What factors affect sustained adoption of clean water and sanitation technologies?
A Systematic Review of Literature
Protocol

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PROTOCOL

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Contents

List of abbreviations

3ie	International Initiative for Impact Evaluation
HMIC	Health Management Information Consortium (database, UK)
IBM-WASH	Integrated Behavioural Model for Water, Sanitation and Hygiene Technologies
IBSS	International Bibliography of the Social Sciences
LMIC	Lower and Middle Income Countries
MDG	Millennium Development Goal
MeSH	Medical Subject Headings (National Library of Medicine, USA)
NGO	Non-governmental organisation
RCT	Randomised controlled trial
WASH	Water, sanitation and hygiene
OECD	Organisation for Economic Co-operation and Development
DFID	Department for International Development
WSP	Water and Sanitation Programme (World Bank)

1. Background

1.1 Aims and rationale for review

Progress on expanding access to improved water and sanitation in developing countries has been mixed. According to 2012 estimates, approximately 89% of the global population had access to an improved water source [1]. This represents an increase of 13% over 1990-levels and is above the Millennium Development Goal (MDG) Target set for 2015. However, most of the countries in Sub-Saharan Africa are not on track to meet MDG targets. Only 66% of the world's population has access to improved sanitation – far below the MDG Target of 75% by the year 2015. Progress against sanitation targets has been particularly slow in Sub-Saharan Africa and South Asia [1].

It is estimated that 88% of the 1.3 million annual diarrhoea-related deaths among children under the age of five are attributable to unsafe water, sanitation, and hygiene [2, 3], and improvements in water quality, sanitation, and handwashing are associated with 17 – 48% reductions in the risk of diarrhoea among children under the age of five [4]. Impacts of inadequate water and sanitation are particularly pronounced for women and girls. Inadequate sanitation facilities may expose women to the risk of violence and finding adequate locations for open defecation can require significant time and energy resources [5]. Women and girls also bear the majority of the time and energy burden associated with fetching drinking water and may potentially increase the risk of violence and injury [6].

The provision or promotion of low-cost water, sanitation, and hygiene (WASH) technologies at the individual, household, or community-level combined with interpersonal or mass media communication on their use and maintenance is a key strategy employed for addressing these gaps in coverage, particularly in Low and Middle Income Countries (LMICs). Examples of these household-level technologies include handwashing stations to encourage handwashing with soap [7]; chlorine dispensers or chlorine tablets for point-of-use treatment of water from wells or standpipes [8, 9]; household-based water treatment with filters or chemical additives, and improved latrines [10]. These technologies require initial adoption by the intended population (including any associated behaviour change) and that this adoption is sustained over-time in order to result in health improvements. The purposes of this review are to assess the factors that influence the sustained adoption of these water, sanitation, and hygiene improvements at the individual, household, and community-level.

1.2 Definitional and conceptual issues

1.2.1 Water, sanitation, and hygiene technologies

Water, sanitation, and hygiene (WASH) technologies refers to the specific technologies, hardware, tools, or devices that support consumption of safe drinking water, effective containment and/or deactivation of human faeces, or improved handwashing practices. Specific examples include:

- Household water treatment and storage, including: filter technologies, point-of-use water treatment with chemicals additives (for example Sodium Hypochlorite-based water treatment systems), ultra-violet filtration devices, solar disinfection, modified or improved water storage containers.

- Sanitation, including: improved latrine / toilet designs, ecological sanitation technologies, child potties, sani-pads (for infant faeces disposal).

- Handwashing hardware, including: handwashing stations that include soap and water, hand sanitizers, and soapy water.

- Water supply, including: specific handpump technologies, small-scale treatment and distribution systems, rainwater harvesting interventions, protected and/or improved wells and other technologies specifically designed to improve water availability or distribution at the community or household-level.

1.2.2 Behavioural determinants

Behavioural determinants are the constellation of psychological, social, environmental, or technological factors that shape individual-level behaviours or clusters of behaviours. For the purposes of this review, these factors have been classified into three main categories:

- Contextual factors: background characteristics of the individual, setting, or location that can influence behavioural outcomes.

- Psychosocial factors: psychological, social, or cultural factors that can influence behavioural outcomes.

- Technological factors: aspects of a specific technology or device that influence its use and sustained use over time.

1.2.3 WASH Interventions

We differentiate specific technologies from the associated messaging and/or intervention activities pursued to promote their use and adoption. Interventions or behaviour change communication strategies can focus on specific technologies (such as social marketing of point-of-use water treatment methods) or specific behavioural outcomes (i.e: community-led total sanitation as a means to increase latrine construction). Interventions may target specific psychosocial factors (such as increasing knowledge regarding disease risk), contextual factors (such as financing or microcredit loans for water supply improvements), or technological factors (increasing local manufacturing capacity for sanitation components).

1.3 Research background

The majority of systematic reviews and meta-analyses related to water and sanitation technologies have focused on impact and health gains related to water, sanitation, or hygiene improvements [4, 8, 9, 11-13] and typically support the conclusion that these improvements are effective at reducing the risk of diarrhoea in children under the age of five. In addition to systematically documenting evidence of health impact, several of these studies provide compelling evidence for the need to further understand factors that determine use and adoption of improved water and sanitation technologies. Clasen et al. [8], Arnold and Colford [9] and Waddington et al. [13] all

note that intervention trials which account for intervention compliance are associated with smaller reductions in diarrhoea, highlighting the fact that the impact of water and sanitation interventions on diarrhoea is ultimately dependent on behaviour change and adoption among intended beneficiaries. Arnold and Colford [9] and Waddington et al [13] also note an inverse relationship between study duration and impact on diarrhoea.

Only a limited number of systematic reviews have examined behavioural outcomes, specifically the factors that influence the adoption and sustainability of water and sanitation technologies. Waddington et al. [13] use a diffusion-of-innovation approach to examine the limited literature on adoptions and sustained adoption water, sanitation, and hygiene interventions, and draw attention to the need for more detailed systematic process evaluations and comparisons between interventions. Fiebelkorn et al. [14] systematically reviewed behaviour change research on point-of-use water treatment interventions in LMICs, finding that few published studies provided sufficient detail on behaviour change approaches used, theoretical models were often unspecified, and suffered from methodological shortcomings.

1.4 Theoretical Grounding for Review

This systematic review will employ the forthcoming Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH) to provide theoretical grounding to our research questions as well as to guide our analysis and characterization of "factors" that may influence adoption and sustained adoption of water and sanitation technologies. The IBM-WASH framework incorporates the models of Curtis [15], Mosler [16], Figueroa and Kinkaid [17], and Coombes and Devine [18, 19] and key behaviour change theories such as the Health Belief Model [20, 21], the Theory of Reasoned Action and Theory of Planned Behaviour [22, 23], Social Cognitive Theory [24], and Roger's Diffusion of Innovation Theory [25].

The framework has three large, overlapping dimensions that mutually influence one another:

1. *Contextual factors:* factors related to the individual, setting, and/or environment that can influence behaviour change and adoption of new technologies;
2. *Psychosocial factors:* behavioural, social, or psychological determinants that influence behavioural outcomes and technology adoption; and
3. *Technological factors:* specific attributes of a technology, product, or enabling device that influence its adoption and sustained use.

These three interacting dimensions (Figure 1) not only encompass our understanding of WASH-related practices, but are also consistent with the idea of reciprocal determinism in Social Cognitive Theory, which describes mutual interactions between the individual, the behaviour, and the environment in which the behaviour is practiced [24].
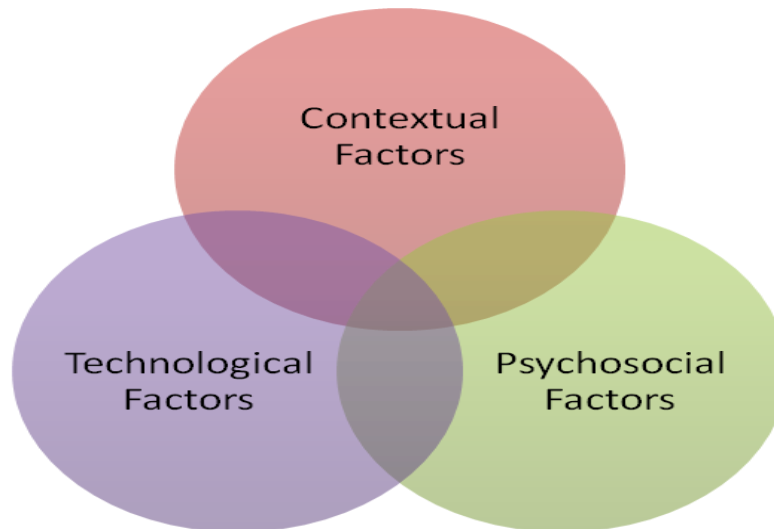
Contextual Factors are background characteristics of the setting or environment that are beyond the scope of influence of most programmatic activities; however, they exert significant influence on the adoption or specific products or behaviours. These include access to markets and products, access to enabling resources (such as water for handwashing or water treatment), socioeconomic and demographic characteristics, characteristics of the household, and the built and natural environment.

Psychosocial factors are the psychological, social, or cultural factors that can influence both adoption and sustained use of products and behaviours. Psychosocial factors have been described by various names in models such as the Health Belief Model [20, 21], the Theory of Reasoned Action and Theory of Planned Behaviour [22, 23], Social Cognitive Theory [24]. In operational frameworks, such as FOAM, these factors are often referred to as "behavioural determinants" [18, 19]. For Figueroa and Kincaid, these factors are referred to intermediate outcomes in the path towards behaviour change [17]. For Curtis, these factors are identified as the psychological determinants related to behaviours[15].

