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Report No: ICR00005467

IMPLEMENTATION COMPLETION AND RESULTS REPORT

TF-17336; TF-B3715

ON

GRANTS FROM THE GLOBAL ENVRIONMENT FACILITY
AND THE
POLLUTION MANAGEMENT AND ENVIRONMENTAL HEALTH MULTI DONOR TRUST FUND

IN THE AMOUNT OF US$8.85 MILLION

TO THE

ARAB REPUBLIC OF EGYPT

FOR A

EGYPT: SUSTAINABLE PERSISTENT ORGANIC POLLUTANTS (POPS) MANAGEMENT PROJECT

June 28, 2022

Environment, Natural Resources & The Blue Economy Global Practice
Middle East And North Africa Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective Dec 31, 2021)

Currency Unit =	US$
EGP 15.71 =	US$1
0.064 US$ =	EGP1

FISCAL YEAR
July 1 - June 30

Regional Vice President:	Ferid Belhaj
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ABBREVIATIONS AND ACRONYMS

CPF	Country Partnership Framework
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egyptian Electricity Holding Company
ERR	Economic Rate of Return
ESF	Environmental and Social Framework
GC	Greater Cairo
GDP	Gross Domestic Product
GEF	GEF Global Environment Facility
GNSC	GEF National Steering Committee
GHG	Greenhouse Gas
GoE	Government of Egypt
GM	Grievance Mechanism
GRS	Grievance Redress Service
ICR	Implementation Completion & Results Report
IFR	Interim un-audited Financial Report
ISN	Interim Strategy Note
ISR	Implementation Status & Results Report
M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation
MENA	Middle East and North Africa
MoE	Ministry of Environment
MoERE	Ministry of Electricity and Renewable Energy (formerly MOEE)
MSEA	Ministry of State for Environmental Affairs
MTR	Mid-Term Review
NGO	Nongovernmental Organization
NIP	National Implementation Plan
NPV	Net Present Value
PCBs	Polychlorinated Biphenyls
PCU	Project Coordinating Unit
PDO	Project Development Objective
PMEH	Pollution Management and Environmental Health
PMU	Project Management Unit
POM	Project Operations Manual
POPs	Persistent Organic Pollutant
PPE	Personal Protective Equipment
PPS	Project Preparation Study
PPSC	POPs Project Steering Committee
SC	Steering Committee
SDS	Sustainable Development Strategy

TABLE OF CONTENTS

DATA SHEET

BASIC INFORMATION

Product Information

Project ID	Project Name
P116230	Egypt: Sustainable POPs Management Project
Country	**Financing Instrument**
Egypt, Arab Republic of	Investment Project Financing
Original EA Category	**Revised EA Category**
Full Assessment (A)	Full Assessment (A)

Organizations

Borrower	Implementing Agency
Arab Republic of Egypt	Egypt Environmental Affairs Agency (EEAA)

Project Development Objective (PDO)

Original PDO

The project development objective is to improve the management and disposal of targeted stockpiles of obsolete pesticides, including Persistent Organic Pollutants (POPs) and Polychlorinated Biphenyl (PCBs), in an environmentally sound manner.

FINANCING

	Original Amount (US$)	Revised Amount (US$)	Actual Disbursed (US$)
World Bank Financing			
TF-17336	8,100,000	8,100,000	8,093,464
TF-B3715	750,000	749,312	749,312
Total	**8,850,000**	**8,849,312**	**8,842,776**
Non-World Bank Financing			
Borrower/Recipient	15,500,000	15,650,000	15,650,000
Total	**15,500,000**	**15,650,000**	**15,650,000**
Total Project Cost	**24,350,000**	**24,499,312**	**24,492,776**

KEY DATES

Approval	Effectiveness	MTR Review	Original Closing	Actual Closing
13-Jun-2014	08-Sep-2014	21-Jan-2018	30-Jun-2021	31-Dec-2021

RESTRUCTURING AND/OR ADDITIONAL FINANCING

Date(s)	Amount Disbursed (US$M)	Key Revisions
14-Aug-2018	2.75	Change in Loan Closing Date(s)
16-Sep-2020	4.94	Additional Financing Change in Results Framework Change in Components and Cost Change in Loan Closing Date(s) Reallocation between Disbursement Categories
25-Jun-2021	5.54	Change in Loan Closing Date(s) Reallocation between Disbursement Categories

KEY RATINGS

Outcome	Bank Performance	M&E Quality
Moderately Satisfactory	Moderately Satisfactory	Substantial

RATINGS OF PROJECT PERFORMANCE IN ISRs

No.	Date ISR Archived	DO Rating	IP Rating	Actual Disbursements (US$M)
01	28-Oct-2014	Satisfactory	Satisfactory	.10
02	30-Apr-2015	Satisfactory	Satisfactory	.70
03	06-Aug-2015	Satisfactory	Moderately Satisfactory	.70
04	12-Feb-2016	Moderately Satisfactory	Moderately Satisfactory	.70
05	11-Sep-2016	Moderately Satisfactory	Moderately Unsatisfactory	.70
06	25-Jan-2017	Moderately Satisfactory	Moderately Unsatisfactory	1.24
07	03-Aug-2017	Moderately Satisfactory	Moderately Satisfactory	1.42
08	25-Mar-2018	Moderately Satisfactory	Moderately Satisfactory	2.43
09	14-Nov-2018	Moderately Satisfactory	Moderately Satisfactory	3.27
10	10-Jun-2019	Moderately Satisfactory	Moderately Satisfactory	3.51
11	14-Dec-2019	Moderately Satisfactory	Moderately Satisfactory	4.76
12	22-Jun-2020	Moderately Satisfactory	Moderately Satisfactory	5.04
13	21-Dec-2020	Moderately Satisfactory	Moderately Satisfactory	5.25
14	19-Jul-2021	Satisfactory	Satisfactory	5.64

SECTORS AND THEMES

Sectors

Major Sector/Sector	(%)
Agriculture, Fishing and Forestry	**10**
Public Administration - Agriculture, Fishing & Forestry	10
Industry, Trade and Services	**90**
Other Industry, Trade and Services	90

Themes

Major Theme/ Theme (Level 2)/ Theme (Level 3)	(%)
Private Sector Development	**100**
Jobs	100
Environment and Natural Resource Management	**100**
Environmental Health and Pollution Management	90
Air quality management	30
Water Pollution	30
Soil Pollution	30
Environmental policies and institutions	10

ADM STAFF

Role	At Approval	At ICR
Vice President:	Inger Andersen	Ferid Belhaj
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Director:	Junaid Kamal Ahmad	Ayat Soliman
Practice Manager/Manager:	Charles Joseph Cormier	Lia Carol Sieghart
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I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

A. CONTEXT AT APPRAISAL

Context

1. **The cost of environmental degradation in Egypt was high and its burden fell disproportionately on the poor**. Air quality, water pollution, land degradation and desertification as well as hazardous and solid waste management are key contributors to environmental degradation in Egypt. For many years, there was widespread use of chemicals in a large spectrum of sectors. In rural areas, agrochemicals were extensively used in agriculture.[1] In industrial areas, toxic chemicals were widely used in a multitude of sectors found in every town and in urbanized areas throughout the country, such as textiles, tanning and metal finishing, mining, and processing manufacturing. In addition, a growing number of chemicals were used in homes and surrounding domestic environments.

2. **Obsolete pesticides (OPs) constituted an immediate threat to the health of humans and livestock**, particularly since they were often improperly stored in populated areas, which could leak into and contaminate groundwater and the environment.[2] DDT and lindane were officially prohibited from agricultural use in Egypt in 1980, and in 1996 a Ministerial Decree prohibited the import and use of multiple persistent organic pollutants (POPs) pesticides including aldrin, dieldrin, endrin, chlordane, heptachlor, DDT, toxaphene and lindane.[3] There were at least three factors that contributed to indiscriminate dumping and possible scavenging: (i) the absence of designated and environmentally sound, storage and disposal sites in Egypt, (ii) the high cost of export to proper disposal facilities, and iii) the lack of local (incineration) facilities that were in compliance with international standards.

3. **Polychlorinated Biphenyls (PCBs) are one of the 21 POPs under the Stockholm Convention**[4], with typical applications in the power sector as insulation and/or cooling fluid in transformers and dielectric fluid in capacitors. A study conducted in 2009 in the Egyptian power sector found that there were approximately 100,000 transformers in the country and 10-40% of these were believed to be contaminated by PCBs. Many of these transformers were in various states of online and offline use and haphazardly stored on plant premises. PCBs are persistent and transported through air – by evaporating and re-condensing – the so-called “global distillation”. Due to its chemical and bio-chemical stability and its high solubility in fatty tissue, the substance enters the food chain as a bio-accumulator. Studies in Egypt have found evidence of POPs and PCBs infiltrating water systems and contaminating food, polluting residential areas, ports, irrigation canals, and found in coastal sediments and fish (see Annex 4 for references to local studies).

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[1] In Egypt, cotton fields were treated with insecticides before 1950 and from 1950–1955, some cotton fields were treated using DDT. Major obsolete pesticides (OPs) used in Egypt during a 30-year period were toxaphene (1955–1961), endrin (1961–1981), DDT (1952–1971), and lindane (1952–1978).

[2] Mansour SA., 2009. Persistent organic pollutants (POPs) in Africa: Egyptian scenario. *Human & Experimental Toxicology* 28(9):531–566.

[3] Sallam KI, Morshedy AM. 2008. Organochlorine pesticide residues in camel, cattle and sheep carcasses slaughtered in Sharkia Province, Egypt. *Food Chemistry* 108:154–164.

[4] The Stockholm Convention on Persistent Organic Pollutants (May 2001) was aimed at reducing and eliminating releases of twelve of the most dangerous POPs to human health, including eight pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, and toxaphene); two industrial chemicals (polychlorinated biphenyls or PCBs and hexachlorobenzene); and three unintended by-products (polychlorinated dibenzo-p-dioxins and dibenzofurans, hexachlorobenzene, and PCBs).

4. **Recognizing the importance of the issue, the GOE ratified the Stockholm Convention on POPs and completed a National Implementation Plan (NIP) in accordance with the requirements of the Convention**.[5] The NIP (i) provided an assessment of the older generation of transformers and condensers, manufactured before the 1980s which contained PCBs that were being phased out and needed proper storage and disposal measures; and (ii) provided a preliminary inventory of industrial source wastes which had the potential to generate comparatively high quantities of dioxins and furans during disposal. The NIP also recommended actions on the : (i) amendment of laws and legislation; (ii) completion of an inventory and collection and processing information about sources and emissions of POPs, PCBs and dioxins and furans; (iii) completion of a database on hot spots and remediation of the contamination sites; (iv) disposal of obsolete pesticides and PCBs; (v) improvement of coordination between the Ministry of Environment (MoE: formerly the Ministry of State for Environmental Affairs) and other institutions; (vi) strengthening environmental inspection, monitoring, evaluation and reporting; and (vii) establishing a mechanism for information exchange and community participation.

