers and their consultants, and the Department of Sanitation</p>
<p>USEPA (2000) Onsite Wastewater Treatment Systems - Special Issues Fact Sheet 2. High-Organic-Strength Wastewaters (Including Garbage Grinders)</p>	<p>2000 Report on high concentration wastewater in septic tanks. Recommends increased emptying and need for better soak away. in-sink garbage disposal units increase septic tank loadings of BOD by 20 to 65 percent, suspended solids by 40 to 90 percent, and fats, oils, and grease by 70 to 150 percent.</p>	<p>Negative</p>	<p>Desktop study</p>	<p>USA</p>	<p>Environmental Protection Agency</p>
<p>Galil, Noah L. and Yaacov, Lila (2000) Integrated solid waste systems including domestic garbage disposers. 5th European Biosolids & Organic Residuals Conference</p>	<p>2000 LCA of FWD is good compared with other options. Penetration of >60% may cause 50%-70% increase in biogas, 23-27% increase in treatment cost and 26-30% increase in maintenance cost. Waste volumes fall by 3.3-18.7%.</p>	<p>Neutral</p>	<p>Secondary research</p>	<p>Israel</p>	

<p>Wainberg, R.; Nielsen, J.; Lundie, S.; Peters, G.; Ashbolt, N.; Russell, D.; and Jankelson, C. (2000) Assessment of food disposal options in multi-unit dwellings in Sydney. CRC for Waste Management and Pollution Control Limited. Report 2883R</p>	<p>2000 5 different studies, including lab studies, LCA and cost-benefit. LCA of FWD is good compared with other options and centralised composting is poor. FOG, BOD will not cause operational sewer problems up to 15% penetration. Increase in sewage flows are very small (less than 0.1% increase in Instantaneous Maximum Flow at 50% penetration). LCA said home composting was best, FWD second, followed by co-disposal and centralised composting. FWD most expensive, home composting cheapest. Cost most significant above 25% penetration as capital investment in treatment needed.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>Sydney, Australia</p>	<p>InSinkErator</p>
<p>MAEJIMA KEN (2001) The Trend of Drainage Technology(3). Food Waste Grinder Drainage Systems. Kuki Chowa, Eisei Kogaku 75;NO.3; 207-212</p>	<p>2001 Author abstract which doesn't give results of studies and isn't clear on country viewpoint, other than there are existing regulations that need to be complied with.</p>	<p>N/A</p>	<p>Primary Research</p>	<p>Japan</p>	
<p>Rosenwinkel, K.-H. and Wendler D. (2001) Influences on the anaerobic sludge treatment by co-digestion. IWA, "Sludge management entering the 3rd millennium. Taipei, Taiwan</p>	<p>2001 Concludes that FWD should only go to cities with separate sewerage system, in good condition, with minimum gradient of at least 2%, to WwTW with AD. 30-50% increase in final sludge, 90-100% increase in biogas. Approves of FWD subject to conditions, but reminds that primary function of WwTW is to clean water and therefore recommends monitoring.</p>	<p>Neutral</p>	<p>Desktop study</p>	<p>Germany</p>	
<p>Galil, N. and Shpiner, R. J. (2001) Additional pollutants and deposition potential from garbage disposers. CIWEM 15 34-39</p>	<p>2001 Ground particles should not cause blockages in gravitational sewers of normal design. Heavy materials such as eggs shells and bones could. Faster rotation and smaller particle size from FWD will cause least problems.</p>	<p>Neutral</p>	<p>Secondary research</p>	<p>Israel</p>	
<p>Galil, N.I. and Yaacov, L. (2001) Analysis of sludge management parameters resulting from the use of domestic garbage disposers. Water Sci. & Tech. (2001) 44 27-34</p>	<p>2001 60% market penetration of FWD would lead to: energy potential of biogas increase by 50%-70%; investment in WwTW increase by 23-27% and increase operating costs by 26-30%.</p>	<p>Neutral</p>	<p>Secondary research</p>	<p>Israel</p>	