Technology Factors represent the third dimension in the IBM-WASH framework. With the exception of Diffusion of Innovations Theory [25], specific aspects of technology (product) that facilitate behaviour or "hardware" have been absent from most conceptual or operational frameworks or reduced to a small set of considerations. Technological factors, emphasize various aspects related to products and their use that can modify the extent to which they influence households, such as: the extent to which products are shared, the public versus private aspects of the behaviour, ease and convenience of the product, and the link between products and behaviours and commercial markets.

The three dimensions in this framework exist on multiple-levels, each of which influences sustained adoption. The arrangement into levels also draws on various ecological models, such as the Social Ecological Model of McLeroy et al. [26] and structural-environmental model of Sweat and Denison [27]. The IBM-WASH framework identifies five levels that should be considered by both researchers and program developers:

1. Societal / Structural
2. Communal
3. Interpersonal / household
4. Individual
5. Behavioural/Habitual

The full IBM-WASH framework presents a synthesis of these three dimensions (Technological, Contextual, Psychosocial) and five levels of influence. Given the dynamic relationships between these sets of factors and levels, the IBM-WASH framework eschews a traditional "boxes and arrows" approach and is presented in the form of a matrix (Table 1) populated by specific behavioural determinants thought to influence the sustained adoption of water, sanitation, and hygiene practices and technologies.

Levels	Contextual	Psychosocial "software"	Technology "hardware"
Societal/ Structural	Policy and regulations, climate and geography	Leadership/advocacy, cultural identity	Manufacturing, financing, and distribution of the product; current and past national policies and promotion of products
Community	Access to markets, access to resources, built and physical environment	Shared values, collective efficacy, social integration, stigma	Location, access, availability, individual vs. collective ownership/access, and maintenance of the product
Interpersonal/ Household	Roles and responsibilities, household structure, division of labor	Injunctive norms, descriptive norms, aspirations, shame	Sharing of access to product, modeling/demonstration of use of product
Individual	Wealth, age, education, gender, livelihoods/employment	Self efficacy, knowledge, disgust, perceived threat	Perceived cost, value, convenience, and other strengths and weaknesses of the product
Behavioral/ Habitual	Favorable environment for habit formation, opportunity for repetition of behavior	Existing water and sanitation habits, outcome expectations	Ease/Effectiveness of routine use of product

Many existing frameworks related to water and sanitation only specify levels of influence for psychosocial determinants [15, 17]. However, products and behaviours can operate on many levels as well. While behaviour change for a specific product or behaviour is limited to the individual or household-level, the unit of intervention is often at the communal level. Interventions such as handwashing stations, chlorine dispensers, or improved latrine technologies, often result in products that are shared among multiple households or compounds. Thus is it is our position that aspects related to the product or the behaviour themselves must be understood within a broader multi-level context. Contextual and environmental factors are also often presented as an external block of factors that influence the individual psychosocial factors. These contextual determinants, which are often external to the scope of most WASH programs, also operate at multiple levels.

For the purposes of this review, we will be focusing on factors from the Behavioural/Habitual level to the Communal level.

Within this framework are specific factors that could influence sustained adoption of water, sanitation and hygiene practices (Table 1). The operational definitions of these factors are described in Table 2.

1.5 Authors, funders, and other users of the review

This review is funded by the International Initiative for Impact Evaluation (3ie) through the Systematic Review Call 4. The review team consist of researchers from Johns Hopkins Bloomberg School of Public Health (JHSPH) and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b). Specific staff include:

Project co-ordination and Content expertise	Robert Dreibelbis (JHSPH) will lead the review and provide overall project coordination and management. Robert was the lead author on a systematic review of behaviour change models in water, sanitation, and hygiene literature that served as the basis for the theoretical model used for this analysis. Robert will draw from his prior systematic review experience as well as provide content expertise through his experiences working on water and sanitation programs via his affiliations with Johns Hopkins University and Emory University's Center for Global Safe Water. Robert will serve as the primary and coordinating author of the systematic review.
	Kristyna Hulland (JHSPH) will co-author project documents as well as lead methods development and analysis and synthesis of the data. Kristyna will draw from her prior experience conducting systematic reviews related to Population, Environment, and Health interventions as well as her experience working on behaviour change models and interventions for low-income countries.
	Farhana Sultana (icddr,b) will lead the grey literature search and review as well as coordinate with Bangladesh-based partners and organizations. Farhana is a member of the Water Sanitation and Hygiene Research Group, Centre for Communicable Diseases at icddr,b.
	Luke MacDonald, Kellogg Schwab, and Peter Winch, faculty members at the Johns Hopkins Bloomberg School of Public Health will provide strategic direction for the project. Dr. Winch will serve as the principal and senior investigator for the overall project.
	Reviewers will be advised by experienced researchers and policy makers in water, sanitation and hygiene including: Tom Clasen (London School of Hygiene and Tropical Medicine), Rob Quick (Centers for Disease Control and Prevention), Julia Rosenbaum (FHI360) and Almud Weitz (Water and Sanitation Program). The Advisors will be invited to comment on the search strategy, review protocol, and draft report.

Systematic review methods:	Kristyna Hulland will work together with Peggy Gross, informationist at the Johns Hopkins Welch Medical Library in the development of search strategies, systematic review methods, and approaches to synthesis.
Statistical analysis (if relevant):	Luke MacDonald will lead any statistical analysis necessary for the final research product.
Information retrieval:	Peggy Gross, informationist at Johns Hopkins Welch Medical Library will assist in information retrieval. Nina Martin (JHSPH) will serve as student assistant for the project and will work with Peggy on information retrieval and management.

1.6 Review questions and approach

The primary research question for our systematic review is:

Q1) **What are the factors that influence the sustained adoption of clean water and sanitation technologies?**

Using the IBM-WASH as a theoretical guide for this research, each of the three main dimensions of the framework constitute a specific sub-question within our systematic review:

Q1a) **What are the contextual factors that result in adoption of water and sanitation technologies (i.e. what are the key environmental, political, and demographic factors influencing behaviour)?**

Q1b) **What are the psychosocial factors that result in adoption of water and sanitation technologies?**

Q1c) **What are the technological factors that result in adoption of water and sanitation technologies (i.e. what aspects of WASH technologies facilitate behaviour change)?**

Water and sanitation technologies can operate at multiple-levels within a given context. Individual- and household-level technologies - such as household water filters or improve sanitation technologies - may differ from community-level technologies - such as improved water points or communal sanitation systems. Our final sub-questions will explicitly address differences between potential intervention levels:

Q1d) **How do the factors that influence the sustained adoption of water and sanitation technologies differ between individual- or household-level technologies and community-based technologies?**

Our understanding of the factors that influence the adoption and sustained adoption of these factors will be drawn primarily from "views" studies – qualitative or mixed method studies in which individuals provide information on the knowledge, attitudes, and opinions that influence current water and sanitation practices or the adoption of specific technologies or behaviours. It will also draw from observational studies which associate specific population characteristics ore reported characteristic against behavioural outcomes (See Section 2 – Methods).

We will use the IBM-WASH models (described above) to guide the framework synthesis of results from this section. Framework synthesis utilizes a larger conceptual model to guide coding and analysis of studies, and has been used successfully used to in the synthesis of multiple study types. Framework synthesis also allows for the iterative adaptation of the original conceptual model in light of emerging or new evidence identified during the coding and synthesis stage.

Understanding these barriers and facilitators to adoption and sustained adoption of WASH technologies alone is not sufficient to inform and shape policy and practice. It is important to understand the extent to which current intervention strategies reflect these barriers and facilitators. The second stage of our review will address this question, specifically:

> **Q2)   What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies and how successful are these interventions at fostering adoption and sustained adoption?**

This stage of our review will focus predominantly on intervention evaluations in which behavioural outcomes are reported and/or the focus, process evaluations of health impact trials, and other studies which document specific components and characteristics of interventions intended to improve adoption and/or sustained adoption. Findings from this phase of synthesis will draw primarily on those outcome and/or impact evaluations appropriately designed to assess intervention effectiveness. Ideally, this would include both pre- and post- intervention measures in both intervention(s) and an appropriately allocated control group; however, criteria for this final stage of synthesis will be dependent up on quality and quantity of existing literature.

This third phase of our synthesis will allow us to assess the effectiveness of interventions in addressed the barriers and facilitators of adoption and sustained adoption of WASH technologies. Using a mixed methods approach, we will compare the known barriers and facilitators to adoption (Phase 1, Q1 and sub-questions) against the described characteristics of WASH interventions (Phase 2, Q2), thus combing the results of our two syntheses. This stage of our synthesis will specifically address the following question:

> **Q3)   To what extent do existing interventions address known barriers to and/or leverage known facilitators of the sustained adoption of water and sanitation technologies?**

1.7.2 Type of review approach

Our two-stage review will proceed from a broad descriptive mapping of existing literature on the barriers and facilitators to will be used to inform subsequent in-depth syntheses in an iterative manner to answer each of our three key questions:

