

Project Completion Report: Technical for the Asian Development Bank

15 January 2009

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in collaboration with the Ministry of Rural Development, Centre for Affordable Water and Sanitation Technology,
& Massachusetts Institute of Technology

Pilot and Demonstration Activity (PDA) for Cambodia: Adaptation and Verification of Arsenic Mitigation Technology

TA 6325 - REG: Promoting Effective Water Policies and Practices (Phase 5) – “RETA 6325”

As per the Letter of Agreement (LOA) between the Asian Development Bank (ADB) and Dr. Davin Uy, Director of Research and Development, Institute of Technology of Cambodia (ITC), the Project Completion Report is hereby submitted. The format of this Report follows that of the LOA and the Appendices 1 to 4. The requirements achieved are compared directly to the requirements set out in the LOA (in black text) for easier understanding how the project was conducted and completed (in blue text) versus those requirements.

The views expressed in this paper/presentation are the views of the author and do not necessarily reflect the views or policies of the Asian Development Bank (ADB), or its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequence of their use. Terminology used may not necessarily be consistent with ADB official terms.

The reporting requirements are provided in point number 3 of the LOA:

a) Submit the following minimum required reports, which will be subject to ADB's review and acceptance	Reports Submitted
(i) Project Inception Report: to be submitted one (1) month after signing of the Letter of Agreement;	➤ Project Inception Report was submitted on after signing of the LOA.
(ii) Project Mid-term Report: Financial and Technical, to be submitted two (2) months after the start of the PDA;	➤ Project Mid-term Report was submitted on 26th September 2008. We did not send it earlier because we would like to capture the findings and comments from the project mid-term stakeholders' consultation meeting in Phnom Penh on 26 th August 2008.
(iii) Project Completion Report: Financial and Technical, to be submitted within 30 days after completion of the PDA;	➤ This is the project completion report. This Project Completion Report is submitted in Jan 2009, within 30 days since the completion of the PDA
(iv) Detailed Summary of Expenditures (see Appendix 3) for payments made, <u>together</u> with proofs of payment and other supporting documents acceptable to ADB, to be submitted together with the Inception, Mid-Term and Completion Reports.	➤ Detailed Summary of Expenditures was submitted to ADB, with supporting documents, together with the Inception, Mid-term and Completion Reports.
(b) Without limiting the generality of the foregoing, the EA will also:	Reports Developed and Resources Expended

<p>(i) Furnish ADB all information and/or reports concerning the results of the different activities under the PDA;</p>	<ul style="list-style-type: none"> ➤ A report titled “Kanchan Arsenic Filter Evaluation of Applicability to Cambodia; Phase I Technical Report, September, 2008”, has been sent to ADB in September 2008. ➤ A follow-up report titled “Kanchan Arsenic Filter Evaluation of Applicability to Cambodia; Phase II Technical Report”, is expected to be completed in January 2009. A Technology Verification Lessons Learned report is attached to this Report. ➤ There were concerns by some stakeholders on the safety of the waste water generated by the filter. A paper explaining the safety of the sludge is attached with this report as well.
<p>(ii) Provide counterpart resources in cash or kind, where appropriate, to complement the available resources for the PDA;</p>	<ul style="list-style-type: none"> ➤ Counterpart resources in cash were provided by the Mondialogo Engineering Competition (US \$6,500) to partially offset the travel expenses of volunteers from CAWST and MIT, as well as to support additional water testing ➤ Contribution in kind has been provided through donated volunteer professional hours and personal funds from these individuals.
<p>(iii) Contribute materials that can be used to disseminate the PDA’s learning via RETA-6325 Promotion and Public Awareness and Knowledge Base components.... The contributions can be made in the form of case studies, write-ups for e-newsletter or website, among others; and</p>	<ul style="list-style-type: none"> ➤ The reports stated in (b) (i) above provide the basis for disseminating the PDA’s learning. It is anticipated that additional materials will be developed and presented at appropriate forums, including conferences, technical papers as well as training programs conducted by CAWST, MIT, ITC and others.