<p>Karrman; Olofsson; Persson; Sander; Aberg (2001) Food waste disposers – a solution for sustainable resource management? A pre-study on Goteborg, Sweden. 6th European Biosolids & Organic Residuals Conference</p>	<p>2001 Swedish material flow analysis comparing FWD with separate food waste collection and composting.. Positive environmental impact. Negative in terms of potential discharges of pollutant to water. FWD "three times less global warming than composting', generates more energy than consumed, 10% in sludge production for 50% pen. FWD negative is discharge of pollutants to water. FWD more expensive than composting if the state pays, less expensive if the hh pays for purchase and installation.</p>	<p>Neutral</p>	<p>Secondary research Goteborg, Sweden</p>	<p>Recycling Board of Goteborg, Swedish Water and Wastewater Association, Swedish Association of Waste Management, Sustainable Urban Water Management</p>
<p>Kegebein, Jörg; Hoffmann, Erhard; and Hahn, Herman H. (2001) Co-Transport and Co-Reuse. An Alternative to Separate Bio-Waste Collection? Wasser-Abwasser GWF 142 (2001) Nr. 6 429-434 Unione Imprese Difesa Ambiente – “Environmental Defense Initiatives Union” (2002) Food waste disposers</p>	<p>2001 Lab tests in Germany. Particle size distribution of FWD output of cafeteria waste and mixes of foods, also biogas yield. Settling more likely to happen on sides than bottom. No problem with normal water flows.</p>	<p>Positive</p>	<p>Primary Research Germany</p>	<p>Prepared by the ANIMA Federation, Federation of the Italian Associations of Mechanical and Engineering Industries</p>
<p>Jun'ya, T.; Hiroyuki, K.; Hiroyasu, S. and Takashi, M. (2003) Environmental impact assessment of introduction of the garbage grinder in Tokyo. Proceedings of Annual Meeting of Environmental Systems Research. 31 159-166</p>	<p>2003 Environmental impacts of the introduction of the garbage grinder in Tokyo were calculated in terms of total CO2 emission and energy consumption in the sewer system and the waste treatment system, and BOD discharge from the sewer system. Two types of garbage grinders were considered: grinders with and without biological treatment facilities before discharging the ground garbage into the sewer. The following two sewage flow conditions were compared: the flow condition at the present time and that after the CSO control project of Tokyo is completed. It was implied that intensive use of garbage grinder is acceptable only when effective use of organic matters in the sewage for energy recovery is achieved together with completion of the CSO control project of Tokyo. (author abst.)</p>	<p>Neutral</p>	<p>Primary Research Japan</p>	
<p>CECED (2003) Food Waste Disposers: An integral part of the EU's future waste management strategy</p>	<p>2003 European Committee of Manufacturers of Domestic Appliances document arguing against potential ban in Bio Waste Directive.</p>	<p>Positive</p>	<p>Position paper</p>	

CIWEM (2003) Food Waste Disposers. Policy Position Statement	2003 Review of FWD by CIWEM's Wastewater Management Panel. Does not find enough evidence to be against FWD.	Positive	Position paper		
Bolzonella D.; Pavan P.; Battistoni P.; Cecchi F. (2003) The Under Sink Garbage Grinder: A Friendly Technology for the Environment. Env. Tech. 24, 349-359	2003 Italian lab tests including investigating settling rates for solids in lab conditions. no blockages, cost savings, better processing at WwTW. No smells as no fermentation before sewers. Study compared lab tests with literature and found ok. FWD enhance biological nutrient removal by increasing Carbon: nutrients ratios. FWD save money. FWD don't block sewers.	Positive	Primary Research	Italy	
Gruvberger, C.; Aspegren, H.; Andersson, B.; La Cour Jansen, J.(2003) Sustainability concept for a newly built urban area in Malmö, Sweden. Water Sci. & Tech. 47, 33-39	2003 2001 Study looking at ecocycle systems in Malmo new build development. Compares source separation with FWD, shows no problem with FWD so far. FWD studies being done by Lund Uni and behaviour studies to start in 2002	Positive	Primary Research	Malmo, Sweden	
Diggelmann C. & Ham, R.K. (2003) Household food waste to wastewater or to solid waste? That is the question. Waste Management & Research 21 501 - 514	2003 Article based on authors' 1998 study. Desk based LCA study looking at 5 scenarios for food waste disposal. FWD to public sewers was joint 2nd best, along with collecting and landfilling. AD not included as collection option, or WwTW option.	Positive	Secondary research	Wisconsin, USA	Partial support received from the National Association of Plumbing-Heating-Cooling Contractors (InSinkErator is an affiliate member)
Koning J de (2004) Environmental aspects of food waste disposers. Possible advantageous effects of food waste disposers for wastewater treatment plants. Food waste disposers versus "biobak" as system for collecting food waste. Tech. Univ. Delft	2004 Report for InSinkErator that says same as Koning J de (2004)	Positive	Article	Netherlands	InSinkErator
Davis, Bob; Graham, Adele and Hearn, Kirstie (2004) Evaluation of food waste disposal units and their part in municipal waste management. 9 th CIWEM European Biosolids and Biowastes Conference	2004 Summary of evidence. "In some European countries the organic content of wastewater has dropped so low that in order to achieve BNR synthetic carbon sources are added to wastewater. The Italian Ministry of Environment has suggested to its water authorities that they provide free FWD to inhabitants in cases where there is not enough organic material arriving at treatment works."	Positive	Desktop study		