Stage 1:   *Mapping*

In the first stage of our study, we will collect all literature that meets inclusion criteria (see Section 2). An initial descriptive overview of studies will be completed and used to systematically document study-specific information on study type / methodology (used to define which studies are included in support of Q1 or Q2 / Q3), location, behavioural outcomes of interest, study quality, and study / intervention characteristics.
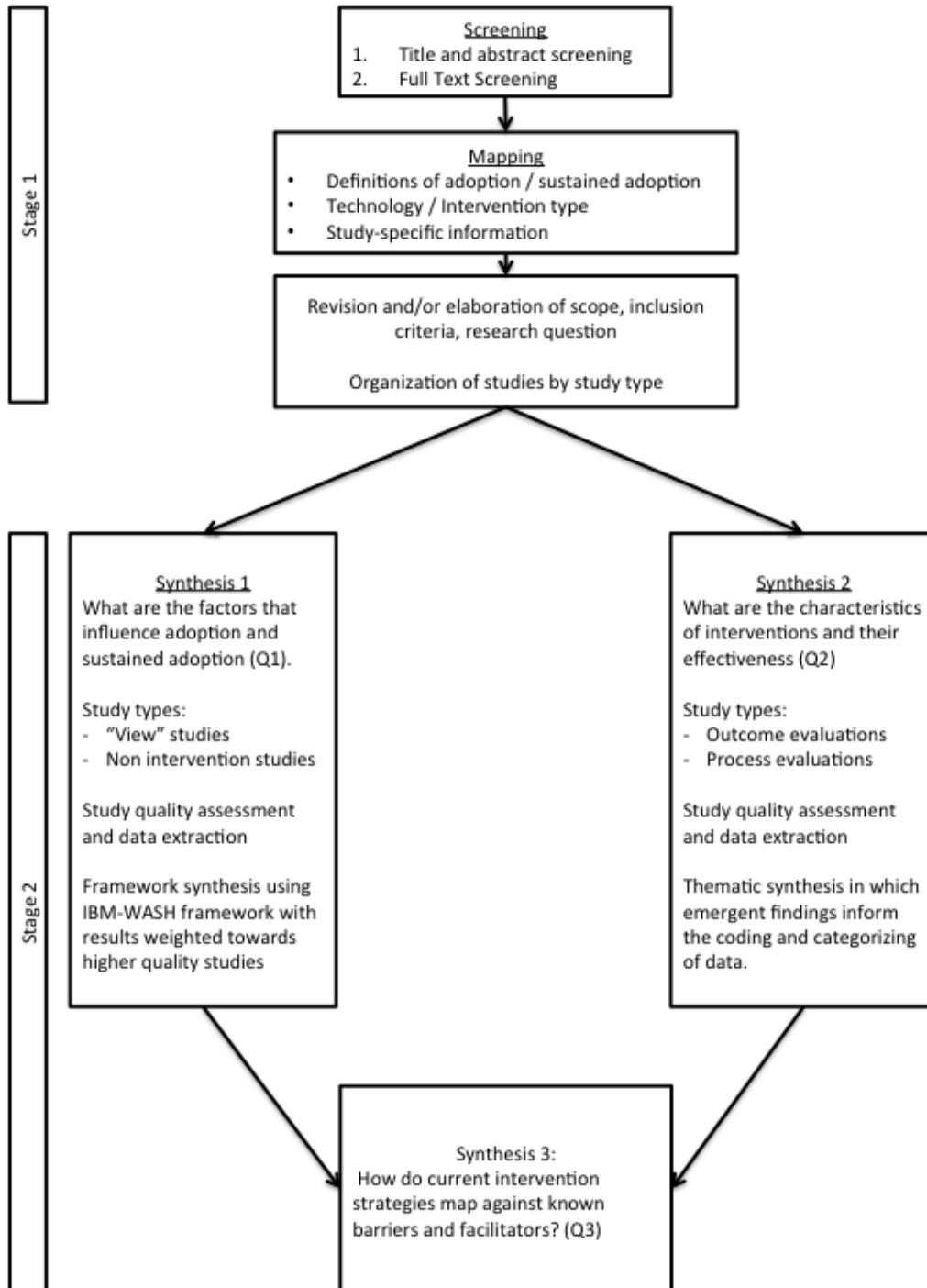
Stage 2:   *In-depth synthesis*

Results from the systematic mapping of identified literature will be used to inform the second stage of our review. This second stage of the project will proceed in three phases.

- In Phase 1, in-depth synthesis of a sub-set of studies will be used to understand the barriers and facilitators to adoption and sustained adoption of clean water and sanitation technologies (**Q1 and sub-questions**). Phase 1 of the synthesis will utilize a framework synthesis approach and draw primarily on qualitative and non-intervention studies. This in-depth synthesis will be used to iteratively inform the adaptation and modification of the IBM-WASH Framework.

- In Phase 2, the adapted framework from Phase 1 will be used as the foundation for a *thematic synthesis* of intervention studies. This stage will allow us to synthesize the characteristics of existing interventions and assess the effectiveness of these intervention strategies to encourage adoption and/or sustained adoption of water and sanitation technologies **(Q2).**

- In Phase 3, we will bring together the multiple study designs and syntheses to compare interventions against the known barriers and facilitators of adoptions /sustained adoption **(Q3).** Using a mixed-methods approach we will compare the key findings and studies from Phase 1 against those of Phase 2 in order to identify potential matches, mismatches, and gaps between current intervention strategies and the important barriers and facilitators to adoption identified in non-intervention studies.

The following diagram provides a visual overview of our study, including screening and detailed mapping (Stage 1) and the subsequent syntheses (Stage 2):

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Stage 1

Screening
1. Title and abstract screening
2. Full Text Screening

Mapping
- Definitions of adoption / sustained adoption
- Technology / Intervention type
- Study-specific information

Revision and/or elaboration of scope, inclusion criteria, research question

Organization of studies by study type

Stage 2

Synthesis 1
What are the factors that influence adoption and sustained adoption (Q1).

Study types:
- "View" studies
- Non intervention studies

Study quality assessment and data extraction

Framework synthesis using IBM-WASH framework with results weighted towards higher quality studies

Synthesis 2
What are the characteristics of interventions and their effectiveness (Q2)

Study types:
- Outcome evaluations
- Process evaluations

Study quality assessment and data extraction

Thematic synthesis in which emergent findings inform the coding and categorizing of data.

Synthesis 3:
How do current intervention strategies map against known barriers and facilitators? (Q3)

2. Methods used in the review

Outline of chapter

2.1 Type of review

This review will systematically document the barriers and facilitators to adoption and sustained adoption of WASH technologies in low- and middle-income countries. We will complete and in-depth map of the existing literature on water, sanitation, and hygiene technology adoption and sustained adoption in low- and middle-income countries. In-depth analysis will proceed in three phases: First, we will utilize the IBM-WASH framework to conduct a framework analysis of the findings from non-intervention studies (observational, qualitative studies, etc.) to synthesize current knowledge on the barriers and facilitators to improved technology adoption **(Q1)**. Second, the revised IBM-WASH model will be used to guide the framework synthesis of intervention studies, process evaluations, and outcome evaluations that describe specific characteristics of WASH interventions and their influence on WASH-related behavioural outcomes and, if possible, the effectiveness of current intervention strategies to promote adoption / sustained adoption of WASH technologies **(Q2).** Third, we will use the results of two previous syntheses to match existing intervention strategies against known barriers and facilitators to adoption / sustained adoption in a mixed-methods synthesis **(Q3)**.

2.1.1 Mapping

Mapping of identified literature is a critical step in our proposed review process. In particular, we anticipate significant heterogeneity in how various researchers and NGOs have defined adoption, sustained adoption, and how specific behavioural determinants are defined and operationalized. Rather than establishing a priori criteria defining adoption, use, and definition and operationalization of specific behavioural determinants – these will be explicitly assessed as part of the mapping. In addition to keywording adapted from the EPPI-Centre (2003) Core Keywording Strategy: version 0.9.7 (See 2.3.3), mapping will systematically document the following information:

- How adoption and/or non-adoption is defined in the study. How has it been measured? (self-report, objective indictor, direct observation, etc.)

- How has *sustained* adoption and or discontinuation been defined (i.e.: length of follow-up) and how has it been measured?

- How have specific behavioural determinants been defined and operationalized in the study?

- For outcome and process evaluations:
    - What are the characteristics of the interventions designed to influence behavioural outcomes related to WASH technology adoption and/or sustained adoption?

- o What are the specific behavioural determinants / barriers and facilitators the intervention is attempting to address?
- For outcome evaluations:
  - o Is the study a randomized-controlled trial (group or individual), non-randomized trial, or one group pre-test post-test design?
  - o Are the characteristics of interventions designed to influence behavioural outcomes related to WASH technology adoption and sustained adoption clearly described?

All data extracted during the mapping and subsequent synthesis will be empirical data either reported in the results or results and discussion section of the paper. Only interpretations of authors / program staff clearly supported by the data (i.e.: "three-fourths of respondents reported X") will be extracted from selected studies.

2.1.2 Revision of research questions

Results from the in-depth mapping of identified studies will be used to identify those studies most relevant to the review question and used as an opportunity to refine / revise review questions. For example, results from the mapping may indicate specific WASH technologies or intervention strategies with a robust body of knowledge that are appropriate for individual synthesis or that insufficient evidence to allow us to answer select review questions. Revisions to the research questions will be discussed with the EPPI-Centre, 3ie, and the project advisory committee.

2.1.3 Data extraction and synthesis

All data extraction will be completed by members of the research team (predominantly RD, KRSH, FS, and NM). All coding, keywording, and synthesis will utilize the EPPI-Reviewer software for managing systematic reviews. Specific data extracted for identified studies will be tailored for the specific review with which it is associated (See 2.3). We will only use primary data reported (verbatim quotes, data tables, etc.), in-text descriptions of interventions or intervention components (for Synthesis 2) or interpretations by the author that are clearly supported by the data. Methods for data extraction and synthesis are tailored for each of our review questions; however, a sample of all studies included in our synthesis will be double coded by members of the research team (RD or KS and one additional study team member) and discrepancies discussed and resolved via consensus. This process will be done iteratively until there are no major discrepancies in extraction and coding between the two authors or until all studies have been double coded and discrepancies resolved. This method of quality assurance will be used in both the mapping and synthesis.

2.2 User involvement

2.2.1 Approach and rationale

There are multiple intended users of this review:

1. Policy and decision makers that are funding and/or implementing behaviour change projects that related to water, sanitation, and hygiene that have a technological component

2. Organizations implementing and/or designing behaviour change projects that involve water, sanitation, or hygiene technologies

3. Academic researchers investigating WASH behaviour change and technology adoption and/or sustainability issues

We will engage with potential users at various stages of this review and actively seek feedback and advice throughout the review process.