5. **To help achieve the goals highlighted in the NIP, the GOE sought funding from the GEF through the World Bank**. The GEF Council approved the project concept in June 2009. A Project Preparation Study, completed in October 2011, found that POPs pesticides (including new POPs) accounted for 10 to 30 percent of the estimated 2,250 to 4,600 tons of obsolete pesticides in Egypt, mostly stored in inadequate conditions. There were more than 100,000 transformers in the distribution systems, of which about 40 percent contained high concentration PCBs (i.e., above 50 parts per million). Most of these PCBs were contained but leakage could result from old and damaged equipment or maintenance and repair. In 2014, the project funded by the GEF was launched to address targeted stockpiles of obsolete pesticides, including POPs and PCBs – the Egypt Sustainable POPs Management Project (P116230).

Bank rationale for engagement

6. **The World Bank had extensive experience with hazardous waste management in many regions and the design of the project was able to draw from the lessons learned from POPs projects in Eastern Europe and South Asia.** The design of the project benefited from the operational experience of previous Bank involvement in Egypt and also international experience in implementing POPs reduction projects, for example among the GEF-funded projects in Moldova, Sri Lanka, and in many countries of Africa (and under the auspices of the Africa Stockpiles Program). Due to the highly, but necessary, regulated approach to handling and managing hazardous waste in projects, the World Bank's comparative advantage in its fiduciary and safeguards procedures was appropriate.

Higher-level objectives

7. **The project was consistent with the Interim Strategy Note for Egypt (ISN)**,[6] which focused on economic management, jobs and inclusion and the World Bank's regional strategy[7] and falls within the provision of inclusion[8], and was especially relevant to the sub-objectives of improving air and water quality and improving water and sanitation.

[5] National Implementation Plan (NIP) for Implementation of the Stockholm Convention: July 2005.
[6] The World Bank Group's Interim Strategy Note for Egypt (Report # 66443-EG) discussed by the Executive Directors on May 31, 2012.
[7] Regional Update 2013. Middle East North Africa: Engaging toward Shared Prosperity.
[8] Inclusion included: improving management of water, sanitation and irrigation systems; improving air and water quality; and expanding access to healthcare.

8. **The project directly contributed to the overall objectives of the Stockholm Convention to protect human health and the environment from POPs**; and specifically responding to Article 3 of the Convention on measures to reduce or eliminate releases from intentional production and use; Article 6 on measures to reduce or eliminate releases from stockpiles and wastes, and Article 10 on public information, awareness and education.

9. **The project was also fully aligned with the GEF strategy for Chemicals and its objective to phase out POPs and their release while contributing to strengthening Egypt's capacity for sound chemicals management**. The project was a first and substantial step towards the elimination of POPs in Egypt. Building capacity to manage POPs would allow the GOE to continue the program after project completion, through a "*learning by doing*" approach and demonstration activities for the disposal of POPs. The focus was to develop capacity to manage obsolete stockpiles and PCBs on a priority basis and to implement a systematic process (blueprint) for sustainable management practices.

Theory of Change (Results Chain)

10. The Project's theory of change (TOC) was not formally developed at appraisal. The ICR team prepared the following (TOC) based on the Project description in the Project Appraisal Document (PAD).

11. **The Project's TOC was organized around the two development outcomes: to improve the capacity of Egypt to *manage* POPs and PCBs and to *dispose* of POPs and PCBs.** Both outcomes included interventions in the MALR, MoERE and EEAA and conducted in an environmentally sound manner. The first results chain financed the capacity building and training of the MALR and EEAA in the tracking, packaging, removal, transport and disposal of high-risk OPs through incineration (internationally and locally) and also supplying the MALR with equipment for testing and analysis of OPs. The EEAA would also institute a Decree regulating the safe use and disposal of agricultural pesticides and would also receive air quality monitoring and laboratory equipment (through additional financing) to analyze air quality sample. Support to the MoERE included inventorying and bar coding of PCB containing equipment, training on procedures for decontamination of PCB-containing equipment and the provision of laboratory equipment to measure the level of PCB contamination in transformer oils. The MoERE would also issue a regulatory ban on the resale of out-of-service transformers that could contain PCBs. This capacity and support to MALR, MoERE and EEAA were intended to improve the targeting of OP and PCB cleanup operations.

12. **The second results chain would strengthen the government's capacity to dispose POPs and PCBs** in an environmentally sound manner**.** These activities include the safe packaging, removal, transportation, export and ultimate destruction of 1,000 tons of high-risk OP stocks in state-of-the-art incineration facilities overseas, with local options to be explored to reduce costs and continue disposal of any residual stockpiles (i.e., through cement kiln incineration). For PCBs, activities would include the acquisition and installation of equipment for decontamination and purification of low to medium-concentration stocks to treat 1000 tons of PCB contaminated oils, and producing an oil suitable for reuse in transformers. All treatment and transport procedures would be in accordance with the EMPs/ESIAs developed for each site and in accordance with guidelines in the Stockholm and Basel Convention.

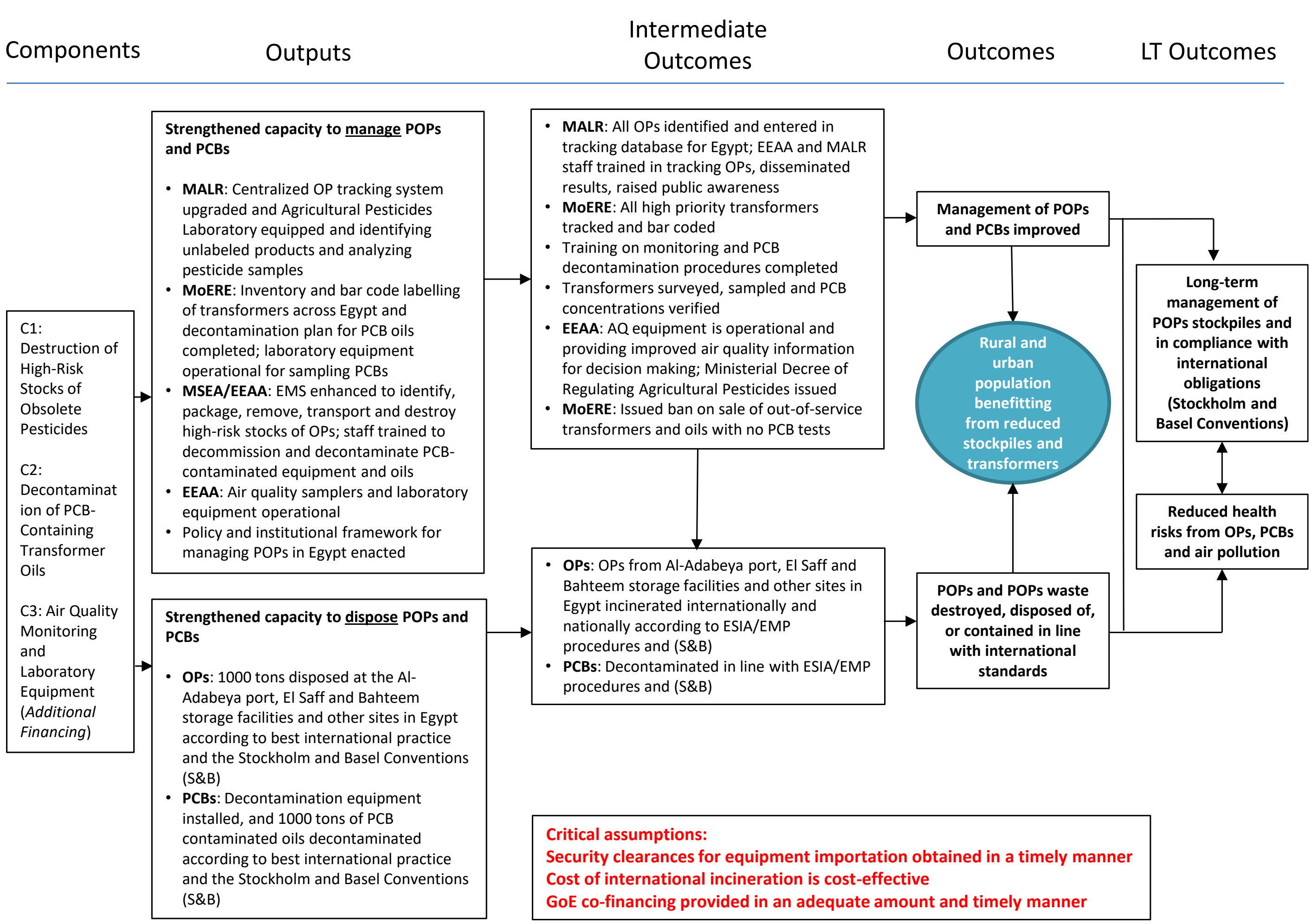
13. **Activities would be implemented in an "environmentally sound manner" in accordance with the requirements of the Stockholm and Basel Conventions,** which offers the following definition of environmentally sound management on PCBs, and relevant to all POPs and to both parts of the PDO: "*Environmentally sound management of hazardous wastes or other wastes means taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects, which may result from such wastes*" (article 2 paragraph 8, Basel Convention). A set of technical guidelines developed by UNEP operationalizes

this definition by defining "the practicable steps" related to the safe handling of PCBs in the document "**PCB Transformers and Capacitors from Management to Reclassification and Disposal.**" Similarly, the Secretariat for the Stockholm Convention also developed, **"Guidelines on best available techniques and guidance on best environmental practices"** for handling POPs.

14. **Project outcomes would support Egypt's long-term objective of managing POPs stockpiles in compliance with the Stockholm and Basel Conventions and protect human health from POPs risks**. This includes the 3.1 million direct project beneficiaries working in or living near the Project sites.

15. **The main assumptions to the achievement of outcomes include both internal and external factors**. The project will include the procurement of goods that require timely internal security clearances for the import of equipment. In addition, the cost of international incineration is deemed to be a cost-effective disposal option (otherwise alternative local solutions would need to be developed). Finally, the Government of Egypt has committed to provide sufficient and timely co-financing to support project activities.

Figure 1. Theory of Change at preparation



Project Development Objectives (PDOs)

16. The project development objective is to improve the management and disposal of targeted stockpiles of obsolete pesticides, including Persistent Organic Pollutants (POPs) and Polychlorinated Biphenyl (PCBs), in an environmentally sound manner.

Key Expected Outcomes and Outcome Indicators

17. The key expected outcome was strengthened capacity to manage and safely dispose of OPs and PCBs. The PDO-level results indicators to assess the achievement of this outcome were: 1) Persistent Organic Pollutants (POPs) pesticides and POPs waste destroyed, disposed of, or contained in an environmentally sound manner (tons), and 2) direct project beneficiaries (number), of which female (%).