Evans, T.D. (2004) Food Waste Disposers - Water Use	2004 The question of water use arose from CIWEM's Policy Position Statement (PPS, 2002) on food waste disposers (FWD) which says: "The change in water usage associated with operation of FWD has been measured to be trivial or not significant. "David Howarth (Environment Agency, Water Resources Policy Manager, Demand Management) queried this conclusion because of the citation by Paul Herrington (1996) that water usage by FWD was 35 litres per use. The purpose of this paper is to review the source from which Herrington got his data and compare it with other studies. Looks at 12 studies and concludes that Thackray et al (1976) over-estimated water use and that it is negligible.	Positive	Desktop study		
Parex Appliances (2004) Stage Two Report	2004 Marketing study for FWD companies. Householder marketing survey. Noise not a reason for not getting one, main reason is people not seeing the need, followed by environmental concerns.	Positive	Primary Research	New Zealand	Parex Appliances (Distributor of In-Sink-Erator)
Koning J de (2004) Effects on wastewater treatment focused on additional production of biogas. Tech. Univ. Delft	2004 Dutch study on potential impact of FWD at WwTW. Concludes: The advantage of the increase in self supply in electricity partly compensates for the increase in the costs for central sludge treatment; the increase in costs per p.e. will be minimal or negligible.	Positive	Secondary research	Netherlands	In-Sink-Erator
Waste management in buildings — Code of practice. BS 5906:2005	2005 BSI standard. Includes FWD as a 'complimentary tool to methods of waste storage and collection'. Developers should consult about discharge of any wastes to sewers.	N/A	Position paper	UK	
Minami, Y. and Otsuka, M. (2005) Study On Occurrence And Influence Of Instant Positive Pressure In Model Of High-Rise Apartments: Part 1 Basic research regarding to the drainage performance evaluation to drainage stack system with food waste grinder. J. Env. Eng. (591) pp.53-60	2005 Abstract only: "It is reported that the food waste grinder drainage system was installed in 50000 houses in the 2003 year. In the drainage stack system with the food waste grinder drainage system, ground food waste accumulates near a leg joint of house drain and collides with flowing drainage water so as to generate instant positive pressure exceeding a judgment standard thereby causing seal destruction of trap. This has been regarded as a problem."	Negative	Primary Research	Japan	

Crockett, P. M. (2005) Report PPW17-05 Costs/Benefits of Utilizing Garbarators to Divert Household Organic Waste for The Regional Municipality Of Halton.	2005 Canadian report for Halton Municipality arguing against FWD. Will achieve a lower diversion rate than segregated collections and is more expensive. Concerned about using capacity at WwTW that is already full and will restrict potential of the area to grow.	Negative	Secondary research	Halton, Canada	
Lundie, S. and Peters, G.M. (2005) Life cycle assessment of food waste management options. J. Cleaner Production 13 275–286	2005 Article based on the 2000 LCA work by same authors. LCA in Sydney of composting options. Home composting came out best. FWD performed well on energy use, climate change and acidification potential, less well on eutrophication and toxicity potential.	Positive	Article	Sydney, Australia	InSinkErator and the Cooperative Research Centre for Waste Management and Pollution Control
Davis, R. D.; Graham, A. and Hearn, K. (2005) Policy document on food waste disposers. WRC, Report No.: UC6689/2	2005 WRc report for AMDEA and CESA. Summarises existing studies.	Positive	Desktop study		AMDEA, CESA
Evans, T.D. (2005) Impact Of Domestic Food Waste Disposers On Wastewater Treatment In-Sink-Erator Food Waste Management Position Paper. Facts to Consider for the Various Methods of Managing Food Waste	2005 Summary of evidence	Positive	Desktop study		InSinkErator
Legislative Assembly of the Australian Capital Territory (2005) Water and sewerage amendment regulation.	2005 Industry summary showing FWD to be the best option.	Positive	Position paper		InSinkErator
Browne, P. (2005) Food Waste Disposers as a means of waste diversion from landfill. Report to County Surveyors Society Waste Committee 22 November 2005	2005 Ban on FWD rescinded. Was in place to save water, but found the impact of FWD is negligible.	Positive	Position paper	Australian Capital Territory	
Marashlian, N. & El-Fadel, M. (2005) The effect of food waste disposers on municipal waste and wastewater management. Waste Manage Res 2005: 23: 20–31	2005 Report by Head of Waste and Passenger Transport Mgt at Worcestershire CC for CSSWC. Estimates 50% penetration would decrease MSW to 15% of current level in 10 years.	Positive	Primary Research	Hereford & Worcestershire	
	2005 Lab tests in Beirut. Total food in MSW falls from 63% to 58% with 25% penetration. Increase in water ranges from 0.72% to 2.35%. Few concerns about sewer blocking, but is area specific. Overall, net economic benefit of between 7.2 and 44%, depending on penetration and cost of MSW disposal.	Positive	Primary Research	Beirut, Lebanon	