<p>(iv) Refund the ADB any unutilized funds in the original currency of payment within 30 days upon completion of the PDA.</p>	<p>➤ As this project met, and in some areas exceeded, the scope of work and accomplished all activities planned, and as personal funds were spent to extend and expand the studies, there are no unutilized funds to refund to ADB.</p>
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The LOA states; "The Executing Agency shall carry out the PDA described in Appendix 1 with due diligence and efficiency, and in accordance with the arrangements described in Appendix 1."

Appendix 1

Cooperation Fund for the Water Sector

PILOT AND DEMONSTRATION ACTIVITY (PDA)

Activity Title:	Adaptation and Verification of Arsenic Mitigation Technology
Executing Agency:	Institute of Technology of Cambodia
PDA Start Date:	10 February 2008
Activity End Date:	31 December 2008
Contact Details:	Dr. Davin Uy Director of Research and Development Institute of Technology of Cambodia Blvd. Pochentong, BP. 86 Phnom Penh, Cambodia

1. Objectives:

The first objective of the PDA to:

(i) verify the performance and suitability of the Kanchan Arsenic Filter (KAF) as an arsenic mitigation option for Cambodia context through field technical research and pilot demonstration;

The phase1 field testing results were consistently excellent. A tubewell in Kiensvay, kandal province, containing high arsenic and phosphate levels, worse than the average condition in arsenic-affected region in Cambodia, was selected as the testing site. 10 filters were installed, and they had an average 95-97% arsenic removal throughout the 11-months study (almost 13,000 liters of water filtered), reducing the raw water arsenic concentration of over 650 ug/L (micrograms per liter) to within the Cambodian

standards of 50 ug/L consistently. There was no observed trend of increasing arsenic contamination over the 11-months duration of the study, covering both the dry and wet seasons. The removal effectiveness for the other contaminants including; bacteria (*E.coli* and total coliform), phosphates, iron and turbidity were all encouraging and generally very consistent.

The phase 2 pilot testing results were very encouraging as well. A total of 30 filters were installed in Kandal and Prey Veng provinces, representing diverse water chemistry, including high and low ranges for parameters that can affect the filter performance. The filters were monitored for 3 months. All of the filters satisfied the 6 priority parameters of the Cambodian Drinking Water Standards for small water supplies, namely arsenic, iron, pH, turbidity, total dissolved solids, and *E. coli*) during the study. We expect many of these 30 filters will continue to perform well, matching the results in phase 1.

Overall, the filter performance in Cambodia has been excellent, and we believe that there is wide scope of applicability of the filter in Cambodia, as well as in other neighbouring countries. According to a national survey conducted by UNICEF and MRD in 2007, almost 20 % of rural households in Cambodia depend primarily on groundwater as their drinking water source, and filters can be an immediate solution for these households.

The second objective of the PDA to:

(ii) A technology verification guidance manual will be prepared based on the lessons learned in the field research and pilot demonstration studies to establish a general technology verification procedure which may be used to evaluate other water treatment technologies in the future.

The *Technology Verification Lessons Learned Report* has been prepared to provide a general technology verification procedure which may be used to evaluate other household water treatment technologies, and is attached to this Report.

2. Scope and location of Work / Description of Activities:

The specific activities under the Pilot and Demonstration Activity (PDA) are described in the table below:

Field Technical Research

	Activities from Project Plan/ Appendix 1 of LOA	Activities Accomplished	Achieved LOA?
Location of work	➤ 1 community near Phnom Penh	➤ A community in Kien Svay, Kandal province was selected	Yes
Scope of work	<ul style="list-style-type: none"> ➤ 10 filters in total (5 configurations) ➤ Monitored weekly ➤ Evaluated for technical performance 	<ul style="list-style-type: none"> ➤ 10 filters in total (5 configurations) were installed on Feb. 3, 2008 ➤ Monitored 3 times per week by ITC and/ or MRD staff for 11 months. ➤ Water samples were collected and tested weekly from Feb to Aug, and monthly from Sep to Dec. 	Yes
Description of activities	➤ Install 10 filters in 5 different configurations (2 of each) for testing under field conditions	➤ 5 configurations were installed (2 filters of each configuration) to see if any particular configuration improved results under field testing conditions	Yes
	➤ Supervised construction and installation	➤ Construction and installation was supervised by Dr. Davin Uy of ITC, and by CAWST staff	Yes