Components

18. **Component 1: Destruction of High-Risk Stocks of Obsolete Pesticide** (US$ 3.83 million): The component was designed to disposal of high risk stocks known and inventoried at time of project appraisal, and those that could be identified as high risk stocks through a first level risk assessment. Activities included: 1) Carrying out an environmentally sound program for the safe packaging, removal, transportation, export and destruction of approximately 1,000 tons of identified high risk stocks of pesticides and other high-risk obsolete pesticides, following a risk-based prioritization approach, in state-of-the-art facilities overseas, 2) upgrading MALR's Central Agricultural Pesticides Laboratory to identify unlabeled products and analyze pesticide samples, and 3) enhance the EMS of MSEA/EEAA to identify, package, remove, transport and destroy high-risk stocks of OPs.

19. **Component 2: Decontamination of PCB-Containing Transformer Oils** (US$ 4.27 million): The component was designed to procure equipment for dechlorination and purification of PCB-contaminated oils, which will produce oil suitable for reuse in equipment. Activities included: 1) carrying out of a management program of PCBs and PCB-containing equipment in the public electricity generation, transmission and distribution sectors, including: (a) the acquisition and installation of equipment for dechlorination and purification of low to medium-concentration stocks of approximately 1000 tons of PCB contaminated oils; (b) providing technical assistance to EEAA and MoERE/EEHC staff to address the decommissioning of PCB-containing equipment; (c) provision of laboratory support and the acquisition and utilization of instruments, electronic equipment and chemicals for sampling to measure the level of PCBs; and 2) enhance the environmental management system of MSEA/EEAA to identify and decontaminate PCB-contaminated oils, including training of staff of EEAA and the Cooperating Ministries to track, monitor and decontaminate PCBs and PCB-containing equipment to ensure sustainable project outcomes, monitoring of project performance indicators, and dissemination of results, including raising public awareness.

B. SIGNIFICANT CHANGES DURING IMPLEMENTATION (IF APPLICABLE)

Revised PDOs and Outcome Targets

20. The PDO and outcome targets were not revised.

Revised PDO Indicators

21. The PDO indicators were not revised, however PDO indicator #2 (Direct project beneficiaries) was underestimated at appraisal since it only included the surrounding population at Al-Adabeya port, El Saff and Bahteem storage facilities (approximately 30,000) and should have included the population in the other (OP and PCB) sites in Egypt, which in the case of OPs grew from 35 to 65 sites once the OP inventory was reviewed and cleanup plans finalized. Similarly, the affected population around PCB sites could not be fully determined ex ante until the transformer sampling revealed the PCB concentration – warranting treatment and thus the optimal transport routing to avoid populated areas. After accounting for these additional OP and PCB sites, the revised number of beneficiaries increased from 30,000 to 3.1 million.

Revised Components

22. Components 1 and 2 were not revised. Component 3: Air Quality Monitoring and Laboratory Equipment was added as part of the Additional Financing described below. The activity was to support the purchase of air quality monitoring and laboratory equipment to capacitate the GoE to perform apportionment of air pollution sources and other chemical substances. Since the grant was only $750,000 – it was more efficient to use an existing and experienced PMU and fiduciary processes than a new, stand-alone PMU. To measure the performance of this activity, an intermediate outcome indicator, "*AQ equipment is operational and providing improved air quality information for decision making*", was added to the results framework.

Other Changes

23. **Level 2 restructuring approved on August 29, 2018**: The project was granted the first extension of the closing date from November 30, 2018, to September 30, 2020, to complete the PCB inventory, the Feasibility Study for decontamination, the procurement process and treatment of the 1000 tons of PCB oils.

24. **Additional Financing signed on September 16, 2020**: The project was provided Additional Financing by adding Component 3: Air Quality Monitoring and Laboratory Equipment for the purchase of air quality monitoring and laboratory equipment. The restructuring also included an extension of the closing date of the parent grant (GEF) from September 30, 2020, to June 30, 2021 (aligning with the closing date with AF) to complete the decontamination of PCB oils in Component 2.

25. **Level 2 restructuring, approved on June 25, 2021**: The project was provided a third extension of the closing date from June 30, 2021, to December 31, 2021, to accommodate the delivery of the PCB decontamination equipment and begin disposal operations.

Rationale for Changes and Their Implication on the Original Theory of Change

26. The changes do not affect the Theory of Change.

II. OUTCOME

A. RELEVANCE OF PDOs

Rating: High

Assessment of Relevance of PDOs and Rating

27. **The project is highly relevant to the World Bank's engagement in Egypt.** Environmental sustainability is considered a long-term issue for Egypt and is a cross-cutting theme in World Bank's Country Partnership Framework (CPF) FY2015-2019 (extended until 2021). The project remains consistent with the objectives of the CPF, for instance Objective 2.4: *Enhanced access to improved agriculture and irrigation services* where the project safely managed and disposed of obsolete pesticide stockpiles – an externality of agricultural production. Likewise, PCBs are a residual by-product of energy production, and their safe treatment contributes to Objective 2.2: *Improved energy generation capacity and energy efficiency*. The CPF also recognizes that "environmental degradation negatively affects health as well as prospects for future economic growth," and identifies air, water and soil pollution among its environmental challenges. The 2021 Systematic Country Diagnostic (SCD) for Egypt also identifies air, water and waste pollution to be high priorities because of their impact on human health and productivity (sections on *Environment and Natural Resource Use, Policy Area and Pathway 4: Promote Sustainability of Natural Resource Use*). The project's activities to eliminate the health risks associated with OPs and PCBs are aligned with these objectives. The project also contributes to the objectives of the MENA Regional Strategy Update 2021 to promote a *green, resilient, and inclusive development/growth* (GRID approach) by reducing health risks to vulnerable populations. The training and capacity building in EEAA/MALR/MoERE and development of the OP and PCB inventories builds Egypt's capacity to manage these risks today and develop actions to reduce these risks in the future (i.e., aligning with the pillar on building human capital).

28. **The project built on the World Bank's previous and existing support to Egypt's commitment to address pollution management issues.** The project built on and complemented sectoral technical assistance and investment lending projects that focused on pollution management issues such as the Egypt Pollution Abatement Project (EPAP I) (P054958; FY98), Second Pollution Abatement Project (EPAP II) (P090073; FY06), Pollution Management & Environmental Health Program (PMEH) (P164419; FY21) and the Greater Cairo Air Pollution and Climate Change Program (P17258; FY26). The common outcome in each of these projects was to reduce the risks of pollution through abatement programs and to increase the capacity of Egypt to manage these risks. The SPMP specifically contributed to this legacy by disposing of OPs stored near populated and residential areas and reducing work-related hazards posed by PCBs.

29. **The project contributed to Egypt's objectives on cleaner production and consumption.** Project activities are consistent with the objectives of the Sustainable Development Strategy (SDS): Egypt 2030[9], which aims to "*prevent environmental degradation and maintain positive balance and allow Egypt to move to more sustainable consumption and production patterns, protect biodiversity and fulfill environmental international obligations*…". In particular, the cleanup of OPs and PCBs contributes to the Key Performance Indicator (KPI) #5 for the Environment, "*Percentage of hazardous wastes safely disposed (treatment, recycling, final disposal)*" (page 32 in Strategy). The set of Environment Programs launched in conjunction with the Strategy calls for *developing a system for disposal of hazardous wastes* (page 33) and the information systems, training activities and disposal options put in place contribute to the achievement of this national program.

[9] https://www.arabdevelopmentportal.com/sites/default/files/publication/sds_egypt_vision_2030.pdf

30. **The project directly supported Egypt's international commitment to the Stockholm and Basel Conventions.** The identification, packaging, removal, transportation and destruction of high-risk stocks of OPs and PCBs is also consistent with Egypt's international obligations under the Stockholm and Basel Conventions to which the country is a signatory .[10] The project directly contributes to the overall objectives of the Stockholm Convention to protect human health and the environment from POPs; specifically Article 3 of the Convention on measures to reduce or eliminate releases from intentional production and use; Article 6 on measures to reduce or eliminate releases from stockpiles and wastes; and Article 10 on public information, awareness and education. The overall goal of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is to protect human health and the environment against the adverse effects that may result from the generation, transboundary movements and management of hazardous and other wastes. The project's objectives to develop the OP/POPs management system and the safe transboundary shipment and disposal of OP wastes meets the requirements under the Basel Convention.

31. **The relevance of the PDO is rated as High.** Strong alignment of the PDO with Egypt's CPF, the previous and current pipeline of World Bank support in pollution management, the objectives and KPI's of Egypt's Sustainable Development Strategy: Vision 2030 and international commitments to the Stockholm and Basel Conventions indicate the project was highly relevant.

B. ACHIEVEMENT OF PDOs (EFFICACY)

Rating: Substantial

Assessment of Achievement of Each Objective/Outcome

32. **The PDO was structured around two main objectives**: to strengthen the Government of Egypt's capacity to *manage* and *dispose* of POPs and PCBs, and to do so in an environmentally sound manner.

33. **Objective 1: to strengthen the Government of Egypt's capacity to manage POPs and PCBs in an environmentally sound manner.** As outlined in the Theory of Change, project activities and outputs led to significantly stronger Government capacity to identify, inventory, and dispose of POPs and PCBs and contribute to the long-term outcomes of managing POPs in the future and lowering the associated health-related risks. Even though there was no PDO-level indicator to measure the strengthening the capacity of POPs management, the series of capacity building and demonstrated disposal activities act as a proxy to that measure. For example, the MALR developed the centralized OP tracking system and staff were trained in inspection, monitoring and disposal of OPs (*achieving Intermediate Results Indicator (IRI) #2*). Training activities also included numerous outreach programs with the local population to raise awareness of the risks of OPs and hence the positive benefits of project activities. This also helped to mitigate any local concerns and support local communities with a greater understanding of the health risks and how to avoid contact with such substances. Training and outreach activities are summarized on the project's website and in Annex 1.[11] The use of the OP tracking system by MALR also helped identify a greater number of OP stockpile sites, 65 (with 370 tons), from an original estimate of 35 (350 tons) at appraisal. This increased the number of OPs to be disposed (20 tons) and the number of project beneficiaries by 260,000. The MALR also issued a Decree of Regulating all Agricultural Pesticides in Egypt in February 2018 which regulates and controls OPs with clear procedures for storage, safe handling, packaging, and

[10] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (*http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx*)
[11] http://www.popsegypt.com/English/ProjectActivities.aspx

disposal.[12] With the tracking system, clearer regulations and greater local awareness, these actions contribute to the long-term sustainability of tracking, recording and regulating OPs for safe storage and future disposal and the reduction of health-related risks from an even greater number of beneficiaries.