<p>Report on Social Experiment of Garbage Grinder Introduction. Technical note of National Institute for Land and Infrastructure Management, Japan. No. 226 March 2005</p>	<p>2005 80% of participants wanted to use FWD after trial. 7litre/kg food waste. 2.3 uses per day. No deposits in external sewers. Level of deposits found in culverts (mainly eggshells) was 1.3 to 3 times greater. Deposits considered minor as limited blockages as a consequence. No difference in n-Hex in sewers. Increase in BOD and sludge, but no discernible increase in influent. Popularization of FWD would not increase environmental burdens. Overall cost saving when compared to current incineration solution. Results from first field trial in Japan. 301 FWD installed over 3 years. From 200 to 2004, 12 reports of blogged discharge traps (S traps), 4 of blocked house drains and 19 of disposer failure. Survey showed about 40% had some clogging of pipes, 80% said kitchen hygiene was improved, 70% were 'very' or 'fairly' bothered by noise and vibration.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>Japan</p>	<p>Edited by InSinkErator</p>
<p>Pernilla Tidåker, P.; Kärrman, E.; Baky, A.; Jönsson, H. (2005) Wastewater Management Integrated with Farming - An Environmental Systems Analysis of the Model City Surahammar. Department of Biometry and Engineering, Uppsala</p>	<p>2005 Looked at agricultural impacts of sludge and blackwater treatment. Relevant comment for FWD:"This means that installation of food waste disposers only had a minor influence on the environmental impact categories studied."</p>	<p>Positive</p>	<p>Secondary research</p>	<p>Surahammar, Sweden</p>	<p>MISTRA</p>
<p>Ayako, Y.; Hiroki, Y.; Hiroaki, M.; Toshiaki, Y.; Masahiro, T. (2006) Garbage Grinder's Use and Pollution Loads in Hotel's Kitchen in Utanobori Town, Hokkaido. J. Japan Sewage Works Association.43 116-126</p>	<p>2006 Abstract only on hotel FWD, showing larger impact</p>	<p>N/A</p>	<p>Primary Research</p>	<p>Japan</p>	
<p>Basic research regarding the evaluation of the horizontal pipe's performance to carry waste water contain food waste disposed of using a food waste grinder. Part 2: Examination on carrying performance in house drain. Journal of Environmental Engineering, Vol 603. pp85-91</p>	<p>2006 Abstract only, no results</p>	<p>N/A</p>	<p>Primary Research</p>	<p>Japan</p>	
<p>Is it OK to use a food waste disposer? Leo Hickman's guide to a good life. Guardian 8th August 2006</p>	<p>2006 Newspaper column. Opinion piece.</p>	<p>Positive</p>	<p>Article</p>		