	<ul style="list-style-type: none"> ➤ 40 litres of water poured into each filter daily ➤ Weekly visits to assess filter performance ➤ Photos to be taken ➤ Samples of raw and filtered water collected and taken to ITC's lab for testing 	<ul style="list-style-type: none"> ➤ Every day, household owners poured 20L of water into each filter in the morning, and another 20L of water in the evening ➤ ITC and/or MRD staff visited the filters 3 times per week ➤ Photos were taken and included in reports ➤ Every week, water samples (raw and filtered) were collected and tested on site and at ITC laboratory 	Yes
	<ul style="list-style-type: none"> ➤ Testing for water quality parameters (chemical and biologic) 	<ul style="list-style-type: none"> ➤ Parameters tested include: arsenic, iron, phosphate, pH, turbidity, total coliform, and E. coli ➤ Selected samples preserved and sent to France and USA for cross-checking 	Yes
	<ul style="list-style-type: none"> ➤ Water is not being consumed 	<ul style="list-style-type: none"> ➤ Water was not consumed during the field technical study 	Yes
	<ul style="list-style-type: none"> ➤ Water quality results will be analyzed for best filter configuration 	<ul style="list-style-type: none"> ➤ Analysis indicated that pre-rusting the iron nails provided slight arsenic removal improvement during the initial week vs. original design. No apparent improvement from manual or mechanical aeration. 	Yes

	<ul style="list-style-type: none"> ➤ Data will be made available to all interested parties for review and comment 	<ul style="list-style-type: none"> ➤ Data were presented and made available to all interested during the mid-term stakeholder consultation meeting. ➤ We will present the research findings in various international conferences and forums in 2009 and beyond. ➤ We will put the research reports on the CAWST and MIT websites 	Yes
	<ul style="list-style-type: none"> ➤ A mid-term review meeting will be held to evaluate research results and revise strategies as needed 	<ul style="list-style-type: none"> ➤ A mid-term stakeholder consultation review meeting was held on 26th Aug 08 and results thoroughly discussed. ➤ A total of 26 participants from the government, NGOs, and research institutions attended the meeting ➤ Two key activities in the next phase were decided. First, to continue the on-going field research at Kien Svay, Kandal to observe long term trends. Second, we will test the filter in more challenging locations to determine the limitation of the filter, with close consideration on rusting characteristics and water chemistry. 	Yes
	<ul style="list-style-type: none"> ➤ A final meeting will be held to evaluate field research project, disseminate findings and prepare for next steps 	<ul style="list-style-type: none"> ➤ A final meeting was held on 2nd January 2009 to disseminate the final Phase 1 findings, together with the Phase 2 findings. A total of 38 participants, including government, NGOs, and research institutions, attended the final meeting. 	Yes

Pilot Demonstration Study

	Activities from Project Plan/ Appendix 1 of LOA	Activities Accomplished	Achieved LOA?
Location of work	<ul style="list-style-type: none"> ➤ 3 communities representative of Cambodia 	<ul style="list-style-type: none"> ➤ After consultation with project partners and stakeholders in during the mid-term consultation meeting, it was decided to install a total of 30 in 2 provinces for the following reasons: <ul style="list-style-type: none"> ○ Unexpected delay in the start of Phase 2 due to national election and political tension ○ More useful scientific information can be extracted from the study design by installing less number of filters, but testing at greater frequency ○ Logistically difficult to visit many communities and many filters due to resource limitation 	Partially
Scope of work	<ul style="list-style-type: none"> ➤ 60 total filters installed ➤ Visited weekly for 6 months ➤ Assess technical performance and social acceptance 	<ul style="list-style-type: none"> ➤ Phase 2 was slightly delayed and scope was changed for reasons discussed above. ➤ Technical testing and social survey were successfully conducted. 	Partially