34. For PCBs, the MoERE developed a bar code tracking system, labeled over 18,750 PCB-containing transformers, sampled 13,000 of them for their PCB concentration and conducted PCB decontamination training at five selected storage/screening lab sites (*achieving IRI #6*). A total of 1013 tons of PCB oil was identified as needing treatment with 789 tons in in-service transformers and 169 in out-of-service transformers. The PCB inventory, testing and bar-coding system helped prioritize the locations of PCB contaminated oil and helped identify optimal transport routing for PCB oils requiring shipment to the centralized decontamination units. This lowered the overall risk to the local population by routing transport trucks through unpopulated areas. The project, in collaboration with the MoERE, also developed an innovative approach to treating PCB oils in transformers that were in service (online) allowing for continuous decontamination activities while not interrupting power supply. This reduced the overall health and safety risk of disconnecting transformers from the distribution network and was also more cost-effective and time saving. Over 68 percent of the oil treated to date used this method. The MoERE also issued a ban on the sale of out-of-service transformers and recycling of oils that have not undergone PCB testing. This will restrict the reuse of PCB contaminated oil and further reduce potential health risks. Finally, the MoERE has formed a dedicated PCB unit for the disposal and management of PCBs.

35. The project acquired air quality monitoring and laboratory equipment, under the Additional Financing, to increase the capacity of EEAA to monitor and analyze air quality – and in particular to identify the sources of air pollution (i.e., a source apportionment study). Six months of air quality data has been generated since project closing – and the samples are providing information on the composition of air quality (for example the split between black and brown carbon sources, which have very different types of interventions). Building this capacity was a priority for EEAA since previous source apportionment studies needed to be conducted by sending monitored samples outside the country to be analyzed (*achieving IRI #7*). The equipment is also currently being used to develop EEAA's Integrated Climate - Air Quality Management ("Action") Plan, which will determine government actions for both climate and air quality. In addition, this equipment also strengthens EEAA's capacity to analyze other hazardous air pollutants.

36. **Objective 2: to strengthen the Government of Egypt's capacity to dispose POPs and PCBs (in an environmentally sound manner)**. The capacity to dispose of POPS and PCBs was demonstrated through the destruction of 1500 tons of POPs - 1082 tons of OPs and 418 tons of PCBs (*partially achieving PDO indicator #1 of disposing 2000 tons of POPs and IRI #1*; for details see Annex 1B – Outputs by Component). A total of 712 tons of OPs from El Saff and Bahteem (at Al-Adabeya Port) were shipped to France to be incinerated and 370 tons of OPs were sent for co-processing in cement kilns locally in Egypt (*achieving IRI #3 and 4*).[13] The second batch of 370 tons was disposed locally due to significantly increased disposal/incineration costs in France and Sweden (by 40%) and through working with local incinerators to be in compliance with international requirements.[14] The development of local options represents an innovation for Egypt by increasing its long-term capacity and to dispose of OPs in an environmentally sound and cost-effective manner.

[12] See http://extwprlegs1.fao.org/docs/pdf/egy170788.pdf.
[13] A video documentary was produced in 2017 on the destruction of Lindane stored in the port for more than 18 years and which demonstrates a major achievement for Egypt to properly repackage, export and destroy hazardous POPs in line with Best International Practice: *https://www.youtube.com/watch?v=KDiFw6n8YL4*
[14] Specifically, in 2017, the International Consultant TAUW assessed the capability of four Egyptian cement plants for disposal of OPs by co-processing OPs and in 2019 a reassessment was conducted to evaluate the compliance of these plants in accordance with UN requirements, the Industrial Emission Directive (or equivalent) and UNEP Basel Convention technical guidelines on the

37. For PCBs, the project decontaminated and purified a total of 418 tons of PCB oils (out of the 1000 planned) using two decontamination units (*partially achieving IRI #5*) and producing an oil suitable for reuse in transformers. The shortfall during the latter part of disposal was mainly due to: (i) the contractor's inability to provide the third PCB decontamination unit on a rental basis in a timely manner, and (ii) the actual time taken to decontaminate and reduce the PCB concentration from a high level of PCB contamination (700 ppm) to an acceptable level of 50 ppm (taking several weeks instead of days per transformer). The rate of decontamination is such that the remaining 582 tons is anticipated to be completed before the end of the year (2022). What is most important is that the local capacity and equipment allow the dedicated PCB unit within MoERE to treat more oil in the future (beyond the targeted 1000 tons by the project).

38. **PDO objectives were conducted in an environmentally sound manner**. The handling, repackaging, transport and disposal protocols followed for OPs were based on those in the National Implementation Plan (NIP) prepared for compliance with the Stockholm and Basel Conventions and outlined as procedures in the ESIAs/ESMPs for each site. Training for workers was provided on Occupational Health and Safety (OHS) aspects and the use of proper Personal Protection Equipment (PPE) in the handling and repackaging of materials. For PCBs, training workshops were provided to MoERE on surveying transformers, sampling, labeling & coding of transformers for their level of toxicity (i.e., red markers for concentrations greater than 50 ppm), and Occupational Health and Safety (OHS) including measures provided in the ESMP. These best practices have been internalized and will continue in future decontamination activities.

39. **The achievement of the PDO generated important occupational and local benefits as reflected by the number of project beneficiaries – including those who were female**. The removal of OPs/POPs directly benefited site-specific workers (in both MALR and MoERE), and communities living in and around contaminated sites. Along with the reduced potential for environmental health impacts, the removal of these hazards has direct fiscal and community benefits. Al-Adabeya port is located near international waters and the OPs/POPs in storage were a potential hazard to workers. In El Saff, the population density is over 5,000 inhabitants/km^2 and the storage site is less than 100 meters from these communities. In addition, the storage site contained a granary of food stocks next to the obsolete pesticide stockpiles. Residential communities in other ports and sites in Alexandria, Delta and Upper Egypt were also in close proximity to stockpiles. Given the population density around these sites – approximately 3.1 million people live within 2 km from the storage sites and directly benefitted from the risk reduction of their removal. **The PDO target of 30,000 was underestimated at appraisal since it did not account for the population around the 30 additional OP sites identified through the OP inventory and tracking tool (+260,000 people) or the PCB sites until the transformers had been tested for PCB contamination and the transport routes selected off-site treatment (+2.8 million)**. While the chronic health impacts can be slow, the benefits of OP and PCB removal from residential areas were immediate and observed first-hand by residents. In recent interviews with residents of El Saf, they indicated noticeable declines in health-related effects.[15] The distribution of these benefits also leaned towards women who may have increased exposure through washing contaminated clothes of workers and children or working with potentially contaminated food.[16,17]

environmental sound co-processing in cement kilns. After remedial actions, one incinerator was found to be in full compliance (Lafarge) and was used by the project to dispose of the OPs.

[15] https://www.worldbank.org/en/news/feature/2019/12/05/egypt-a-cleaner-environment-leads-to-better-health-for-the-residents-of-el-saf-city

[16] Sharaf, N. et al. 2013. Pesticides Usage in Agriculture among Rural Women in Egypt: Association Between Serum Organo-Chlorine Pesticide Residues and Occurrence of Diabetes. *World Journal of Medical Sciences* 9 (1): 08-15.

[17] Government of Egypt. 2005. Implementation of the Stockholm Convention, National Implementation Plan – Egypt.

Justification of Overall Efficacy Rating

40. **The overall efficacy is rated as *Substantial* given the achievement of the PDO and PDO indicators.** The project built local institutional capacity to identify, analyze, treat and dispose of OPs/POPs and PCBs in an environmentally sound manner, which speaks to the sustainability of outcomes. Even though there was no PDO-level indicator measuring the capacity of managing OP/PCBs, this did not appear to affect the project. Innovative approaches were developed, such as using local cement kilns for OP destruction instead of sending OPs abroad for incineration and procuring new technology for PCB decontamination, instead of renting and are backed up by regulations, guidelines, and training through a learning by doing approach. The information systems developed also increased the beneficiary population by targeting more OP sites and indirectly through avoiding population centers in the transport of PCBs. The training provided under the project included OHS practices is a strong indication of client institutional strengthening. Although the sub-PDO indicator of disposing 1000 tons of PCBs was only partially achieved (418 tons), the capacity (ability to manage) built in the MoERE is expected to achieve the objective by end of the year. The continued relevance of the project and long term sustainability of its outcomes is evidenced by (i) the successful disposal of POPs-containing pesticides stored in the country and exceeding the target (1082 tons against 1000 tons), (ii) government's commitment to continue disposal of high-risk obsolete pesticides in the agriculture sector which was demonstrated by the expedited disposal of about 70 tons of OPs stored in the ports, to avoid accident hazards similar to Port of Beirut explosion and (iii) formation of PCB unit in MoERE for disposal and management of PCB contamination in the power sector.

C. EFFICIENCY

Rating: Substantial

Assessment of Efficiency and Rating

a. Economic efficiency

41. **The approach to gauging efficiency at appraisal was based reducing the population's health risk and the cost-effectiveness of interventions**. At appraisal, a benefit-cost analysis was not conducted due to a lack of reliable baseline data as well as data on related health impacts. The approach adopted maximum risk reduction as the criterion to prioritize POPs activities to benefit segments of the population, such as workers in the power sector and those working with or near OP stockpiles. With the removal of OPs/POPs and PCBs as a health risk (*PDO indicator #1*), and the identified beneficiaries assessed by *PDO indicator #2*, workers and residential populations in the vicinity of stockpiles benefitted from these activities. At appraisal the export of OPs/POPs for destruction was deemed as the most cost-effective disposal option given the lack of appropriate facilities in Egypt (although the project would seek local solutions throughout implementation). At the time, the average cost of repackaging, transport and disposal of OPs was about $US3,400/ton (including contingencies) which compared favorably with costs in other programs such as the Africa Stockpiles Program (~$US3,103/ton). The estimated cost for the identification, treatment and dechlorination of PCB oils was estimated to be about $US6,600/ton.

42. **The efficiency analysis at completion is based on estimates of the health-related benefits of reduced exposure to OPs/PCBs and the cost-effectiveness of alternative disposal options**. Table 1 provides an analysis of the economic benefits of reducing health risks (i.e. a counterfactual of deaths avoided through the removal of POPs). The realization of these benefits would accrue approximately 10 years after the removal of POPs due to the long-term nature of the effects. The internal rate of return is thus estimated in 10, 15 and 20-year intervals to show how benefits change over time and project costs are presented both with and without Government co-financing to demonstrate the robustness of the results. As an additional sensitivity test, mortality rates are varied. The results show that the IRR is well above the feasible range (i.e., comparable to discount (market) rates of 6-12 percent) even in year 10 with a mortality rate of 5 per 1000. These results are robust if the Government's contribution is added to total investment costs (i.e., $US15.65 million), the timeline is extended to 20 years or if the mortality rate increases (see Annex 4 for further details).