<p>Tidåker, P.; Kärrman, E.; Baky, A.; Jönsson, H. (2006) Wastewater management integrated with farming –an environmental systems analysis of a Swedish country town. Resources, Conservation and Recycling 47 295–315</p>	<p>2006 Article based on 2005 work by same authors. LCA of wastewater system, including agricultural production (displacing mineral fertilisers). Based on Surahammar, with FWD as 'control', separate collection and usual WwTW as 2nd option, and FWD and blackwater as 3rd. Reduced mineral fertilisers in blackwater example were cancelled out by increased infrastructure and need for transport. Yields also impacted by soil compaction. But less eutrophication than FWD. "Not assessing FWD, but phosphate recycling. However, "No significant difference in environmental impact appeared when the existing disposer system and the sludge utilisation system were compared. This means that installation of food waste disposers only had a minor influence on the environmental impact categories studied."</p>	<p>Positive</p>	<p>Article</p>	<p>Surahammar, Sweden</p>	<p>MISTRA</p>
<p>Kegebein, J. (2006) PhD summary FWD Uni of Karlsruhe</p>	<p>2006 PhD summary, only abstract in English. Only looked at separate sewers, not combined. In case of separate sewers, no evidence of increased rats, poss. increase in maintenance, FWD more expensive than collection due to cost of FWD, but if this borne by householder, than savings for authority. LCA shows better than composting and less good than AD.</p>	<p>Positive</p>	<p>Primary Research</p>	<p>Germany</p>	
<p>Malmqvist, P-A.; Heinicke, G. (2006) Strategic planning of the sustainable future wastewater and bio waste system in Göteborg, Sweden. Proc. Cities of the Future: Urban Sustainability and Water. IWA World Water Congress, Beijing</p>	<p>2006 Swedish strategic study looking at bio waste and wastewater planning in Goteburg. FWD was 1 of 4 (out of 8) options that was considered 'equally sustainable'. The others were; food collections to AD, nutrients extracted at WwTW, and incineration with ashes going to land. From a long-term environmental point of view, including nutrient lock-in. Results were weighted to take account of politics and public attitudes.</p>	<p>Positive</p>	<p>Secondary research</p>	<p>Goteborg, Sweden</p>	<p>MISTRA</p>
<p>Food waste disposers: part of the solution or the problem? Materials Recycling Week November 9 2007 16-17</p>	<p>2007 MRW article arguing for and against</p>	<p>Neutral</p>	<p>Article</p>		
<p>LARAC National and Regional Feedback Sheet from 'Sink Macerators - A Solution to Food Waste' event. October 2007</p>	<p>2007 Arguments for and against FWD.</p>	<p>Neutral</p>	<p>Article</p>	<p>UK</p>	

Davidsson, Å.; la Cour Jansen, J.; Appelqvist, B.; Gruvberger, C.; Hallmer, M. (2007) Anaerobic digestion potential of urban organic waste: a case study in Malmö. Waste Manage Res 25: 162–169	2007 Swedish study looking at AD potential for sewage and food wastes. FWD gives higher gas yield at mesophilic, but source-sep gives higher at thermophilic, where FWD not stable. Issues around stability of AD depending on the base substrate and mix of materials.	Neutral	Primary Research	Malmö, Sweden	Oforsk, the committee for Science and Research in the Oresund Region and the Danish Ministry of Science, Technology and Innovation
Androulla Constantinou. MSc Dissertation 2007. The Impact of Household Food Waste Disposal Units on the Water Industry. Imperial College.	2007 Desktop study calculating hypothetical increased FWD uptake in Anglia Water region. Shows increased water use, wastewater flow, BOD and COD, ammonia and phosphorous and sludge production. Concludes this will increase costs of primary treatment and sludge disposal by 5.15% between 2006 and 2035 in best case and 30.4% in worst case. Concludes that it depends on sewer network, cost-benefit of alternatives and impact on behaviour. Cost transfer issue needs to be sorted.	Neutral	Secondary research	UK	
Battistoni, P.; Fatone, F.; Passacantando, D.; Bolzonella, D. (2007) Application of food waste disposers and alternate cycles process in small-decentralized towns: A case study. Water Research 41 893 – 903	2007 Measured effect of FWD in village in Italy. 67% equivalent market penetration. Improved wastewater treatment; more cost effective over 4-5 years than source separate collections due to rural nature of area, no adverse impacts on sewer network.	Positive	Primary Research	Italy	Gagliole Municipality and the COSMARI public utility
2007 “Systemstudie Avlopp” future sustainable sewage systems - Gothenburg- English summary.doc	2007 Sustainable future sewage systems in Gothenburg, weighted for importance, main factor being nutrient recycling. Blackwater bottom. FWD joint top with phosphorus extraction and AD. Looking more at nutrient recycling, so food waste isn't as important as blackwater. However no issues raised with FWD.	Positive	Secondary research	Gothenburg, Sweden	Recycling Committee, Gothenburg Water and Sewage Administration, Gryaab (a regional sewage works)
Evans, T.D. (2007) Environmental Impact Study of Food Waste Disposers: a report for The County Surveyors' Society & Herefordshire Council and Worcestershire County Council, published by Worcestershire County Council.	2007 Presentation of H&W study and international research. Shows good carbon footprint, cost savings and no recorded negative impact on sewer network.	Positive	Secondary research	Hereford & Worcestershire	The County Surveyors' Society
Evans, T.D. (2007) Environmental impact study of food waste disposers. for the County Surveyors' Society & Herefordshire Council and Worcestershire County Council	2007 Financial and GWP implications of different options for food waste, shows FWD to have lower CO2e impact and be more cost effective	Positive	Secondary research		The County Surveyors' Society