Description of activities	<ul style="list-style-type: none"> ➤ Install 20 filters in each of three communities representative of Cambodia using best configuration developed in field technical research 	<ul style="list-style-type: none"> ➤ A total of 30 filters were installed in communities representative of Cambodia ➤ The original design was determined to be the best design, and this configuration was installed in the households ➤ Filters were constructed and installed by a local NGO, ITC and MRD. 	Yes
	<ul style="list-style-type: none"> ➤ Conduct arsenic awareness raising, health education campaign and community consultation in each of the three communities 	<ul style="list-style-type: none"> ➤ Arsenic awareness education, and filter operation and maintenance procedure, were given to the filter households. ➤ During each of the filter testing/ follow-up visit, we reinforce arsenic awareness message to the households 	Yes
	<ul style="list-style-type: none"> ➤ Households selected for filters on basis of demand 	<ul style="list-style-type: none"> ➤ From the mid-term review, it was decided that we will test the filter in more challenging locations to determine the limitation of the filter, with close consideration on rusting characteristics and water chemistry. As such, the households in Phase 2 study were selected according to this criterion. ➤ Nevertheless, over 90% of the filter receiving households depends on groundwater for their drinking water source for both the dry and wet seasons. 	Yes

	<ul style="list-style-type: none"> ➤ Households with filters to receive instructions on proper O&M as well as health and hygiene practices 	<ul style="list-style-type: none"> ➤ As discussed above, the households with filters received instruction on arsenic awareness, filter operation, maintenance, and health and hygiene at the time of filter installation, and during follow-up filter testing and monitoring visits 	Yes
	<ul style="list-style-type: none"> ➤ Households will use filter as needed and drink from filter 	<ul style="list-style-type: none"> ➤ As part of the recommendations from the mid-term review meeting, it was decided that the households should not drink the filtered water yet, until the ADB project is complete, and final technical report is prepared. Then the key policy-makers and stakeholders will discuss on the findings and recommend on filter usage policy. 	No, but Good
	<ul style="list-style-type: none"> ➤ Two in-depth assessments will be conducted: 1st: after 2-3 months 2nd: after 4- 5 months ➤ Including technical and social components 	<ul style="list-style-type: none"> ➤ Technical testing was conducted 3 times, in October, November, and December 08. ➤ The filtered water for all 30 filters was tested for the 6 priority parameters according to the Cambodian drinking water standards, ➤ Social survey was conducted in December 08. 	Yes
	<ul style="list-style-type: none"> ➤ Raw and filtered water will be tested 	<ul style="list-style-type: none"> ➤ Both the raw and filtered water were tested for the 6 priority parameters as discussed above. 	Yes
	<ul style="list-style-type: none"> ➤ Social Assessment; Interviews with Users and Focus Group Meetings to evaluate: 	<ul style="list-style-type: none"> ➤ A social survey questionnaire form was prepared, and administered by MRD staff in December 08 to all 30 filter households ➤ The survey contains question pertaining to 	Yes

	<ul style="list-style-type: none"> • user acceptance • rate of sustained use • perceived benefits • perceived costs and barriers • proper use • other relevant factors that may affect sustainability 	user acceptance, usage rate, perceived benefits, perceived costs, perceived barriers, and proper use.	
	➤ Data compiled and analyzed and made available for review and comment	<ul style="list-style-type: none"> ➤ The phase 2 findings, including technical and social results, were presented and thoroughly discussed during the final project stakeholders consultation meeting, held on 2nd Jan 09. ➤ Copies of the PowerPoint presentation were given to all participants and other relevant stakeholders who were unable to attend. ➤ We will compile all technical findings into a final technical report, and will disseminate the report among all interested parties. 	Yes
	➤ A final meeting to disseminate findings and to coordinate next steps	➤ The final meeting was held on 2 nd Jan 09 to disseminate findings and to coordinate next steps.	Yes