Table 1. Internal rate of return (IRR) under alternative mortality rates and project costs

GEF costs only ($US8.85 million)	**Mortality rate per 1000**					
Mortality rate	**5**	**6**	**7**	**8**	**9**	**10**
IRR-10 (years)	45.6%	48.0%	50.1%	52.0%	53.6%	55.1%
IRR-15	58.2%	60.5%	62.6%	64.4%	66.0%	67.5%
IRR-20	59.4%	61.8%	63.8%	65.5%	67.1%	68.5%
GEF + Government's contribution ($US24.35 million)	**Mortality rate per 1000**					
Mortality rate	**5**	**6**	**7**	**8**	**9**	**10**
IRR-10	32.7%	34.9%	36.8%	38.5%	40.0%	41.4%
IRR-15	45.5%	47.7%	49.6%	51.2%	52.7%	54.0%
IRR-20	47.2%	49.3%	51.1%	52.7%	54.1%	55.4%

43. **At completion, disposal costs were much lower than appraisal estimates due to the identification of local disposal options**. Of the 712 tons of OPs collected, repackaged and exported internationally for incineration in France, the actual cost for the first batch of Lindane from Al-Adabaya Port was US$1,914/ton and $1,239/ton for the second batch stored in El Saff (Table 2). At appraisal, international export and incineration of OPs was the only option available, until the feasibility of local options could be assessed, and the institutional and legal arrangements made with private operators in the cement industry (i.e., cement kilns were known to be a local option, but the regulatory and legal arrangements were not in place). The implementation of local options became more urgent when the price for exporting OPs for incineration in France rose by 40% prompting the PMU to expedite the processing of the last batches (totaling 370 tons) via co-processing in cement kilns in Egypt. This local option cost between US$261-418/ton since most of these costs were for repackaging and transport costs (i.e., the cement manufacturers had only a minimal incineration charge) making this option dramatically more cost-effective (Table 2). The cost savings also allowed the project to cost-effectively remediate the 30 additional sites identified in MALR's OP tracking system and for the same budget allocation. The project costs of PCB decontamination included the acquisition of the decontamination units, customs clearances, PCB analysis and the training of workers in procedures, safe handling and operating the decontamination units (i.e., CAPEX). The Government co-financed the laboratory equipment for PCB testing and the MoERE covered the costs of decontaminating transformer

oils (i.e., OPEX). This resulted in a dramatic cost savings than if it were to be handled only through private operators. Even though only 418 tons of PCBs were treated – this still corresponded to a lower unit cost compared to the estimate at appraisal ($US5,935/ton versus $US6,600/ton) and when the MoERE completes the remaining 582 tons – this will represent a unit cost of US$2,478/ton – well below the original estimate at appraisal. See Annex 4 for details.

Table 2. Cost-effectiveness of disposal options

OPs/PCBs eliminated	Unit cost ($US/ton)		Amount (Tons)	
	Appraisal	Actual	Appraisal	Actual
OPs	3,400		1,000	
Lindane and Associated Wastes Stored at Al-Adabaya Port (exported)		1,914		241
Pesticides and Associated Wastes Stored at El Saff (exported)		1,239		471
OPs in the rest of Egypt (local incineration)				
Ports		261		86
Delta		304		106
Greater Cairo		261		118
Upper Egypt		418		60
PCBs				
Decontamination units, customs, PCB analysis, training (current)	6,600	5,935	1,000	418
Decontamination (anticipated by end of 2022)		2,478		1,000

44. **The cost-effectiveness of disposal methods also compares favorably to other Bank projects.** This includes the Moldova POPs Stockpiles Management and Destruction Project (P090037) in which the cost per ton of PCBs eliminated was US$4,200, the China PCB Management and Disposal Demonstration Project (P082993), where each ton of eliminated PCB cost US$4,100 and the Lebanon PCB Management in the Power Sector Project where the average cleanup cost was US$2,125 per ton.

b. Design and implementation efficiency

45. **The project was designed to maximize efficiencies by targeting OPs/POPs and PCBs through inventorying, laboratory testing and competitive bidding.** As part of the design, inventorying activities led to a prioritization of the most hazardous materials requiring immediate attention and in priority geographical areas. In the case of OPs the tracking system developed by MALR identified stockpiles that required repackaging for safe handling and disposal (i.e., those stored near sensitive and highly populated areas). It also helped identify 30 additional OP sites (total 65) that could be remediated as a result of using local cement kilns and cleaning up more sites for the same money. In the case of PCBs, the inventorying of transformers and testing of oils led to a prioritization of those to be decontaminated. Project efficiency also benefitted from the competitive bidding process where cost-effective options for decontamination and disposal of PCB wastes were identified through the feasibility study and based on the inventory of PCB wastes in the power sector. On the other hand, delays in obtaining the decontamination equipment and longer oil decontamination periods did lead to the underachievement of the final target of 1000 tons of PCBs.

46. **The project was extended three times however this did not result in any cost overruns and led to greater achievement of most indicators.** Closing date extensions added 3 years to implementation, however, this led to the overachievement of treating and disposing 1082 tons of OPs and at 65 sites instead of 35 (a greater number of sites equates to a greater number of beneficiaries). The only additional costs were the Bank's supervision costs. The extensions also allowed the project to build the capacity of Egypt to test, treat and dispose of PCB oils in the future – and using a new technique of treating online transformers. Unfortunately, the delays led to the underachievement of the ultimate target by project closing (418/1000) – however the capacity and commitment are present to continue this work (e.g., the PCB unit in the MoERE).

47. **Overall, efficiency is rated as *Substantial*** given the high internal rates of return under various assumptions of avoided health risks by the population and the cost-effectiveness of local options developed during project implementation. Improved management of OPs and PCBs led to the identification of more cleanup sites (transformers) that benefitted the environment and a greater population. The capacity building efforts (training and in developing MALR and MoERE's inventories) increased the administrative efficiency and accuracy of information to be used in tracking, monitoring and managing OPs and PCBs in the future. The human capacity and procedures taught also strengthen compliance with best international practice in the safe handling, transport, storage and disposal of hazardous wastes and is consistence with the Stockholm and Basel Conventions.

D. JUSTIFICATION OF OVERALL OUTCOME RATING

48. **The overall outcome rating of the project is Moderately *Satisfactory*** given the relevance of the PDO to the CFP and Egypt's Sustainable Development Strategy: Vision 2030 (*High*), the efficacy in building capacity to manage and dispose OPs and PCBs using local technology and according to best international standards, while achieving most of the PDO disposal target of 1500 tons and reducing health risks to over 3.1 million people (*Substantial*), and for the significant cost efficiencies realized during project implementation (*Substantial*).

E. OTHER OUTCOMES AND IMPACTS (IF ANY)

Gender

49. The project contributed to the risk reduction to female agricultural workers who are normally handle or are more exposed to pesticides. Females represent about 49.1% of the population in Suez and about 47.9% in El Saf.

Institutional Strengthening

50. **Extensive training and capacity building activities took place among Government stakeholders, civil society, and the media.** Capacity building and awareness training occurred at several different levels from project orientation with the public to detailed technical level training of Government staff and national workers. For example, in implementing the repackaging the of Lindane in Al-Adabya, and in surveying the site in El-Saff, repackaging activities were conducted by national workers after receiving all required training and in compliance with national legislation, measures provided in the Environmental Management Plans, and international best practices, including on Occupational Health and Safety (OHS) aspects and the proper use of Personal Protective Equipment (PPE). For PCBs, training workshops were provided

on surveying transformers, sampling, labeling & coding of transformers, and OHS including measures provided in the EMP. Teams and the labs' staff were provided with required materials and training materials for these activities, including training on the use the PCB Analyzers supplied under the project. Public outreach was also conducted in the Governorates where OPs/POPs and PCBs were located (see Annex 1. B. Key Outputs by Component for a list of trainings and meetings).

Mobilizing Private Sector Financing

51. **Though originally not envisaged, the project was able to involve the private sector in a significant way in the disposal of POPs contaminated OPs.** To dispose 378 tons of OPs locally (about 35 percent of the total OPs disposed), the project partnered with private cement industries and paid for co-processing in cement kilns. While this collaboration did not mobilize private sector financing, it demonstrated the potential role that private sector can play in the management of POPs in Egypt and also in other parts of the world.

Poverty Reduction and Shared Prosperity

52. **By improving health and environmental conditions of about 3.2 million people, the project indirectly contributed to the poverty reduction and share prosperity.** As evidenced from the feedback from local community, the disposal of 1500 tons of POPs across various locations in Egypt has directly benefitted health condition of about 3.1 million people. In addition, the overall environmental condition in the broader influence area of these sites is also expected to be improved. These improvements are expected to improve the productivity of the people, thereby improving their social and economic wellbeing.

Other Unintended Outcomes and Impacts

53. **The project was responsive to external events that would ultimately influence project activities**. In the context of 'Port of Beirut Explosion' in Beirut on August 4, 2020, the Government of Egypt (GOE) made the decision to expedite disposal of all POPs stored in various ports of the country. Based on the capacity built through the project and the inventory of hazardous chemicals in six ports, the project developed a strategy to package, transport and dispose 70 tons of OPs through local cement kilns. In addition to being an unplanned/ unintended outcome, this also demonstrates the capacity developed by MOE and MALR through the project, in the management of OPs.

III. KEY FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOME

A. KEY FACTORS DURING PREPARATION

54. **The institutional, technical, economic, financial, procurement, and safeguards assessments were carried out and overall, the project was ready for implementation**. Below are some specific issues to highlight during preparation.

55. **The PDO reflected the key development challenges to achieving the project's outcomes.** The PDO clearly focused on a specific sub-set of hazardous wastes with known health effects and that need to be managed to reduce the risks to the workers and the general population. Sound management and disposal of POPs and PCBs is relevant in both the local and global contexts and hence the PDO was also addressing compliance with the Stockholm Convention on POPs.

56. **The project's components logically partitioned activities and included stakeholder consultations, training and built on the recommendations from the National Implementation Plan (NIP)**. Activities were divided between those addressing high-risk POPs from agriculture and PCBs from the electricity sector which was logical because of the different sources and stakeholders, but also because of the differences in testing and treatment options. Among the lessons learned from other projects in Egypt, the importance of local institutional involvement was critical. The hazards of POPs materials were largely unknown by the general population, so information campaigns were conducted in collaboration with local institutions in the areas of POPs stockpiles. The capacity to appropriately store, handle, analyze, package and dispose of materials also needed to be built, and hence, technical training was necessary. The project also built on the findings, actions and recommendations from the NIP conducted in accordance with requirements of the Stockholm Convention. The project also benefitted from international experience in environmental clean-up projects which promoted the use of a 'risk-based assessment' and 'Learning by Doing' approach to determine the level of effort and human and financial resources.