Lawton, M. (2007) Food Waste Disposal Options Study. Braidwood Research and Consulting Ltd.	2007	Looked at whether FWD should be banned on new housing development; concluded no. No evidence that blocked sewers or were worse than other options, esp. when compared to existing situation - going to landfill as MSW. Many drivers, some misinformation. FWD makes sense where sewage system is modern, well-designed and operated, adequate WwTW, AD and useful use of digestate. Do not use where history of blockages. Home composting best option. Shortage of data about FWD.	Positive	Secondary research	New Zealand	Hobsonville Land Company
EPA Strive Report Series No 11: Examining the Use of Food Waste Disposers	2008	Desktop study looking at international literature and local situation in Ireland. Concludes that existing WwTW do not have capacity, that CSOs are used too frequently, that FWD does not promote source separation, or waste hierarchy, or waste prevention, or polluter pays principle; states that cost burden will be passed on to all water users, regardless of FWD use. Recommends regulatory controls based on local area and by-laws to restrict FWD use at both waste and water level. Irish WwTW do not have capacity or capability to take extra loads (11% structural failed, 13% mechanically failed, 28% under-capacity, <30% of plants serving <15k pop met effluent standards.)	Negative	Secondary research	Ireland	Irish Government under the National Development Plan
Market Transformation Programme (2008) BNXS43: Food Waste Disposers – an overview	2008	Desktop study looking at impact of FWD in terms of water, energy and waste reduction. Does not consider impact on sewer network.	Neutral	Desktop study		Defra's Market Transformation Programme
Down the drain. WRAP study. March 2008	2008	Research on amount of food waste going down sinks. Estimates it's currently 1.8m tonnes, approx. 1.5m of that is avoidable. Can't quantify impact of macerators as sample size of homes with them too small in this study	Neutral	Primary Research	UK	WRAP
Gustafsson, A. (2008) Slopad avgift för avfallskvarn. Svenska Dagbladet 1 September 2008	2008	Article stating that Stockholm Water wants to scrap annual FWD fee to incentivise use	Positive	Article	Stockholm	
Ulfves, V; Cocks, J. and Evans, T. (2008) Food Waste Management in New Zealand. Report for Parex Industries Ltd. MWH New Zealand Limited	2008	Report for Parex Industries in New Zealand (InSinkErator distributor) to explore potential for FWD and issues. Concludes is viable if AD used at WwTW and need for BNR. But home composting best option.	Positive	Desktop study		Parex Industries LT (Distributor of InSinkErator)

Tendaj, M.; Snith, Å; von Scherling, M.; Hellström, M.; Mossakowska, A. and Millers-Dalsjö, D. (2008) Kitchen Disposal Units (KDU) in Stockholm. Stockholm Water's pre-study on the preconditions, options and consequences of introducing KDU in households in Stockholm. Stockholm Water	2008 Very comprehensive study for Stockholm Water evaluating current position of FWD ban. Concludes changing to allow them under permitting system, so they only go where sewer network can cope and up to certain penetration level. Only looks at public network, not individual households; says one WwTW will not work due to nitrogen removal, but for other will improve. Slight increase in biogas production. Negligible increase in water use.	Positive	Primary Research	Stockholm, Sweden	Stockholm Water
Town of Banff (2008) Composting Trial. Participate in Banff's new organics composting effort	2008 Copy of website page promoting doorstep food waste collection or use of FWD, which were previously discouraged, but now ok due to upgraded WwTW.	Positive	Promotional literature	Banff, Canada	
Cassirer, T; Luthman, T.; Safi, I.; Svanmo, J. and Talebi, Z.S. (2008) Waste disposers - A viable option for increasing biogas production at Käppala WWTP? Project Report Chemical Engineering KTH Chemical Engineering Högskoleingenjörsutbildningen	2008 Swedish study investigating potential to increase biogas yield at Kappala plant by introducing FWD. Plant has 20% over-capacity, no need for increased pumping power, marginal increase in energy in WwTW processes, no other problems at plant. Increased biogas yield of 7m ³ /person/yr. Largest cost is FWD itself, payback over 1-5 yr. depending on supplier. FWD considered most env-friendly option. Main risk is in pipes with 90degree bends and sewer with history of overflow. Calculations all based on Kappala system, which is large and has constant flow. Net economic gain at WwTW.	Positive	Secondary research	Kappala, Sweden	
MEL Research North East Public Sector Food Waste Research Project. A Study of Public Sector Food Waste Arisings and Processing Options within the North East Region ORGANICS PROJECT PHASE 2 2009-10 p38	2009 Research on organic waste arisings in public sector buildings in NE. Found that the one prison surveyed and 67% of hospitals surveyed used FWD.	N/A	Primary Research	UK	RENEW, the Environment Agency, NISP, John WarrenABP Limited and Eric Evans of Bio Recycling Solutions
Water UK Position Paper on Macerators, Feb 2009	2009 Macerators are not BPEO, use large volumes of water, undermine waste reduction messages, put unnecessary load on sewer network, will cause blockages and flood incidents. Includes the problems of macerators used for care home and hospital sanitary wastes and flushable products. Concerned about FOG and other debris.	Negative	Position paper	UK	Water UK
Butler, L. (2009) Food waste disposers under the spotlight. The Loop	2009 Loop magazine with opinion pieces and articles for and against FWD.	Neutral	Article		