2.2.2 User Involvement in designing the review

An advisory panel consisting of representatives from various international organizations, government organizations, and academic institutions will provide feedback on the proposed protocol, including: search strategy, coding and synthesis, and framework and methods for analysis. Organizations included on the advisory panel include: WSP, Centers for Disease Control and Prevention, CARE International, FHI360, and the London School of Hygiene and Tropical Medicine.

2.2.3 User involvement in process of conducting the review

We will announce a "Request for Relevant Research", which will be emailed directly to contacts at various NGO, academic researchers, and public-sector organizations engaged in water, sanitation, and hygiene programming (See Appendix 2.1). This may include emails from contacts at organizations including: CARE, WaterAid, SHARE (Sanitation and Hygiene Applied Research for Equity), BRAC, Water.org, and other organizations. Researchers at academic institutions and specific researchers will be identified from personal networks of the members of the review team. In addition, we will review the abstracts and titles from the 2011 Water and Health Conference at University of North Carolina to identify other researchers that may have additional studies to include in our review.

2.2.4 User involvement in interpreting the review results

We will distribute a draft copy of our initial final report via our advisory panel as well as organizations that participated in the call for research.

2.2.5 User involvement in communication and dissemination of review results

A final report will be prepared in both print and electronic formats. Specifically, the electronic format will be made publically available via the Johns Hopkins Global Water Program website and publicized in the website's award-winning Global Water Magazine. We will facilitate dissemination of findings via the websites and contacts of organizations

2.3 Identifying and describing studies

2.3.1 Identification of potential studies: Search strategy

Published research:

Our database search strategy will include articles published in the following databases:

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- PubMed
- Embase
- PsychInfo
- Web of Science
- Global Health – OVID
- Global Health – WHO (Including: LILACS and REPIDISCA)
- Africabib
- Water Resources Abstracts
- Bioline
- JSTORE
- Scopus
- IBSS
- Anthropology Plus
- JOLIS

Where possible, we will employ a three-part search term using Boolean indicators. See Appendix 2.3 for an example search string tailored to PubMed. The search term will encompass the three concepts related to our research questions:

1) WASH Technologies: includes terms for water treatment, sanitation and hygiene. To reduce the number of non-relevant results, Concept 1 consists of two parts: Concept 1A refer to stand alone terms included in our search. Concept 1B consist of terms that are ANDed with water and hygiene terms.

2) Behaviour / Sustained Adoption: includes terms reflecting sustained adoption of a behaviour/use of a technology, behaviour change and adherence.

3) Lower and Middle Income Countries (LMIC): because we are specifically interested in determining successful interventions in countries with low existing rates of clean water, sanitation and hygiene, the included terms and countries limit our search to LMIC only.

Our final search will be: (Concept 1A OR Concept 1B) AND Concept 2 AND Concept 3.

We will hand-screen a number of peer-reviewed journals that may not be covered by our existing database search strategy or that may not provide sufficient indexing of qualitative / behavioural research, including:

- Environmental Science and Technology
- Development in Practice

In addition, we will scan reference lists of articles included in the review for additional published material. We may include key journals iteratively in the hand search if they have published included studies. In particular, we will assess the reference lists of applicable systematic reviews (See Parker-Fiebelkorn, 2012 [14] for one such example) and include relevant studies that have the potential to contribute to our review.

Website search:

In order to capture findings from the field, we will conduct a systematic search of the grey literature, targeting reports from NGOs and governmental organizations that provide water and sanitation services. We will target reports and documents published on websites of a number of international and national organizations involved in water, sanitation, and hygiene interventions. A complete list of websites is provided in Appendix 2.3.

Library search:

We will formulate a search of the current JHU library catalogues to identify relevant anthropological and sociological literature. This search will be limited to those books and resources located within the Sheridan libraries collection. We will work with the JHU informationist team to translate our search terms for use the JHU library system.

Research in Process / Request for Relevant Research:

To identify relevant research reports not available in academic literature, we will conduct a "Request for Research in Process / Relevant Research" through individual contacts with key organizations and partners engaged with the review process. We will develop a dedicated email address for materials submitted in the grey literature. Findings from these unpublished studies will be subject to the same set of quality checks as all other studies and only included in the systematic review if they meet quality control standards.

We will use the EPPI-Reviewer database system to keep track of records and to code studies found during the review. Titles and abstracts will be imported into these databases.

2.3.2 Screening studies: applying inclusion and exclusion criteria

Full citation information will be retrieved from each database and imported to EPPI Reviewer, removing duplicates. Two reviewers will screen articles by title and abstract for articles that meet the inclusion/exclusion criteria. Discrepancies in screening will be resolved by a third-party reviewer from the review team. Articles marked 'Pull to Check' will be retrieved for full text review.

The process of initial screening will apply exclusion criteria to titles and abstracts. During title and abstract screening, studies will be marked as "included", "excluded", or "pull to check" in cases where title and abstract alone are insufficient for determining inclusion. After screening, full reports will be obtained for those studies that appear to meet the criteria. These reports will be entered into a second database of included studies. The inclusion and exclusion criteria will be re-applied to the full reports and those that do/did not meet these initial criteria will be excluded.

Eligible study designs: Included studies will be organized by study design and study methodology. We anticipate four main categories of studies to be included in our review:
1) Qualitative studies (including interviews, focus group discussions or unstructured observations of behaviours) which may include: pilot project, formative research used to inform specific pilot, qualitative assessments of

specific interventions, trials of improved practices, and other predominantly qualitative research activities that provide information on individual knowledge, attitudes, and beliefs ("views") regarding the barriers and facilitators of use or adoption of a specific WASH technology or WASH behavioural outcomes.

Examples include:

- Wood S, Foster J, & Kols A (2012) Understanding why women adopt and sustain home water treatment: Insights from the Malawi antenatal care program. *Social Science & Medicine* 75(4):634-642.

- De Ver Dye T, *et al.* (2011) A qualitative assessment of beliefs, attitudes, and behaviors related to diarrhea and water filtration in rural Kenya. *American Journal of Public Health* 101(8).

- Sultana R, *et al.* (2013) An improved tool for household faeces management in rural Bangladeshi communities. *Tropical Medicine & International Health*.

2) Non-intervention/ observational studies that associate specific respondent characteristics or reported knowledge, attitudes, and beliefs against use / adoption of a specific WASH technology or a WASH behavioural outcome

Examples include:

- Aiken BA, Stauber CE, Ortiz GM, & Sobsey MD (2011) An assessment of continued use and health impact of the concrete biosand filter in Bonao, Dominican Republic. *American Journal of Tropical Medicine and Hygiene* 85(2):309.

- Awoke W & Muche S (2013) A cross sectional study: latrine coverage and associated factors among rural communities in the District of Bahir Dar Zuria, Ethiopia. *BMC Public Health* 13(1):99.

- Freeman MC, Trinies V, Boisson S, Mak G, & Clasen T (2012) Promoting Household Water Treatment through Women's Self Help Groups in Rural India: Assessing Impact on Drinking Water Quality and Equity. *PloS ONE* 7(9):e44068.

3) Outcome evaluations and/or process evaluations which report on behavioural outcomes associated with specific WASH technologies (adoption, use, sustained adoption, discontinuation, etc.)

Example studies include:

- Parker AA, *et al.* (2006) Sustained High Levels of Stored Drinking Water Treatment and Retention of Hand-Washing Knowledge in Rural Kenyan Households Following a Clinic-Based Intervention." *Epidemiology and Infection* 134(5): 1029-36.

- Pattanayak SK, *et al.* (2009) Shame or subsidy revisited: social mobilization for sanitation in Orissa, India. *Bulletin of the World Health Organization* 87(8):580-587.

- Luoto J*, et al.* (2011) What point-of-use water treatment products do consumers use? Evidence from a randomized controlled trial among the urban poor in Bangladesh. *PloS ONE* 6(10):e26132.

Exclusion criteria are (in-order of application):

1) Not about a WASH intervention, WASH behaviours, and/or WASH behaviour change.

2) Study conducted in a health facility, school, day care centre, restaurant, or other public or private sector institutional setting and/or primarily focused on the behaviours of healthcare workers, teachers, or other employees of an institution or business.

3) Study focuses on vector control or oviposition (example: Seng CM et al. (2008). Community-based use of the larvivorous fish Poecilia reticulata to control the dengue vector *Aedes aegypti* in domestic water storage containers in rural Cambodia. Journal of Vector Ecology 33(1): 139-44.)

4) Study published before 1980.

5) Study not conducted in a low or middle income country (see Appendix 2.3).

6) Study does not report on primary data (editorials, policy documents, review articles, etc.).

7) Study is an in-depth case study of a single individual.

8) Study published in a language other than English, French, Spanish, or Portuguese.

2.3.3 Characterising and mapping included studies

The studies remaining after application of the inclusion criteria will be coded with a set of keywords. These keywords will build upon the EPPI-Centre (2003) Core Keywording Strategy: version 0.9.7. including keywords specific to the context of the review. This strategy will help to map the characteristics of studies included in the review.

Keywords will encompass several dimensions of the studies reviewed including:

- Description of the technology/behaviour of interest and/or intervention characteristics related water, sanitation or hygiene promotion

- Level of the technology / behaviour and/or intervention e.g., household-level, community level, *etc.*

- Study design, e.g., randomised controlled trial, cross-sectional/ecological assessment, *etc.*

- Behavioural/adoption outcomes measures, method of verification, and length of follow-up (if applicable)

- Geographical location, e.g., which lower middle income county, urban/rural

- Barriers and facilitators (e.g.: behavioural determinants) against which adoption and/or sustained adoption are reported (from IBM-WASH Framework: contextual, psychosocial, technological)

- Characteristics of the intervention (if applicable), including: stated theory or rationale for the intervention, key intervention activities and targeted behavioural determinants (if available), and intervention level (individual, communal, societal / structural)

All the keyworded studies will be added to the larger EPPI-Centre database, for others to access via the website.