57. **The project complemented a parallel UNEP-managed GEF project, MEDPOL, which targeted and disposed of high-concentration PCBs.** Prior to project appraisal, it was estimated that of the 100,000+ transformers in Egypt, about 10-40% were contaminated by PCBs at a level above 50 parts per million (ppm). This is the threshold above which the Stockholm Convention mandates environmentally sound management, based on the potential for harmful effects on human health and the environment. The UNEP GEF project targeted high-concentration PCBs which were present in relatively small amounts in the country and the focus of Component 2 was on decontaminating/dechlorination of low to medium-concentration stocks of PCB-contaminated transformer oils, which when decontaminated, could be reused.

58. **The results framework (RF) was sufficient in tracking progress on the disposal aspects – but could have benefitted from a PDO-level indicator measuring improved POPs management and an intermediate outcome indicator for beneficiaries.** Since the PDO was split into two results chains – one for management and one for disposal, there should have been a high-level indicator measuring the improved management capacity. Although the absence of this indicator did not limit the significant amount of capacity building conducted or its effectiveness in implementation and affecting outcomes. Indicators were also provided for cleanup operations in the priority areas – El Saff and Al-Adabya and for the development of management information systems to track and inventory POPs and PCBs. The methodology for project beneficiaries should have taken into account the populations residing near all project sites – although many of these were still unknown at preparation since they were predicated on inventory completion for OPs and sampling outcomes in the case of PCBs. PDO #2 (project beneficiaries) could have also benefitted from an intermediate outcome indicator to measure, for example, the awareness of the population to the reduced risks from the removal of materials. These awareness activities are typically coupled with the design of the Grievance Redress Mechanism (GRM) for local communities. After the removal of OPs from El Saff, the PMU completed a video story recording the process and results which were rated 'highly satisfied' by surrounding communities.[18]

59. **Project risks were appropriately rated as high – but the evidence from previous projects should have indicated that internal clearances could delay the procurement process**. Due to the nature of handling and disposing of hazardous substances, the project rightly categorized design, social and environmental, capacity and governance risks as high. In addition, Egypt's low capacity in managing these types of wastes implied not only international expertise to help guide activities – but international options for disposal – which created the potential for a lengthy approval and clearance process. For example, security clearances for the importation of decontamination equipment for Component 2 delayed activities for up to a year. Experience from other projects have shown this to be an endemic issue with procurement and the project could have developed solutions to try and mitigate this risk to a greater degree.

[18] Available at: *https://www.youtube.com/watch?v=KDiFw6n8YL4*.

60. **The institutional readiness of the implementing agencies was also identified as a potential risk factor – due to their lack of experience with these types of environmental risks and disposal techniques – and thus the important role of Steering Committees**. Due to the inter-ministerial nature of the project's activities, a POPs Project Steering Committee (PPSC) was formed to guide and coordinate project implementation and maintain inter-ministerial cooperation. It was chaired by the Chief Executive Officer (CEO) of EEAA and included representatives of EEAA, MALR, MoERE, and the Ministry of International Cooperation (MOIC). In addition, the GEF National Steering Committee (GNSC) was responsible for the monitoring and oversight of the Egypt GEF portfolio and included the participating ministries in addition to other ministries with direct relevance to the GEF in Egypt. Both of these Committees were important for coordination among the various stakeholders.

B. KEY FACTORS DURING IMPLEMENTATION

(a) Factors subject to the control of the government and/or implementing entities control

61. **PMU hiring delays in the first seven months after effectiveness, coupled with an initial lack of experience in developing the Terms of Reference (TORs) and bidding documents for hazardous waste led to slow implementation during the first two years.** The project was effective in September 2014 and by March 2015 the PMU was fully staffed, although key staff turnover continued to influence implementation (e.g., PMU Manager resigned in January 2016 and was not filled until the following October, and a new full-time procurement person was needed by the December 2016 mission). Combined with the unfamiliarity of writing TORs for hazardous wastes, this chain of events meant delays in the hiring of an international consultant to oversee Component 1 activities (e.g., procedures consistent with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal) and the procurement of PPE for Component 2. Although the PAD included a detailed set of training activities to be conducted on these capacity gaps (see pages 45-46 in PAD), issues still arose and may be linked to the late staffing issue. In addition, Egypt's lack of experience in logistics and processing the safe transport and disposal of hazardous waste led to legal delays to export POPs from Al-Adabya port and importation clearances for PCB decontamination equipment. Implementation issues also resided in the MoERE, where slow PCB sampling and verification of transformers led to delays in developing the feasibility study to determine the final options/facilities for decontamination, procurement and operation of the facilities. During implementation, further delays were experienced from the contractor's inability to provide a third PCB decontamination unit on a rental basis (3 were originally planned) and longer than expected time to lower the concentration of the oils to less than 50 ppm (taking several weeks instead of days per transformer). These were the primary reasons for only 418 tons being treated by project closure instead of the targeted 1000 tons.

62. **Despite these delays the Government took steps to increase its proactivity including the co-financing of key infrastructure that would help the project achieve its objectives and contribute to the long-term sustainability of the project.** The GoE contributed about US$15.65 million[19] (US$12.1 million in cash) for various project activities such as development of a specialized laboratory for POPs testing at the MALR, purchase of equipment and chemicals, identification/ classification of OPs in the entire country, remediation of El Saf site, conducting the PCB inventory, and the establishment of three interim storage sites and five central labs by the MoERE.

(b) Factors subject to World Bank

63. **The World Bank team took proactive steps at several stages of the project, but greater attention could have been paid to initial capacity constraints in international hazardous waste management and RF indicator adjustments**

[19] As against US$15.5 million committed at project appraisal.

and the MTR and during restructurings. As mentioned above one of the main limitations of progress during the first two years was the GoE's unfamiliarity in catering TORs and procurement in compliance with the international requirements of the Stockholm and Basel Conventions. It was also evident that greater initial training should have been provided on the entire process of appropriate storage, transport and disposal of POPs and PCBs. The World Bank team also could have used the MTR and restructurings as an opportunity to adjust the Results Framework to include a PDO-level indicator on improving POPs management capacity.

(c) Factors outside the control of government and/or implementing entities

64. **Changes in the prices of incineration and exchange rate uncertainties affected project activities.** For instance, the devaluation of the Egyptian Pound hindered the procurement of PPE and most notably Component 1 was highly affected by the 40% increase in the costs of incineration in France and Sweden – prompting the PMU to expedite the development of local options for the destruction of OPs (i.e., co-processing in cement kilns).

65. **The onset of COVID-19 in 2020 also slowed implementation progress**. In particular, workers were not allowed to be on site and travel bans restricted the mobility of international consultants and interest of international bidders. Offices were closed and, in many cases, important face-to-face meetings could not be held – as was the convention with the Steering Committees. These restrictions obviously effected the project and set back progress by 6-9 months.

IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

A. QUALITY OF MONITORING AND EVALUATION (M&E)

M&E Design

66. **The Theory of Change (TOC) was clear, and the indicators were adequate in monitoring progress towards the PDO.** Although no TOC was required at appraisal – the PDO, activities and set of indicators to monitor progress were sufficient and the Results Framework (RF), for the most part, was adequate in tracking project progress with specific, measurable, achievable, relevant, and time-bound indicators. Improvements could have included a PDO-level indicator on improved capacity to manage POPs since the PDO was split into two results chains – managing and disposal. Even though the indicator for management was missing – this was still measured through the extensive capacity building activities according to best international practice and the demonstrated capacity to dispose POPs in an environmentally sound manner (and in compliance with the Stockholm and Basel Conventions). The methodology to calculate the number of project beneficiaries (PDO indicator #2) did not include a significant proportion of project sites that were unknown prior to appraisal, since they were dependent on sampling outcomes for PCB analysis and OP inventorying activities. As a result, there was a gross underestimate of the beneficiaries (30,000 versus 3.1 million). There also should also have been stricter adherence to (and monitoring of) the *Safeguards Gap-Filling Measures* outlined in the PAD (Annex 3, pages 45-46) which could have revealed important deficiencies earlier in implementation. A dedicated M&E Specialist was hired in 2015 which was necessary due to the complexity of activities and coordination among the three Ministries.

67. **The project required quarterly and semi-annual progress reports to measure progress**. The EEAA was responsible for the overall monitoring and supervision of the project and provided quarterly reports on all components on the achievement towards the targets in the Results Framework. These were reviewed every 6 months as a part of

regular supervision missions and reported in the Implementation Status & Results Reports (ISRs). A Mid-Term Review (MTR) was to be undertaken 2 years after the project's effectiveness and an Implementation Completion and Results Report (ICR) 6 months after project closing.

68. **Steering Committees were formed for oversight and coordinated decisions.** The POPs Project Steering Committee (PPSC) met quarterly to resolve inter-ministerial implementation issues, provide policy guidance to the PMU and review the status of implementation of the project (e.g. progress reports, budgets). The project also coordinated with the GEF National Steering Committee (GNSC), who met monthly to review overall implementation progress of GEF projects, resolve any inter-ministerial disputes and endorse new GEF project concepts.

M&E Implementation

69. **M&E reporting was delayed in the first year until the PMU was fully established but reporting was more actively used and updated by the time of the MTR.** Progress towards the targets in the Results Framework remained stagnant until the initial training and capacity building activities started – in particular the inventorying of PCBs and the tracking system for OPs. These were the key instruments to collect information and guide the repackaging, labelling, treatment and disposal activities and in measuring progress. Data was collected regularly as OPs and PCBs were identified, inventoried, transported, and ultimately destroyed by MALR and MoERE staff. Inventories required on-site inspections, sampling of substances and analysis in the laboratories that were ISO 17025 certified.

M&E Utilization

70. **The M&E framework worked well in keeping track of progress and in prompting decisions.** Both the MALR OP tracking system and the PCB inventory information were used initially guide local site training in regional MALR and MoERE offices as well as for local awareness raising campaigns among the general population. It was important to keep track of those trained or part of the capacity building as they would also be responsible for disposal at specific sites. Once training was completed and disposal activities commenced, and the set of quantitative indicators were monitored more closely. By the time of the MTR in 2018 the PMU was able to better gauge the pace of disposal and given the lack of progress on PCB decontamination, it was recommended to extend the project closing date until September 2020 to be able to complete the disposal of all OPs and begin disposal of PCBs.