Tulloch, J. (2009) Waste Not, Want Not: How Malmö Recycles Waste	2009 Article on Malmo's waste. Mentions the use of FWD as one of the tools	Neutral	Article	Malmo, Sweden	
Phil Mills, Speech at Cranfield University "FOGs build up and removal: problems and solutions", 24 March 2010	2010 FOG leads to sewer blockages. FWD can contribute to sewer abuse.	Negative	Article		
Birmingham City Council, Total Waste Strategy 2010	2010 Reviewed literature, found not enough evidence to be conclusive either way	Neutral	Desktop study		Birmingham City Council
Defra. WRc National Food Waste Programme. Comparison of the Sustainability of Food Waste Disposal Options. Dec 2010	2010 Greenhouse gas emissions lowest for kerbside with AD, highest for kerbside with IVC, FWD in the middle. Financial cost highest for FWD, lowest for kerbside with AD, IVC in middle. "The differences observed between the options considered were within the range of uncertainty in these estimates. Within the recognised limitations of this modelling approach the following conclusions can, however, be drawn;"	Neutral	Secondary research	UK	UKWIR, Defra
Better by design - Enabling Londoners to boost recycling in the home through new technologies. Outcomes report from LSX Executive lunch. Dec 2010	2010 Explores new tech, including FWD, which AMDEA promote. Call for better awareness and joined up work between councils, water companies and private business	Positive	Article	UK	AMDEA, Energise London, Food Waste Disposer Group and supported by London Councils
Brachman, S.; Diggelman, C.; Gitter, M. and Keleman, M. (2010) Final Report: Food Waste to Energy and Fertilizer. WasteCap Resource Solutions for Wisconsin Department of Natural Resources.	2010 1 yr. study looking at control, commercial FWD into sewer network and FWD into Tanks and hauled to WwTW. Concludes FWD good, no blockages in main, some issues at local pipe due to diameter, no BOD etc. problems, cost effective.	Positive	Primary Research	Milwaukee, USA	Wisconsin Department of Natural resources, In-Sink-Erator
Evans, T.D.: Andersson, P.: Wievegg, A.: Carlsson, I. (2010) Surahammar – a case study of the impacts of installing food waste disposers in fifty percent of households. Water Environ. J. 24:309-319	2010 Desktop study of WwTW data from 1995 to 2009. FWD in 50% of households: no impact on sewers, no significant change in flow, BOD or Nitrogen loading; 46% increase in biogas (P=0.01). Overall result of waste strategy was 60% reduction in waste to landfill	Positive	Primary Research	Surahammar, Sweden	InSinkErator Europe
Yang, X.; Okashiro, T.; Kuniyasu, K. and Ohmori, H. (2010) Impact of food waste disposers on the generation rate and characteristics of municipal solid waste. J. Mater. Cycles Waste Manag. 12:17–24	2010 Installed FWD and measured reduction in solid waste generated- volume reduction of 40%. No recorded impact at WwTW.	Positive	Primary Research	Japan	