2.3.4 Identifying and describing studies: quality assurance process

Two members of the research group will independently screen articles to apply inclusion and exclusion criteria and keywords. Discrepancies will be resolved through discussion.

2.4 In-depth review

2.4.1 Moving from broad characterisation (mapping) to in-depth review

As described above, this study will draw from a variety of studies assessing multiple types of water and sanitation technologies. Mapping and characterising these studies is a key outcome of the described research and will be used to inform our understanding of the current state of knowledge regarding water and sanitation technology adoption. Results of this initial mapping phase will shared with project partners and used to refine and focus the subsequent in-depth review and quality inclusion criteria. Additional inclusion and exclusion criteria may be applied to the fully mapped set of studies included in this review in order to ensure policy relevant results and utility of findings to key decision makers.

2.4.2 Assessing quality of studies

Study quality will be assessed based on the EPPI-Centre's Weight of Evidence tool (described above). As described by Gough [28], the Weight of Evidence tool is a generic tool for assessing study quality that facilitates the comparison across different study types. The Weight of Evidence tool combines study-specific quality measures on methodological appropriateness with review specific assessments of relevance and appropriateness to answer review questions. The two review-specific criteria (relevance to the review and appropriateness to answer the review questions) will be addressed during our screening process and application of inclusion and exclusion criteria – only those studies that are relevant and appropriate to the review question will be included in the in-depth review.

To assess study-specific quality we have identified generic study criteria that are applicable to a wide range of study types rather than relying on specific quality assessment criteria that are applicable to limited study designs (For example, CONSORT guidelines (and its subsequent adaptation to cluster or group randomized trials) used to assess the quality of outcome evaluations [29, 30].) Our study-specific quality assessment will based on the seven criteria outlined by Harden *et al.* [31]. The seven criteria are:

1. Does the study have an explicit conceptual model or literature review?

2. Are the aims and objectives clearly stated?

3. Is there a clear description of context?

4. Is there a clear description of the sample and how it was recruited?

5. Is there a clear description of the methods used to collect and analyse data?

6. Are there attempts to established the reliability and validity of data analysis?

7. Is there inclusion of sufficient original data to mediate between evidence and interpretation?

Studies will receive one point for each yes answer, for a total potential score of 7. All studies that are subject to this in-depth review of study quality are both relevant and appropriate to the review questions and no pre-determined quality threshold will be used to exclude studies from our analysis. Rather, we will weight the findings of those studies with higher study quality scores over those with lower study scores and prioritize findings supported by higher quality studies over those with lower quality scores. Utilizing this approach allows us to draw conclusions from the full range of available information while giving more weight to higher quality studies.

2.4.3 Synthesis of evidence

2.4.3.1 Overall approach to and process of synthesis

Through the keywording process we will generate a broad characterization of the types of studies included in this review. This information will be used to create a map to describe the research landscape based on research questions, intervention approach, outcome measures, etc. With an improved understanding of the nature of the potential studies that could be included in this review, we will be able to refine our data synthesis approach. Because this review will encompass both qualitative and quantitative findings with varying quality of reporting, our methods for synthesising this data will focus on identifying key themes that characterize behavioural adoption of water, sanitation and hygiene technologies.

The in-depth review will occur in three stages. The first round of synthesis is intended to answer Q1 and its associated sub-questions and will draw primarily on qualitative and non-intervention studies to understand both self-reported and externally identified barriers and facilitators to adoption and sustained adoption of WASH technologies. We will use a "framework synthesis" approach in which codes and categories from an existing theoretical framework are iteratively applied during analysis with emergent findings informing both the initial guiding framework and the synthesis results [32, 33]. The IBM-WASH framework will serve as our initial framework for this stage of synthesis.

In the second stage of our proposed synthesis will take a thematic synthesis approach to characterizing current interventions and assessing their effectiveness in encouraging adoption and sustained adoption (Q2). Outcome and/or process evaluations with the express purpose of changing behaviours and/or adoption of WASH technologies will be included in this stage of synthesis. Given the expected heterogeneity in behavioural outcomes, outcome metrics, and definitions of key behavioural determinants, quantitative methods for creating pooled measures (meta-analysis, meta-regression,

etc.) are an inappropriate synthesis tool. Instead, we will use a thematic synthesis approach, as described by Thomas and Hardin [34]. We will first develop descriptive themes based on line-by-line coding of details related to intervention activities and strategies. These descriptive themes will then be further abstracted to create analytic themes that reflect the expected barriers to and facilitators of adoption and sustained adoption. Where possible, we will then compare specific behavioural outcome measures against studies that describe interventions addressing one or more of the emergent analytic categories in order to define and describe effective intervention approaches. This stage of synthesis will focus primarily on outcome evaluations or studies with designs appropriate for determining intervention effectiveness – studies that including both pre- and post-intervention outcome data on intervention(s) groups and appropriately defined control group(s).

The third stage of our synthesis will utilize a mixed methods approach to bridge the two previous syntheses. This synthesis will answer the question: to what extent do existing intervention strategies address reported and identified barriers and facilitators to adoption and sustained adoption (Q3). Barriers and facilitators identified in Synthesis 1 will be matched against the characteristics of interventions identified in Synthesis 2.

2.4.3.2 Selection of outcome data for synthesis
All synthesis will rely on primary data taken directly from included studies – either in the results or discussion provided there is sufficient data to support any claims made during the discussion. For Synthesis 1, identified behavioural determinants – those determinants marked in the IBM-WASH framework or emergent through our iterative adaptation of the framework will be the "outcomes" of interest. For Synthesis 2, descriptive and analytic codes that describe intervention components or activities will be the focus of our synthesis and compared against behavioural outcome measures. Behavioural outcome data will include behavioural/adoption measures such as uptake, habit formation, and sustained use over a defined period of time.

2.4.3.3 Process used to combine/ synthesise data
Given the heterogeneity of study design, intervention, and outcome measures to be included in this review, synthesis of findings will be divided by intervention type (i.e. clean water, sanitation or hygiene interventions). After studies have been sorted by intervention type, behavioural factors will be compared across studies.

2.4.3.4 Criteria for identifying important review results
The sequential syntheses are likely to identify multiple factors affecting sustainable adoption of clean water and sanitation technologies from different sets of studies [35]. Some of these will come from individual or multiple qualitative studies revealing the perceptions of people delivering or offered these technologies. Some will come from observational studies of associations between an array of factors and sustainable adoption. Lastly, some will come from effectiveness studies that offer evidence of interventions addressing barriers or sustainable adoption or building on facilitators for sustainable adoption. More attention will be paid to factors that are recognised by:

- multiple studies which offer confirmatory findings or

- multiple studies where differences in findings can be explained by differences in context

- high quality studies

Factors will be described alongside the evidence from which they were derived.

2.4.4 Deriving conclusions and implications

Conclusions and implications that can be drawn from the findings may differ between intended users of the results. Potential users include: academic researchers, practitioners, and policy makers. Important implications of the review will be identified iteratively with support from the funding organization (3ie), the systematic review group (EPPI-Centre), and the advisory council. Conclusions and implications will be drawn through discussion with the project advisory board and project support teams at EPPI-Centre and 3ie.

The IBM-WASH Framework, described in the introduction, serves as the underlying Theory of Change for this analysis. Unlike impact or outcome based systematic reviews, in which linear processes can be directly combined and synthesized, our systematic review is more exploratory in nature and will systematically document salient barriers and facilitators to sustained behaviour change as seen by intended beneficiaries, will provide evidence on the extent to which key contextual factors are associated with different behavioural outcomes, the characteristics and effectiveness of existing intervention strategies, and the extent to which current intervention strategies address self-identified barriers and facilitators to adoption.

Academic researchers may have a specific interest in the results from the detailed mapping of the current state of knowledge regarding WASH technology adoption and sustained adoption. Mapping results will identify key knowledge gaps in current understandings of water, sanitation, and hygiene interventions by documenting the extent to which current studies have investigated various barriers and facilitators to behaviour change. The final synthesis of intervention studies against the findings from non-intervention studies will also document the extent to which these barriers and facilitators have been evaluated in a robust manner. Implications of our research will provide a clear avenue for future research in the area of water and sanitation behaviour and behaviour change.

For practitioners, findings from our synthesis of barriers and facilitators may inform intervention strategies to address these barriers and facilitators at the individual- or community-level. Because factors that influence sustained behaviour change are dependent upon intervention context and intervention hardware, our results may suggest a certain typology of intervention strategies or considerations in developing behaviour change strategies for specific technologies or contexts. Implications of our research may highlight key elements of the adapted IBM-WASH framework that are currently ignored or under-represented in current intervention strategies or highlight key factors that successful intervention strategies have employed to foster sustained adoption at the individual, household, or communal level.

At higher levels our findings may suggest specific policy initiatives, reallocation of funding strategies, or key contextual elements that require structural interventions in order to facilitate sustained adoption of clean water and sanitation technologies at the individual or household level. The links between existing intervention strategies and the IBM-WASH framework will demonstrate how existing policy initiatives do or do not

address barriers and facilitators and may suggest ways in which current policy initiative can be developed or adapted to foster adoption. We are working iteratively with 3ie on a Policy Influencing Plan to outline the implications of our research for policy makers and other high-level stakeholders.

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Appendices

Appendix 1.1: Authorship of this protocol

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Acknowledgements

Appendix 2.1: Inclusion and exclusion criteria

Exclusion criteria are:

1) Not about a WASH intervention, WASH behaviours, and/or WASH behaviour change.

2) Study conducted in a health facility, school, day care centre, restaurant, or other public or private sector institutional setting and/or primarily focused on the behaviours of healthcare workers, teachers, or other employees of an institution or business.

3) Study focuses on vector control or oviposition (example: Seng CM et al. (2008). Community-based use of the larvivorous fish Poecilia reticulata to control the dengue vector *Aedes aegypti* in domestic water storage containers in rural Cambodia. Journal of Vector Ecology 33(1): 139-44.)