71. Since the achievement of PDO targets (i.e., 2000 tons of POPs) relied on sampling results from laboratory testing, this required constant data collection to prompt next steps. For instance, results from the sampling of PCB-contaminated transformers were regularly monitored and updated for the PMU to gauge the level of effort and options recommended in the feasibility study for final disposal options. In cases where the sampling revealed little or no presence of PCB-contaminated oil – then this would prioritize areas in order to reach the target of 1000 tons (and since the project focused on low- and medium- concentrations of PCB-contaminated oil – this could mean that a higher volume would need to the processed to reach the target).

72. **The PPSC met regularly to review data and resolve implementation issues and make key and coordinated decisions.** For example, when the price of POPs incineration in France and Sweden increased by 40% - the decision was made to reassess the 4 local cement kilns for their compliance with national and international disposal standards and assess their feasibility of co-processing the remaining OP stockpiles. Expedited decisions were also made, for example,

when the Beirut explosion occurred and there was an accelerated plan developed to dispose of all stocks in Egyptian ports (70 tons).

Justification of Overall Rating of Quality of M&E

Rating: Substantial

73. **The M&E system was reflective of the TOC and provided the linkages between activities and outcomes**. The MALR tracking tool and PCB inventory were central information systems to the prioritization of sites, training and disposal activities. While there were some limitations in the M&E design with the absence of a PDO-level indicator measuring POPs management and measurement issues with the number of project beneficiaries – these shortcomings did not affect the outcome. Capacity building and training led to better management as demonstrated by the improved management and successful disposal of OPs and PCBs in an environmentally sound manner. Project beneficiaries were still identified as part of the process of identifying stockpiles and in implementing disposal activities. Thus, the overall rating for the quality of M&E is *Substantial*.

B. ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

Environment and Social Safeguards

74. **Due to the high environmental risks associated with pesticide transportation and disposal, the project was classified as Category A and required many site-specific ESIAs/ESMPs which were found to be Satisfactory and in compliance with national and World Bank policy.** The project was governed by OP 4.00 on "*Piloting the Use of Borrower Systems to Address Environmental and Social Safeguard Issues in Bank-Supported Projects*" and triggered two additional Environmental Safeguards Policies: (i) Environmental Assessment OP 4.01, and (ii) Pest Management OP 4.09. Due to the high potential risk associated with project activities, the project was classified as a Category "A" as per World Bank policies. A total of 15 ESIAs/ESMPs were completed for the various sites and reviewed by the EEAA/ EIA department including consultations and disclosure on their website.[20] With some subsequent (minor) revisions, these instruments were prepared and cleared in conformity with national Egyptian legislation and World Bank environmental policy OP 4.01. In terms of capacity building, repackaging of OPs were implemented mostly by national workers after receiving all required training and in compliance with national legislations, measures provided in the Environmental Management Plans, and international best practices, including on Occupational Health and Safety (OHS) aspects and the use of proper PPEs. For PCBs, training workshops were provided on surveying transformers, sampling, labeling & coding of transformers, and Occupational Health and Safety (OHS) including measures provided in the EMP. Teams and Labs' staff were provided with required materials and training materials for these activities, including training on the use the PCB Analyzers provided under the project.

[20] *http://www.eeaa.gov.eg/en-us/mediacenter/reports/relatedreports/gef.aspx*). POPs project website: *http://www.popsegypt.com/English/*.

Financial Management

75. **The project management maintained acceptable records and adhered to the arrangements stated in the project's Grant Agreement and the project's FM arrangements were found to be *Satisfactory***. A dedicated Financial Management Specialist was part of the PMU throughout the project's implementation. The PMU submitted semi-annual Interim Financial Reports (IFRs) and annual Financial Statements to the World Bank. The IFRs reported on both actual and planned expenditures by category and component following the cash basis of accounting to record the project's transactions. Audit reports identified areas to be reconciled or corrected – but otherwise did not find any significant material issues. The PMU promptly followed up on any issues discovered through the audit process. The final audit report for 2021 has also been submitted.

Procurement

76. **Procurement post-reviews (in 2017, 2018, 2019, 2020, 2021) found that procurement processes, and/or contract administration complied with agreed provisions and adherence to all related anti-corruption practices**. Prior to 2016, when a full-time procurement specialist was hired, procurement lagged slightly because of other factors such as legal issues with exporting OPs from Al-Adabya port and the longer than anticipated PCB sampling of transformers. After 2016 the PMU was able to accelerate procurement and from there the Post Reviews only found minor issues related to the entering and updating information into STEP in 2019 and 2020 – but were remedied by the PMU in a timely manner. Record-keeping was found to be of acceptable availability, quality, security and completeness of procurement records. Overall, procurement was rated as *Moderately Satisfactory* in most ISRs through implementation.

C. BANK PERFORMANCE

Quality at Entry

77. **Project preparation benefitted from a Project Preparation Study which built on the recommendations from the NIP and the ongoing UNEP MEDPOL project**. Several recommendations of the NIP were to complete an inventory and collection and processing of information on the sources and emissions of POPs, PCBs and dioxins and furans; completion of a database on hot spots and remediation of the contamination sites; and disposal of obsolete pesticides and PCBs. A GEF-funded Project Preparation Study, completed in 2011, then built on these recommendations and through surveys found that POPs pesticides (including new POPs) accounted for 10 to 30 percent of the estimated 2,250 to 4,600 tons of obsolete pesticides in Egypt, mostly stored in inadequate conditions. In addition, there were more than 100,000 transformers in the electrical distribution system, of which about 40 percent contained high concentration PCBs (i.e., above 50 ppm). Most of these PCBs were contained but leakage could result from old and damaged equipment or maintenance and repair. The project benefitted from these surveys in defining the locations for OP removal (i.e., mainly El Saf and other hotspot areas) and the locations of the PCB transformers (but untested). Egypt also received funds under a parallel United Nations Environment Programme (UNEP) managed GEF project, Program for the Assessment and Control of Pollution of the Mediterranean, an arm of the Mediterranean Action Plan (MEDPOL), which targeted the disposal of

high-concentration PCBs (i.e., >50ppm). In this regard, the SPMP focused on the potentially larger volumes of low to medium-concentration stocks of PCB-contaminated transformer oils, which when decontaminated, could be reused.

78. **These previous preparation studies helped set expectations for the Results Framework and M&E.** Findings from the above studies provided key initial data on the magnitude of the challenge, which the project was able to define it's targets. This was particularly important for PCB decontamination which had little or no experience in the MENA region and required a lot of international experience to be brought in initially. This included the translation of procedures from the Stockholm and Basel Conventions into OHS and procedures in the ESIAs/ESMPs for each site. On the other hand, obsolete pesticides had a more familiar legacy of project experience to draw upon in the Africa Stockpiles Program. Bringing in the international experience was an essential part of ensuring implementation readiness.

79. **An efficiency analysis at preparation did not include a benefit-cost analysis mainly because of the lack of data on the health impacts of project interventions.** Results of such analysis would have shown benefits of a similar magnitude to what was found in this ex-post analysis. But it would have been too difficult to weigh any different alternative disposal options at that time since the inventorying work completed above would still be insufficient to perform an ex-ante exercise prioritizing sites without the sampling results of materials from OPs or PCB concentrations in the case of transformer oils. What was supplied were estimates of unit costs of disposal ($/ton) based on experience elsewhere and adapted as best as possible to the Egyptian case.

80. **Institutional and fiduciary arrangements took into consideration lessons learned from previous project experience – but the identified risks were still realized despite the proposed mitigation actions.** Risks were clearly identified at appraisal and mitigation measures were developed to avoid any implementation delays. However, some institutional risks were still realized such as the formation of a fully staffed PMU – which should have been a precondition for effectiveness. This also delayed the requisite training plans outlined in the *Safeguards Gap-Filling Measures* to ensure institutional, regulatory and coordination gaps could be addressed. Actions could have alleviated some of the procurement issues that later arose by 2016, and the security clearances by 2020, which carried forward such that project extensions were needed.

Quality of Supervision

81. **The World Bank team proactively identified issues and was candid in their assessment to management**. A total of 14 missions (two per year, 2 virtually) were undertaken by the task team and progress was reported in the ISRs and letters to management listing the timely actions necessary to be taken. Direct engagement with the client and other stakeholders (MALR and MoERE) addressed issues and pressure was levied to a higher level when necessary. For example, the nearly one-year delay in obtaining security clearances for the rental unit for the decontamination equipment for PCBs was elevated several times to the Ministry of International Cooperation (MoIC). In this regard, the project could have benefitted from more frequent reporting prior to the MTR and could have elevated critical implementation issues on Component 2 activities.

82. **Actions from the MTR resulted in accelerated pace of activities and an extension to achieve project outcomes**. At the MTR (Jan 2018), overall progress towards the PDO had been quite low (only 241 tons of OPs incinerated abroad or 12% of the 2000-ton objective) and the main constraints were delays in the PCB inventory which fed into the Feasibility Study of disposal options. Meetings with high-level management of MoERE resulted in an agreement to expedite the inventory with set completion dates, and the precise contents of the Feasibility Study including the technical, market

options and business models for such decontamination facilities. It was also agreed that an Action Plan for the PCB inventory, after the first 1,000 tons of PCBs are identified, should be prepared and implemented by the MoERE and be financed by the MoERE's own cost. To accommodate the disposal of the remaining OP stockpiles and decontamination of PCB oils, the project's closing date was extended until September 2020. With the level of commitment, it was decided to not change any of the outcome or output indicators. By Sept 2018, the MoERE had identified 820 tons of PCB oils in the inventory, issued the ban on the sale of out-of-service transformers and oils without PCB testing, and implemented the bar code system for labeling identified PCB transformers at five selected storage/screening lab sites.

83. **At the time of the Additional Financing in 2020, targets for OPs were nearly achieved but equipment delays were experienced for PCB decontamination**. By Feb 2020, 788 tons of OPs had been disposed and the remaining stockpiles were in preparation of being incinerated locally. By June 2020, the Feasibility Study was complete and had concluded on the technology to be adopted for the decontamination units, however there were delays in obtaining security clearances for the 3rd decontamination unit (a rental) and delays in the bidding process due to COVID. The additional financing was viewed as an opportunity to support the institutional and analytical capacity of EEAA on air quality management and to also provide additional time for the PCB decontamination to take place. Indicators were not adjusted since the majority of OPs were disposed and it was believed that PCB decontamination would be accelerated once the unit arrived. In hindsight, lowering the PCB oil decontamination indicator from 1000 tons may have been warranted given the delays and history to date.

84. **Low staff turnover during the project helped to maintain the continuity of supervision**. A total of 4 Task Team Leaders were responsible for the project over its lifetime – and the core team remained largely the same. The transition of the TTLs and teams was smooth and no major challenges were encountered.