Thomas, P. (2011) The effects of food waste disposers on the wastewater system: a practical study. <i>Water & Env. J.</i> 25 : 250-256	2011 Thames Water lab study of output from FWD fed with food waste accumulated by 18 volunteers. Output allowed to settle in bucket for 2 hours, ammonia, nitrogen and phosphorous all in high levels in supernatant, suggesting value will be lost during secondary treatment.	Negative	Primary Research	UK	Thames Water
Evans, T. D. (2012) Domestic food waste, the options compared (particularly food waste disposers) and their carbon and financial costs. Municipal Engineer	2011 Article summarising research in favour of FWD.	Positive	Article		Worcestershire County Council, The County Surveyors' Society, InSinkErator, Monsal, Scottish Water, Severn Trent and Yorkshire Water
AMDEA FWD Group Position Paper: The Science	2011 Runs through 10 reports over last 15 years supporting FWD.	Positive	Position paper		AMDEA
CIWEM (2011) Food waste disposers – policy position paper	2011 FWD valid tool, better than composting and incineration and as good as source sep to AD.	Positive	Position paper		CIWEM
DeOreo, W.B. et al. (2011) California Single-Family Water Use Efficiency Study. Report for California Department of Water Resources. Aquacraft, Inc. Water Engineering and Management	2011 Water use in 735 homes across 10 water agencies metered and logged. 85.6% had FWD. 49.5 l/hhd.d less water use from taps in homes with FWD, could be linked to dishwasher use. "Water agencies should not consider disposals as water wasting appliances."	Positive	Primary Research	California, USA	California Department of Water Resources
Boyle, W.C. (1985) Effect of garbage grinders on wastewater characteristics. University of Wisconsin-Madison. Project 1640 M-213	1976-1984 62 (100% FWD) +163 (45% to 93% FWD during study) households, 9 year monitoring study. "The impact of garbage grinder use on wastewater characteristics in two Wisconsin residential areas over a nine-year period was not measurable."	Positive	Primary Research	Wisconsin, USA	
Bush, E.M.MSc Dissertation (2011). The Recycling of Organics: Opportunities for Municipal Programs and a Case Study for Philadelphia. University of Pennsylvania	2011 Programs should be specific to each city. FWD are a 'smart alternative.' Minimal impact on the city's sewage system and wastewater facilities. Energy and water use negligible	Positive	Secondary research	Philadelphia, USA	
Parry, D.L. (2012) Sustainable Food Waste Evaluation - Final Report. Water Environment Research Foundation	2012 FWD economically attractive with minimal area footprint requirements, with low staff and diesel requirements. Lower carbon footprint than landfilling though higher than compost and collection schemes.	Positive	Secondary research	USA	InSinkErator

Clean Kitchen, Green Community Pilot Programme Press Release (2012). Philadelphia Streets Department

2012 Pilot programme to assess the use of FWD in the city. 100 free FWD will be installed and installation encouraged elsewhere. Volume and composition of waste tested before, during and after the pilot. A focus is made on the cleanliness of the system.

Positive

Article

Philadelphia, USA

InSinkErator are providing the FWD for the study

Kitchen Sinks Go Green, The Philadelphia Inquirer. March 24, 2012

2012 Newspaper Column. Opinions on the Philadelphia FWD pilot project

Neutral

Article

Philadelphia, USA

Iacovidou, E. et al (2012) Food waste disposal units in UK households: The need for policy intervention. Science of the Total Environment. 423:1-7

2012 FWD would lead to additional costs to water industry but savings to local authorities. Policy intervention needed, either to support FWD to produce savings for the local authority or to ban them and reduce costs to the water authorities. Currently in the Anglian region, savings to the local authority are not significant enough to cover the extra expense for the water authorities, especially considering the high water stress prevalent in the region

Neutral

Secondary research

Anglian Region, UK

	Total	Percentage
Article	15	16
Desktop study	12	13
Position paper	8	8
Primary Research	36	38
Promotional literature	2	2
Secondary research	22	23
Total	95	100

The Potential of Food Waste Disposer Units to Reduce Cost: A Literature Review

Glossary of terms used in this spreadsheet

AD	Anaerobic Digestion
BOD	Biochemical Oxygen Demand
BPEO	Best Practicable Environmental Option
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
FOG	Fats, Oils and Grease
FWD	Food Waste Disposers
GWP	Global Warming Potential
hh	Households
IVC	In-Vessel Composting
LCA	Life Cycle Assessment
MSW	Municipal Solid Waste
OM	Organic Matter
p.e.	Population equivalent
TKN	Total Kjeldahl Nitrogen
WwTW	Wastewater Treatment Works