4) Study published before 1980.

5) Study not conducted in a low or middle income country (see Appendix 2.2)

6) Study does not report on primary data (editorials, policy documents, review articles, etc.)

7) Study is an in-depth case study of a single individual

8) Study published in a language other than English, French, Spanish, or Portuguese.

Inclusion criteria for initial screening are:

1) Date: published after 1980

2) Outcomes: must report on behavioural outcomes associated with a specific WASH technology, and at least one of the following:

   a. Knowledge, attitudes, or beliefs (i.e.: "views") of primary users of specific WASH technologies, or

   b. Specific individual/population characteristics (socio-demographic, behavioural, or psychological) associated with use or adoption of a specific WASH technologies

   c. Outcome and/or process evaluations of interventions which include behavioural outcomes of adoption or sustained adoption of WASH technologies either as an end-goal or as part of a larger health / development impact study.

3) Language: must be published in English, French, Spanish, or Portuguese

What factors affect sustained adoption of clean water and sanitation technologies? A Systematic Review of Literature.Protocol.

Appendix 2.2: Search strategy for electronic databases

PubMed Search

Concept 1: WASH TERMS

Concept 1A: Standalone WASH

(((((("toilet facilities" [mesh] OR "sewage" [mesh] OR "sewage" [tiab] OR "latrines"[tiab] OR "latrine"[tiab] OR "toilets"[tiab] OR "toilet"[tiab] OR "ecosan"[tiab] OR "biogas"[tiab] OR "sewer"[tiab] OR "sewers"[tiab] OR "waste management"[tiab] OR "waste management"[mesh] OR "hygiene"[mesh] OR "hygiene"[tiab] OR "hand washing"[tiab] OR "handwashing"[tiab] OR "hand disinfection"[mesh] OR "soap"[tiab] OR "soaps"[mesh] OR "tippy taps"[text word] OR "drinkwater"[tiab] OR "hand cleansing"[tiab] OR "handscrubbing"[tiab] OR "hand scrubbing"[tiab] OR "sanitation"[tiab] OR "sanitation"[mesh] OR "sanitizer"[tiab] OR "sanitiser"[tiab] OR "sanitary"[tiab] OR "sanitary engineering"[mesh] OR "excreta"[tiab] OR "feces"[tiab] OR "faeces"[tiab] OR "waste disposal"[tiab] OR "wastewater treatment" OR "water treated"[tiab] OR "treated water"[tiab] OR "Water Quality"[Mesh] OR "water purification"[mesh] OR "water supply"[mesh] OR "Water Quality"[tiab] OR "water purification"[tiab] OR "water supply"[tiab] OR "water treatment"[tiab] OR "point of use water"[tiab] OR

Concept 1B: Terms "ANDed" with Water terminology

("disinfection"[tiab] OR "disinfecting"[tiab] OR "Disinfectants"[Mesh] OR "Disinfectants"[tiab] OR "Disinfectant"[tiab] OR "Disinfection"[Mesh] OR "disinfection"[tiab] OR "sterilization"[tiab] OR "sterilisation"[tiab] OR "kiosk"[tiab] OR "kiosks"[tiab] OR "truck"[tiab] OR "trucks"[tiab] OR "boil"[tiab] OR "boiling"[tiab] OR "untreated"[tiab] OR "standpipes" OR "systems"[tiab] OR "system"[tiab] OR "systems"[tiab] OR "purification"[tiab] OR "treatment"[tiab] OR "treated"[tiab] OR "storage"[tiab] OR "safe"[tiab] OR "contamination"[tiab] OR "contaminated"[tiab] OR "microbiology"[tiab] OR "quality"[tiab] OR "quantity"[tiab] OR "improved"[tiab] OR "drinking"[tiab] OR "storage"[tiab] OR "source"[tiab] OR "supplies"[tiab] OR "inactivation"[tiab] OR "point of use"[tiab] OR "filtration"[tiab] OR "filter"[tiab] OR "filters"[tiab] OR "filtering"[tiab] OR "flocculation"[tiab] OR "SODIS"[tiab] OR "Environmental health"[tiab] OR "access"[tiab] OR "resources"[tiab] OR "Sanitary engineering"[tiab] OR "potable"[tiab] OR "distribution"[tiab] OR "management"[tiab] OR "chlorine"[tiab] OR "chlorination"[tiab] OR "filtration"[tiab] OR filter*[tiab] OR "sodium hypochlorite"[MeSH Terms] OR "sodium hypochlorite"[tiab] OR "Moringa oleifera seeds"[tiab] OR "Moringa oleifera seed"[tiab] OR "troclosene" [Supplementary Concept] OR "aquatabs"[tiab] OR "tubewells"[tiab] OR "tubewell"[tiab] OR "tube wells"[tiab] OR "tube well"[tiab] OR "tube wells"[tiab] OR "borewell"[tiab] OR "bore well"[tiab] OR "borewells"[tiab] OR "bore wells"[tiab] OR "biofilter"[tiab] OR "biofilters"[tiab] OR "catchment"[tiab] OR "hypochlorite sodium"[tiab])

AND

("Drinking Water"[Mesh] OR "Fresh Water"[Mesh] OR "water"[mesh:noexp] OR "water purification"[mesh] OR "water supply"[mesh] OR "Water Quality"[Mesh] OR water[tiab])))

Concept 2: Behavioral Terms

("adaptive behavior"[Tiab] OR "adaptive behaviour"[tiab] OR "adaptation, psychological"[MeSH Terms] OR "Adaptation"[tiab] OR "Adoption"[tiab] OR "Adopting"[tiab] OR "rejection"[tiab] OR "rejecting"[tiab] OR "facilitating"[tiab] OR "facilitate"[tiab] OR "facilitates"[tiab] OR "facilitator"[tiab] OR "facilitators"[tiab] OR "behavior"[Tiab] OR "behaviors"[Tiab] OR "behavioral"[Tiab] OR "behaviour"[Tiab] OR "behaviours"[Tiab] OR "behavioural"[Tiab] OR "behavior"[MeSH Terms] OR "coping"[tiab] OR "uptake"[tiab] OR "practices"[tiab] OR "practice"[tiab] OR "determinants"[tiab] OR "usability"[tiab] OR "feasibility"[tiab] OR "adherence"[tiab] OR "sustainability"[tiab] OR "sustain"[tiab] OR "sustained"[tiab] OR "attitude"[MeSH] OR "attitude"[tiab] OR "attitudes"[tiab] OR "psychology"[tiab] OR "psychological"[tiab] OR "psychosocial"[tiab] OR "sociological"[tiab] OR change[tiab] OR "social factors"[tiab] OR "sociocultural"[tiab] OR "socio cultural"[tiab] OR "Decision-making"[tiab] OR "Decision making"[tiab] OR "Decision making"[MeSH] OR "implementing"[tiab] OR "Motivation"[MeSH] OR "Motivation"[tiab] OR "Motivations"[tiab] OR "influences"[tiab] OR "influence"[tiab] OR "predictor"[tiab] OR "predictors"[tiab] OR "participation"[tiab] OR "behavior and behavior mechanisms"[MeSH] OR "adaptations"[tiab] OR "observance"[tiab] OR "conformity"[tiab] OR "compliance"[tiab] OR "diffusion"[tiab] OR "process evaluation"[tiab]))

Concept 3: Low and Middle Income Countries

("developing country"[tiab] OR "developing countries"[tiab] OR "developing nation"[tiab] OR "developing nations"[tiab] OR "developing population"[tiab] OR "developing populations"[tiab] OR "developing world"[tiab] OR "less developed country"[tiab] OR "less developed countries"[tiab] OR "less developed nation"[tiab] OR "less developed nations"[tiab] OR "less developed population"[tiab] OR "less developed populations"[tiab] OR "less developed world"[tiab] OR "lesser developed country"[tiab] OR "lesser developed countries"[tiab] OR "lesser developed nation"[tiab] OR "lesser developed nations"[tiab] OR "lesser developed population"[tiab] OR "lesser developed populations"[tiab] OR "lesser developed world"[tiab] OR "under developed country"[tiab] OR "under developed countries"[tiab] OR "under developed nation"[tiab] OR "under developed nations"[tiab] OR "under developed population"[tiab] OR "under developed populations"[tiab] OR "under developed world"[tiab] OR "underdeveloped country"[tiab] OR "underdeveloped countries"[tiab] OR "underdeveloped nation"[tiab] OR "underdeveloped nations"[tiab] OR "underdeveloped population"[tiab] OR "underdeveloped populations"[tiab] OR "underdeveloped world"[tiab] OR "middle income country"[tiab] OR "middle income countries"[tiab] OR "middle income nation"[tiab] OR "middle income nations"[tiab] OR "middle income population"[tiab] OR "middle income populations"[tiab] OR "low income country"[tiab] OR "low income countries"[tiab] OR "low income nation"[tiab] OR "low income nations"[tiab] OR "low income population"[tiab] OR "low income populations"[tiab] OR "lower income country"[tiab] OR "lower income countries"[tiab] OR "lower income nation"[tiab] OR "lower income nations"[tiab] OR "lower income population"[tiab] OR "lower income populations"[tiab] OR "underserved country"[tiab] OR "underserved countries"[tiab] OR "underserved nation"[tiab] OR "underserved nations"[tiab] OR "underserved population"[tiab] OR "underserved populations"[tiab] OR "underserved world"[tiab] OR "under served country"[tiab] OR "under served countries"[tiab] OR "under served nation"[tiab] OR "under served nations"[tiab] OR "under served population"[tiab] OR

What factors affect sustained adoption of clean water and sanitation technologies? A Systematic Review of Literature.Protocol.