	<p>➤ A technology verification guidance manual will be prepared based on the lessons learned in the field research and pilot demonstration studies</p>	<p>➤ A technology verification lessons learned report has been prepared, and is attached with this report.</p>	<p>Yes</p>
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3. Implementation Schedule and Institutional Management Arrangements:

- ITC will be the executing agency (EA) for this project with the Ministry of Rural Development as the government counterpart.
- Technical assistance will be provided by CAWST and MIT
- The Provincial Department of Rural Development (PDRD) will be involved in both phases
- The project will be implemented over a period of about ten (10) months as detailed in the implementation schedule below:

x = Project Plan/ Appendix 1 of LOA = Actual schedule followed

<u>Activities</u>	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Research start-up meeting	X <input checked="" type="checkbox"/>											
Research filters installation	X <input checked="" type="checkbox"/>											
Research filters weekly monitoring	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	X <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Research mid-term review						X	<input checked="" type="checkbox"/>					
Demo study start-up meeting						X	<input checked="" type="checkbox"/>					
Demo study community training and orientation						X		<input checked="" type="checkbox"/>				

Demo study filters installation						X		<input checked="" type="checkbox"/>				
Demo study monthly monitoring						X	X	X	X	X	X	
Demo study 1 st round assessment							X	X	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
Demo study 2 nd round assessment									X	X	<input checked="" type="checkbox"/>	
Project evaluation										X	X	<input checked="" type="checkbox"/>
Overall project completion & dissemination meeting											X	<input checked="" type="checkbox"/>

4. Expected Results (Outputs/Outcomes)

This PDA is expected to achieve the following outcomes (From Project Plan/ Appendix 1 of LOA):	Outcomes
<ul style="list-style-type: none"> If found suitable for Cambodian context, the KAF [Kanchan Filter] is adopted as one of the arsenic mitigation technologies and incorporated in CAWST regular training activities in Cambodia and in the region, teaching local organizations, private sector, and government on proper construction and installation of filters. 	<ul style="list-style-type: none"> CAWST has carefully documented all the findings and learning from this PDA, and has started the process of incorporating the KAF into its regular training activities
<ul style="list-style-type: none"> Increased capacity within ITC and in MRD for verifying arsenic mitigation technologies suitable to Cambodia. 	<ul style="list-style-type: none"> Built knowledge and capacity of ITC on water treatment and field research, especially in quality assurance and quality control Built knowledge and capacity of MRD in household water treatment technologies, verification process, field work, and project management
<ul style="list-style-type: none"> Increased public awareness on the use of KAF 	<ul style="list-style-type: none"> Villagers in the project communities are satisfied with the filter Many neighbouring households who did not get a filter are demanding for further filter dissemination
<ul style="list-style-type: none"> Improved quality of water 	<ul style="list-style-type: none"> Phase 1 and Phase 2 studies demonstrated the excellent technical performance of the filter, meeting the Cambodian standards

5. Measurable Performance Indicators:

Performance Indicator	Measurement and comment
Number and quality of filters installed	10 filters in Kiensvay, Kandal province in Phase 1; 30 filters in Kandal and Prey Veng provinces in Phase 2; All filters are performing very well
Percent of filters meeting Cambodian arsenic guidelines	99% of all filtered water samples met the Cambodian arsenic guideline.
Number of people oriented on KAF	Our training directly reached 31 households, about 200 people. But the positive word-of-mouth effect was surprisingly strong. Many households, whom we did not directly contact, have heard about the filter from their neighbours, and wanted to obtain a filter.
Number of users satisfied with performance	According to the social survey results of 30 households: 97% likes the filter because the filter is easy to operate, and/or the water is clear and safe. 3% dislike the filter because it is big and heavy.
Number of households using the filter	1 household in phase 1; 30 households in phase 2
Number of organizations interested to implement the filter	Plenty.
Upscaling potential in different regions of Cambodia and nearby countries	Very promising, especially given that our phase 2 study has shown that the filter can perform under

a wide range of water chemistry.

Stakeholders Participation:

Stakeholder participation takes several forms in each of the two phases and at different stages as shown in the table below.

A '**YES**' is shown if the Stakeholder Participation is generally in line with the expectations for this stakeholder, otherwise a '**NO**' is shown.

	Field Technical Research		Pilot and Demonstration Study	
Stakeholder participation: <i>National-level MRD</i>	<ul style="list-style-type: none"> • Communicate and coordinate with other governmental ministries and stakeholders through the monthly watsan meetings and other avenues • Coordinate with ITC to host start-up meeting and mid-term review meeting • Prepare communications materials to explain project progress and outcomes • Collaborate with PDRD to assist ITC to conduct filter installation, monitoring, and troubleshooting • Collaborate with ITC to keep records on technology verification process 	YES	<ul style="list-style-type: none"> • Overall co-management of project with ITC • Communicate and coordinate with other governmental ministries and stakeholders through the monthly watsan meetings and other avenues • Coordinate with ITC to host start-up meeting and final project completion meeting • Schedule internal management meetings • Prepare meeting minutes • Lead -up activities, with support from ITC and PDRD • Keep records on technology verification process, and prepare a technology verification manual, with support from ITC and CAWST • Assist ITC to prepare final project 	YES

			completion report	
Stakeholder participation: <i>PDRD</i>	<ul style="list-style-type: none"> • Assist national-level MRD and ITC to conduct filter installation, monitoring, and troubleshooting • Assist national-level MRD to provide guidance on field site selection • Facilitate communications with local authorities • Mobilize local resources to support project activities 	YES	<ul style="list-style-type: none"> • Assist national-level MRD to conduct community awareness, follow-up monitoring, and project evaluation activities • Assist national-level MRD to provide guidance on field site selection • Facilitate communications with local authorities • Mobilize local resources to support project activities 	YES
Stakeholder participation: <i>CAWST</i>	<ul style="list-style-type: none"> • Liaison between ADB and project partners • Provide technical assistance on filter construction, testing and verification process • Deliver necessary education and specialized training • Oversee filter construction and installation • Participate in monitoring and evaluation process • Assist ITC to prepare research documents 	YES	<ul style="list-style-type: none"> • Liaison between ADB and project partners • Provide technical assistance on filter construction, testing and verification process • Deliver necessary education and specialized training to other NGOs on filter construction and installation • Oversee filter construction and installation • Participate in monitoring and evaluation process • Assist ITC to prepare research documents 	YES

Stakeholder participation: <i>MIT</i>	<ul style="list-style-type: none"> • Provide technical knowledge on scientific principles, filter design, troubleshooting methods, and research methodology • Exchange information on arsenic mitigation efforts from Nepal, Bangladesh, India, Ghana • Disseminate research findings to the international scientific community 	YES	<ul style="list-style-type: none"> • Provide technical knowledge on scientific principles, filter design, troubleshooting methods, and research methodology • Exchange information on arsenic mitigation efforts from Nepal, Bangladesh, India, Ghana • Disseminate research findings to the international scientific community 	YES
Stakeholder participation: <i>Other local NGOs and private sector</i>	<ul style="list-style-type: none"> • Provide comments on the research design, site selection, and analytical methods • Share data when appropriate to assist research activities 	YES	<ul style="list-style-type: none"> • Potentially incorporate pilot study activities with existing their arsenic mitigation activities • If KAF performance is verified, then private entrepreneurs can be trained by CAWST on filter construction and sales 	YES

End of Appendix 1 and the Technical Requirements in the LOA

End of Document