"under served populations"[tiab] OR "under served world"[tiab] OR "deprived country"[tiab] OR "deprived countries"[tiab] OR "deprived nation"[tiab] OR "deprived nations"[tiab] OR "deprived population"[tiab] OR "deprived populations"[tiab] OR "deprived world"[tiab] OR "poor country"[tiab] OR "poor countries"[tiab] OR "poor nation"[tiab] OR "poor nations"[tiab] OR "poor population"[tiab] OR "poor populations"[tiab] OR "poor world"[tiab] OR "poorer country"[tiab] OR "poorer countries"[tiab] OR "poorer nation"[tiab] OR "poorer nations"[tiab] OR "poorer population"[tiab] OR "poorer populations"[tiab] OR "poorer world"[tiab] OR "developing economy"[tiab] OR "developing economies"[tiab] OR "less developed economy"[tiab] OR "less developed economies"[tiab] OR "lesser developed economy"[tiab] OR "lesser developed economies"[tiab] OR "under developed economy"[tiab] OR "under developed economies"[tiab] OR "underdeveloped economy"[tiab] OR "underdeveloped economies"[tiab] OR "middle income economy"[tiab] OR "middle income economies"[tiab] OR "low income economy"[tiab] OR "low income economies"[tiab] OR "lower income economy"[tiab] OR "lower income economies"[tiab] OR "low gdp"[tiab] OR "low gnp"[tiab] OR "low gross domestic"[tiab] OR "low gross national"[tiab] OR "lower gdp"[tiab] OR "lower gnp"[tiab] OR "lower gross domestic"[tiab] OR "lower gross national"[tiab] OR lmic[tiab] OR lmics[tiab] OR "third world"[tiab] OR "lami country"[tiab] OR "lami countries"[tiab] OR "transitional country"[tiab] OR "transitional countries"[tiab] OR Africa[tiab] OR Asia[tiab] OR Caribbean[tiab] OR "West Indies"[tiab] OR "South America"[tiab] OR "Latin America"[tiab] OR "Central America"[tiab] OR "Atlantic Islands"[tiab] OR "Commonwealth of Independent States"[tiab] OR "Pacific Islands"[tiab] OR "Indian Ocean Islands"[tiab] OR "Eastern Europe"[tiab] OR Afghanistan[tiab] OR Albania[tiab] OR Algeria[tiab] OR Angola[tiab] OR Antigua[tiab] OR Barbuda[tiab] OR Argentina[tiab] OR Armenia[tiab] OR Armenian[tiab] OR Aruba[tiab] OR Azerbaijan[tiab] OR Bahrain[tiab] OR Bangladesh[tiab] OR Barbados[tiab] OR Benin[tiab] OR Byelarus[tiab] OR Byelorussian[tiab] OR Belarus[tiab] OR Belorussian[tiab] OR Belorussia[tiab] OR Belize[tiab] OR Bhutan[tiab] OR Bolivia[tiab] OR Bosnia[tiab] OR Herzegovina[tiab] OR Hercegovina[tiab] OR Botswana[tiab] OR Brasil[tiab] OR Brazil[tiab] OR Bulgaria[tiab] OR "Burkina Faso"[tiab] OR "Burkina Fasso"[tiab] OR "Upper Volta"[tiab] OR Burundi[tiab] OR Urundi[tiab] OR Cambodia[tiab] OR "Khmer Republic"[tiab] OR Kampuchea[tiab] OR Cameroon[tiab] OR Cameroons[tiab] OR Cameron[tiab] OR Camerons[tiab] OR "Cape Verde"[tiab] OR "Central African Republic"[tiab] OR Chad[tiab] OR Chile[tiab] OR China[tiab] OR Colombia[tiab] OR Comoros[tiab] OR "Comoro Islands"[tiab] OR Comores[tiab] OR Mayotte[tiab] OR Congo[tiab] OR Zaire[tiab] OR "Costa Rica"[tiab] OR "Cote d'Ivoire"[tiab] OR "Ivory Coast"[tiab] OR Croatia[tiab] OR Cuba[tiab] OR Cyprus[tiab] OR Djibouti[tiab] OR "French Somaliland"[tiab] OR Dominica[tiab] OR "Dominican Republic"[tiab] OR "East Timor"[tiab] OR "East Timur"[tiab] OR "Timor Leste"[tiab] OR Ecuador[tiab] OR Egypt[tiab] OR "United Arab Republic"[tiab] OR "El Salvador"[tiab] OR Eritrea[tiab] OR Estonia[tiab] OR Ethiopia[tiab] OR Fiji[tiab] OR Gabon[tiab] OR "Gabonese Republic"[tiab] OR Gambia[tiab] OR Gaza[tiab] OR "Georgia Republic"[tiab] OR "Georgian Republic"[tiab] OR Ghana[tiab] OR "Gold Coast"[tiab] OR Greece[tiab] OR Grenada[tiab] OR Guatemala[tiab] OR Guinea[tiab] OR Guam[tiab] OR Guiana[tiab] OR Guyana[tiab] OR Haiti[tiab] OR Honduras[tiab] OR Hungary[tiab] OR India[tiab] OR Maldives[tiab] OR Indonesia[tiab] OR Iran[tiab] OR Iraq[tiab] OR "Isle of Man"[tiab] OR Jamaica[tiab] OR Jordan[tiab] OR Kazakhstan[tiab] OR Kazakh[tiab] OR Kenya[tiab] OR Kiribati[tiab] OR Korea[tiab] OR Kosovo[tiab] OR Kyrgyzstan[tiab] OR Kirghizia[tiab] OR Kyrgyz Republic[tiab] OR Kirghiz[tiab] OR Kirgizstan[tiab] OR "Lao PDR"[tiab] OR

Laos[tiab] OR Latvia[tiab] OR Lebanon[tiab] OR Lesotho[tiab] OR Basutoland[tiab] OR Liberia[tiab] OR Libya[tiab] OR Lithuania[tiab] OR Macedonia[tiab] OR Madagascar[tiab] OR "Malagasy Republic"[tiab] OR Malaysia[tiab] OR Malaya[tiab] OR Malay[tiab] OR Sabah[tiab] OR Sarawak[tiab] OR Malawi[tiab] OR Nyasaland[tiab] OR Mali[tiab] OR Malta[tiab] OR "Marshall Islands"[tiab] OR Mauritania[tiab] OR Mauritius[tiab] OR "Agalega Islands"[tiab] OR "Melanesia"[tiab] OR Mexico[tiab] OR Micronesia[tiab] OR "Middle East"[tiab] OR Moldova[tiab] OR Moldovia[tiab] OR Moldovian[tiab] OR Mongolia[tiab] OR Montenegro[tiab] OR Morocco[tiab] OR Ifni[tiab] OR Mozambique[tiab] OR Myanmar[tiab] OR Myanma[tiab] OR Burma[tiab] OR Namibia[tiab] OR Nepal[tiab] OR "Netherlands Antilles"[tiab] OR "New Caledonia"[tiab] OR Nicaragua[tiab] OR Niger[tiab] OR Nigeria[tiab] OR "Northern Mariana Islands"[tiab] OR Oman[tiab] OR Muscat[tiab] OR Pakistan[tiab] OR Palau[tiab] OR Palestine[tiab] OR Panama[tiab] OR Paraguay[tiab] OR Peru[tiab] OR Philippines[tiab] OR Philipines[tiab] OR Phillipines[tiab] OR Phillippines[tiab] OR Poland[tiab] OR Portugal[tiab] OR "Puerto Rico"[tiab] OR Romania[tiab] OR Rumania[tiab] OR Roumania[tiab] OR Russia[tiab] OR Russian[tiab] OR Rwanda[tiab] OR Ruanda[tiab] OR "Saint Kitts"[tiab] OR "St Kitts"[tiab] OR Nevis[tiab] OR "Saint Lucia"[tiab] OR "St Lucia"[tiab] OR "Saint Vincent"[tiab] OR "St Vincent"[tiab] OR Grenadines[tiab] OR Samoa[tiab] OR "Samoan Islands"[tiab] OR "Navigator Island"[tiab] OR "Navigator Islands"[tiab] OR "Sao Tome"[tiab] OR "Saudi Arabia"[tiab] OR Senegal[tiab] OR Serbia[tiab] OR Montenegro[tiab] OR Seychelles[tiab] OR "Sierra Leone"[tiab] OR "Sri Lanka"[tiab] OR Ceylon[tiab] OR "Solomon Islands"[tiab] OR Somalia[tiab] OR Sudan[tiab] OR Suriname[tiab] OR Surinam[tiab] OR Swaziland[tiab] OR Syria[tiab] OR Syrian[tiab] OR Tajikistan[tiab] OR Tadzhikistan[tiab] OR Tadjikistan[tiab] OR Tadzhik[tiab] OR Tanzania[tiab] OR Thailand[tiab] OR Togo[tiab] OR "Togolese Republic"[tiab] OR Tonga[tiab] OR Tunisia[tiab] OR Turkey[tiab] OR Turkmenistan[tiab] OR Turkmen[tiab] OR Tuvalu[tiab] OR Uganda[tiab] OR Ukraine[tiab] OR Uruguay[tiab] OR USSR[tiab] OR Soviet Union[tiab] OR "Union of Soviet Socialist Republics"[tiab] OR Uzbekistan[tiab] OR Uzbek[tiab] OR Vanuatu[tiab] OR New Hebrides[tiab] OR Venezuela[tiab] OR Vietnam[tiab] OR Viet Nam[tiab] OR West Bank[tiab] OR Yemen[tiab] OR Yugoslavia[tiab] OR Zambia[tiab] OR Zimbabwe[tiab] OR Rhodesia[tiab] OR "Developing Countries"[Mesh] OR Africa[Mesh:NoExp] OR "Africa, Northern"[Mesh:NoExp] OR "Africa South of the Sahara"[Mesh:NoExp] OR "Africa, Central"[Mesh:NoExp] OR "Africa, Eastern"[Mesh:NoExp] OR "Africa, Southern"[Mesh:NoExp] OR "Africa, Western"[Mesh:NoExp] OR Asia[Mesh:NoExp] OR "Asia, Central"[Mesh:NoExp] OR "Asia, Southeastern"[Mesh:NoExp] OR "Asia, Western"[Mesh:NoExp] OR "Caribbean Region"[Mesh:NoExp] OR "West Indies"[Mesh:NoExp] OR "South America"[Mesh:NoExp] OR "Latin America"[Mesh:NoExp] OR "Central America"[Mesh:NoExp] OR "Atlantic Islands"[Mesh:NoExp] OR "Commonwealth of Independent States"[Mesh:NoExp] OR "Pacific Islands"[Mesh:NoExp] OR "Indian Ocean Islands"[Mesh:NoExp] OR "Europe, Eastern"[Mesh:NoExp] OR Afghanistan[Mesh] OR Albania[Mesh] OR Algeria[Mesh] OR "American Samoa"[Mesh] OR Angola[Mesh] OR "Antigua and Barbuda"[Mesh] OR Argentina[Mesh] OR Armenia[Mesh] OR Azerbaijan[Mesh] OR Bahrain[Mesh] OR "Baltic States"[Mesh] OR Bangladesh[Mesh] OR Barbados[Mesh] OR Benin[Mesh] OR "Republic of Belarus"[Mesh] OR Belize[Mesh] OR Bhutan[Mesh] OR Bolivia[Mesh] OR "Bosnia-Herzegovina"[Mesh] OR Botswana[Mesh] OR Brazil[Mesh] OR Bulgaria[Mesh] OR "Burkina Faso"[Mesh] OR Burundi[Mesh] OR Cambodia[Mesh] OR Cameroon[Mesh] OR "Cape Verde"[Mesh] OR "Central African Republic"[Mesh] OR Chad[Mesh] OR

Chile[Mesh] OR China[Mesh] OR Colombia[Mesh] OR Comoros[Mesh] OR Congo[Mesh] OR "Costa Rica"[Mesh] OR "Cote d'Ivoire"[Mesh] OR Croatia[Mesh] OR Cuba[Mesh] OR Cyprus[Mesh] OR Djibouti[Mesh] OR "Democratic Republic of the Congo"[Mesh] OR "Democratic People's Republic of Korea"[Mesh] OR Dominica[Mesh] OR "Dominican Republic"[Mesh] OR "East Timor"[Mesh] OR Ecuador[Mesh] OR Egypt[Mesh] OR "El Salvador"[Mesh] OR Eritrea[Mesh] OR Estonia[Mesh] OR Ethiopia[Mesh] OR "Equatorial Guinea"[Mesh] OR Fiji[Mesh] OR "French Guiana"[Mesh] OR Gabon[Mesh] OR Gambia[Mesh] OR "Georgia (Republic)"[Mesh] OR Ghana[Mesh] OR Greece[Mesh] OR Grenada[Mesh] OR Guatemala[Mesh] OR Guinea[Mesh] OR "Guinea-Bissau"[Mesh] OR Guam[Mesh] OR Guyana[Mesh] OR Haiti[Mesh] OR Honduras[Mesh] OR Hungary[Mesh] OR "Independent State of Samoa"[Mesh] OR India[Mesh] OR Indonesia[Mesh] OR Iran[Mesh] OR Iraq[Mesh] OR Jamaica[Mesh] OR Jordan[Mesh] OR Kazakhstan[Mesh] OR Kenya[Mesh] OR Korea[Mesh] OR Kyrgyzstan[Mesh] OR Laos[Mesh] OR Latvia[Mesh] OR Lebanon[Mesh] OR Lesotho[Mesh] OR Liberia[Mesh] OR Libya[Mesh] OR Lithuania[Mesh] OR "Macedonia (Republic)"[Mesh] OR Madagascar[Mesh] OR Malawi[Mesh] OR Malaysia[Mesh] OR Mali[Mesh] OR Malta[Mesh] OR Mauritania[Mesh] OR Mauritius[Mesh] OR "Melanesia"[Mesh] OR Mexico[Mesh] OR Micronesia[Mesh] OR "Middle East"[Mesh:NoExp] OR Moldova[Mesh] OR Mongolia[Mesh] OR Montenegro[Mesh] OR Morocco[Mesh] OR Mozambique[Mesh] OR Myanmar[Mesh] OR Namibia[Mesh] OR Nepal[Mesh] OR "Netherlands Antilles"[Mesh] OR "New Caledonia"[Mesh] OR Nicaragua[Mesh] OR Niger[Mesh] OR Nigeria[Mesh] OR Oman[Mesh] OR Pakistan[Mesh] OR Palau[Mesh] OR Panama[Mesh] OR "Papua New Guinea"[Mesh] OR Paraguay[Mesh] OR Peru[Mesh] OR Philippines[Mesh] OR Poland[Mesh] OR Portugal[Mesh] OR "Puerto Rico"[Mesh] OR "Republic of Korea"[Mesh] OR Romania[Mesh] OR Russia[Mesh] OR "Russia (Pre-1917)"[Mesh] OR Rwanda[Mesh] OR "Saint Kitts and Nevis"[Mesh] OR "Saint Lucia"[Mesh] OR "Saint Vincent and the Grenadines"[Mesh] OR Samoa[Mesh] OR "Saudi Arabia"[Mesh] OR Senegal[Mesh] OR Serbia[Mesh] OR Montenegro[Mesh] OR Seychelles[Mesh] OR "Sierra Leone"[Mesh] OR Slovenia[Mesh] OR "Sri Lanka"[Mesh] OR Somalia[Mesh] OR "South Africa"[Mesh] OR Sudan[Mesh] OR Suriname[Mesh] OR Swaziland[Mesh] OR Syria[Mesh] OR Tajikistan[Mesh] OR Tanzania[Mesh] OR Thailand[Mesh] OR Togo[Mesh] OR Tonga[Mesh] OR "Trinidad and Tobago"[Mesh] OR Tunisia[Mesh] OR Turkey[Mesh] OR Turkmenistan[Mesh] OR Uganda[Mesh] OR Ukraine[Mesh] OR Uruguay[Mesh] OR USSR[Mesh] OR Uzbekistan[Mesh] OR Vanuatu[Mesh] OR Venezuela[Mesh] OR Vietnam[Mesh] OR Yemen[Mesh] OR Yugoslavia[Mesh] OR Zambia[Mesh] OR Zimbabwe[Mesh])))

NOT

("animals"[mh] AND "humans"[mh])))

Appendix 2.3: Grey Literature Website search

Grey Literature Source	
USAID Development Experience Clearinghouse and program evaluations	DEC: https://dec.usaid.gov/dec/home/Default.aspx Project eval: http://www.usaid.gov/results-and-data/progress-data/evaluations
OECD	http://www.oecd-ilibrary.org/search/advanced;jsessionid=6mrj8k0ic8vbg.x-oecd-live-01
DFID R4D	http://www.dfid.gov.uk/R4D/Search/SearchResearchDatabase.aspx
World Bank / WSP	http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,menuPK:577938~pagePK:64165265~piPK:64165423~theSitePK:469372,00.html
WaterAid	http://www.wateraid.org/international/what_we_do/documents_and_publications/4939.asp
CARE	http://www.care.org/careswork/searchwork.asp
Water.org	
IRC International Water and Sanitation Centre	http://www.washdoc.info/page/53887
WHO	http://search.who.int/search?ie=utf8&site=default_collection&lr=lang_en&client=_en&proxystylesheet=_en&output=xml_no_dtd&oe=UTF-8&access=p&entqr=3&ud=1&proxycustom=%3CADVANCED/%3E
CDC	http://www.cdc.gov/Publications/
Health Management Information Consortium (HMIC) database	http://www.ovid.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=13051&catalogId=13151&langId=-1&partNumber=Prod-99
British Library of Development Studies Catalogue	http://bldscat.ids.ac.uk/
Bangladesh Rural Advancement Committee (BRAC)	http://www.bracresearch.org/
UNICEF	http://www.unicef.org/publications/index_pubs_wes.html
Water Engineering and Development Centre	https://wedc-knowledge.lboro.ac.uk/refine-search.html
NGO FORUM FOR PUBLIC HEALTH	http://www.ngof.org/resources00.php
RDRS Bangladesh	http://www.rdrsbangla.net/Page.php?pageId=MzgwNzM=
WSP	http://www.wsp.org/library
ELDIS	http://www.eldis.org/
icddr,b	Personal communication

Appendix 3: Draft text for the 'Request for Relevant Research Submissions' to be disseminated widely

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Dear colleague,

In order to inform effective WASH interventions that facilitate long-term behaviour change, we are working in collaboration with the International Initiative for Impact Evaluation (3ie) and the Evidence for Policy and Practice Information and Co-Ordinating Centre (EPPI-Centre) are working to conduct a systematic review to answer the following question:

"What factors affect sustained adoption of clean water and sanitation technologies?"

We would like to invite you to participate in our search by identifying relevant research to include in the review. In particular, if you know of studies (published or unpublished) that have assessed behaviour change / sustained adoption of water, sanitation or hygiene interventions please forward any documents or details to wash.adoption@gmail.com

Because we seek to capture all available evidence, we are grateful for your assistance in compiling grey literature as well as published and unpublished works that may not have been represented in our database searches. We will also share a copy of the completed systematic review when it is available later this year.

Yours sincerely,

Robert Dreibelbis, Department of International Health, The Johns Hopkins Bloomberg School of Public Health
Kristyna Hulland, Department of International Health, The Johns Hopkins Bloomberg School of Public Health
Luke McDonald, Department of Environmental Health, The Johns Hopkins Bloomberg School of Public Health
Farhana Sultana, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Dhaka, Bangladesh.
Kellogg Schwab, Department of Environmental Health, The Johns Hopkins Bloomberg School of Public Health
Peter Winch, Department of International Health, The Johns Hopkins Bloomberg School of Public Health

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