Justification of Overall Rating of Bank Performance

Rating: Moderately Satisfactory

85. **Quality at entry had only minor shortcomings in terms of project design and the identification of potential risks to achieving the PDO, but during supervision more realistic targets should have been taken on board**. The project benefitted from the NIP and GEF preparation studies, but in hindsight, more could have been done to ensure counterpart readiness with the appropriate positions filled in the PMU and training according to the *Safeguards Gap-Filling Measures* assessment in the PAD. During implementation the Bank team was proactive in identifying problems at the MTR and AF and worked with the PMU, EEAA, MALR and the MoERE to resolve them. However, given the repeated delays in Component 2, it may have been beneficial to lower the PCB oil decontamination target at the AF stage. Taking these factors into account, overall the rating for bank performance is *Moderately Satisfactory*.

D. RISK TO DEVELOPMENT OUTCOME

86. **The overall risk to the development outcome is low considering the removal of hazardous substances and the capacity built to ensure the continuation of disposal and decontamination activities.** As evidenced by the interviews conducted with residents in El Saf – people can attest to the difference in the health-related effects of OP removal. The OP tracking system in MALR has prioritized remaining stockpiles to be removed and the Government, through its continued commitment to the Stockholm Convention, will continue the safe removal and disposal of these other stockpiles. Likewise, the PCB inventory similarly prioritizes contaminated oil for further treatment and now has the capacity to do so with the dedicated decontamination units on site. In addition, the MoERE has a dedicated PCB unit and funded the O&M phase of decontamination which shows their commitment to continue the work.

87. **The purchased air quality monitoring equipment complements the current network and serves the mandate of EEAA to supply public information on air quality** – and for which is budgeted annually in their air quality management program. The addition of the laboratory equipment now enables them to analyze their own air quality samples and better utilize their staff's capacities. There is an annual contract between EEAA and Cairo University to host the equipment and to supply its services in analyzing air samples and conducing source apportionment studies. The Bank-Executed Trust Funded activity under the PMEH Program supplied one year of consumables for the laboratory and EEAA has committed to supplying the laboratory afterwards.

V. LESSONS AND RECOMMENDATIONS

88. **Promoting best international practice in the project**. This includes the strong institutional commitment and the systems which were put in place by MoERE (development of a bar code tracking system for labeling identified PCB-containing transformers, instructions to Production, Transmission, and Distribution Companies on PCB management; ban on the resale of out-of-service transformers that could contain PCBs). The establishment and implementation of a regulatory framework and guidelines also reflect this commitment. The project also took timely course correction measures and re-evaluated the technical and economic feasibility of disposal options with local cement kilns for OPs – creating local capacity to handle future stockpiles.

89. **Internal and external risks cannot be under-estimated and mitigation strategies should be flexible and complemented with secondary options**. The project experienced a series of both internal institutional risks from early mobilization (i.e., setting up a fully staffed PMU) and this should be made part of the initial agreement with Government. Contingencies should also be built into the design since price changes can hinder progress substantially – but can be overcome if options are developed. In the case of the disposal of the second batch of OPs – prices outside the control of the project expedited local (incineration) options to be developed. Internal security clearances also delayed activities and there should be early assurances in the design of how these processes can be streamlined – and if not - then accounted for in the design and timeline of activities.

90. **Pre-feasibility studies in brown projects are needed to know the extent of the problem before designing interventions**. In projects where the true extent of contamination can only be revealed through relatively large and expensive pre-feasibility studies – it is important to undertake them prior to design to reduce search or discovery costs during implementation. The SPMP was fortunate to have a GEF-funded Project Preparation Study – but in its absence projects run the risk of not knowing how much of the problem you are tackling or whether you are targeting the highest priority areas or pollutants. From the challenges faced in complying with local regulations, customs clearances and working with foreign contractors – all of these potential bottlenecks need to be surveyed and mitigated in the implementation plan. These were the primary reasons for the project not achieving the 1000-ton PCB decontamination objective.

91. **In pollution clean-up projects, adaptation to local conditions and inherent uncertainties regarding the extent of pollution is largely a process of "learning by doing."** Pollution remediation is a risky business based on its legacy, and an intrinsic level of uncertainty, even with the most advanced knowledge and sophisticated technology. With contamination and pollution, there are complex, multi-factorial conditions that can lead to irregular pollution distributions, unexpected costs and create a high probability for unforeseen situations that are uncovered only during implementation. And this all has implications on costs. No amount of up-front information gathered by drilling, sampling and analysis will lead to 100 percent certainty and thus there is a need to adapt to these circumstances during implementation. In Egypt, the learning led to the development of local incineration options with the cement industry, and with the challenges faced with the

regulations, customs clearances and duration of the PCB decontamination. This also led to the identification of local, cost-effective, solutions for OP and PCB decontamination over treatment options internationally. The development of these options under the project position Egypt to substantially increase proper hazardous waste treatment in the future as these options are available in the country and have been piloted and tested during the Project.

92. **Importance of client and stakeholder ownership**. A major reason why the project was able to achieve its outcomes was due to the ownership and commitment of the client and stakeholders, and in particular the staff from the MoE, MALR and MoERE during implementation. Another indicator of this commitment was the successful co-financing of the project ($15.65 million), and the continued decontamination of PCBs by the MoERE.

ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

a. RESULTS INDICATORS

A.1 PDO Indicators

Objective/Outcome: To improve the management and disposal of POPs and high-risk obsolete pesticides

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
POPs & POPs waste destroyed,disposed or contained in environmentally sound manner	Metric ton	0.00 13-Jun-2014	2,000.00 31-Dec-2021		1,500.00 31-Dec-2021

Comments (achievements against targets):
Partially achieved: 75%

237 tons of obsolete pesticides (Lindane, a POP chemical) at Al-Adabeya Port and 4 tons (DDT and Dicofol) at El Saf and Bahteem storage sites were successfully exported by August 2017 by an international firm for destruction by the Tredi Salaise incinerator in France.

The removal of second batch of high-risk obsolete pesticides (471 tons, mainly Ametryn) at the El Saf site was also completed in July 2019 and the final incineration by Breman in Sweden. The PMU also completed a video story recording the process and the high satisfaction rate by surrounding communities.

A total of 86 tons of OPs were removed from the following five Egyptian ports and incinerated at the La Farge Holcim Cement Kiln in Egypt:

- Alexandria Port
- Adabeya Port – Suez

- Nouabaa Port - Red Sea
- Safaga Port - Red Sea
- El Ein El Sokhna Port - Suez

A total of 370 tons of OPs were collected from 65 additional storage sites across various locations in the Delta, Greater Cairo and Upper Egypt Governorates and incinerated at the La Farge Holcim Cement Kiln in Egypt.

A total of 417.6 tons of PCB-contaminated oil was able to be treated by June 2022 and the remaining 582 tons is expected to be completed by the end of 2022. The primary reasons for the shortfall in achieving the 1000-ton objective after the service contract was awarded, were due to the: i) inability of the PMU/contractor to deploy the third decontamination unit for rent, (ii) high levels of contamination that required a longer treatment period (weeks instead of days), and (iii) several maintenance/ repairs to equipment during this period.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Direct project beneficiaries	Number	0.00 13-Jun-2014	30,000.00 31-Dec-2021		3,100,000.00 31-Dec-2021
Female beneficiaries	Percentage	0.00	50.00		50.00

Comments (achievements against targets):
This indicator is achieved.

A significant share of the obsolete POPs pesticides covered under this project were stored at the Adabeya port, located in the Ataka district, Suez Governorate which is an Industrial/Residential area of 8827 km2 with total population of 27,340 inhabitants including 40% women. Therefore, roughly 27,340 people were considered direct project beneficiaries from the removal of those POPs pesticides.

The El Saff site is located in a residential area of El-Saff Town – Giza Governorate about 52 Km to the south of Cairo. El Saff is a highly populated area of about 100 km2 where 356,586 inhabitants exist.

Other sites were located near (or in) population centers throughout Egypt in Alexandria, the Delta and Upper Egypt, including several other ports. Direct project beneficiaries were defined as those within 2km of storage sites for OPs and PCB sites and including the electrical workers at MoERE/EHC who regularly handle transformers containing PCB-contaminated oil. In total there were approximately 3.1 million direct beneficiaries.

A.2 Intermediate Results Indicators

Component: Component 1: Destruction of High Risk Stocks of Obsolete Pesticide

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Obsolete pesticides including POPs pesticides disposed of in an environmentally sound manner	Metric ton	0.00 13-Jun-2014	1,000.00 31-Dec-2021		1,082.00 31-Dec-2021

Comments (achievements against targets):
This indictor was achieved: 108%

237 tons of obsolete pesticides (Lindane, a POP chemical) at Al-Adabeya Port and 4 tons (DDT and Dicofol) at El Saf and Bahteem storage sites were successfully exported by August 2017 by an international firm for destruction by the Tredi Salaise incinerator in France.

The removal of second batch of high-risk obsolete pesticides (471 tons, mainly Ametryn) at the El Saf site was also completed in July 2019 and the final incineration by Breman in Sweden. The PMU also completed a video story recording the process and the high satisfaction rate by surrounding communities.

A total of 86 tons of OPs were removed from the following five Egyptian ports and incinerated at the La Farge Holcim Cement Kiln in Egypt:

- Alexandria Port
- Adabeya Port – Suez
- Nouabaa Port - Red Sea
- Safaga Port - Red Sea
- El Ein El Sokhna Port - Suez

A total of 370 tons of OPs were collected from 65 additional storage sites across various locations in the Delta, Greater Cairo and Upper Egypt Governorates and incinerated at the La Farge Holcim Cement Kiln in Egypt.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Tracking system for management of obsolete pesticides operational	Yes/No	No 13-Jun-2014	Yes 31-Dec-2021		Yes 31-Dec-2021

Comments (achievements against targets):
This indicator has been achieved.

The tracking system for Obsolete Pesticides (OPs) has been established by the March 2019 mission. Now the MALR has only one place to report OPs. All OPs in the country are reported immediately to the central lab as per the Ministry instructions to all Directorates. The Ministry team that have been trained through on job training by TAUW goes to the reported storage to classify and identify the OPs and put them into the same database format developed by the project. In this way all OPs in the country is really controlled and tracked and they even report to add any new quantities they found. Also, MALR issued a Ministerial Decree of Regulating Agricultural Pesticide in Egypt in Feb. 2018 . This decree regulates and controls the OPs with clear procedures.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Obsolete pesticides at El-Staff removed and disposed of	Yes/No	No 13-Jun-2014	Yes 31-Dec-2021		Yes 31-Dec-2021

Comments (achievements against targets):
This indicator has been achieved.

The removal of second batch of high-risk obsolete pesticides (471 tons, mainly Ametryn) at the El Saf site was also completed in July 2019 and the final incineration by Breman in Sweden. The PMU also completed a video story recording the process and the high satisfaction rate by surrounding communities.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Obsolete pesticides at Al-Adabeya removed and disposed of	Yes/No	No 13-Jun-2014	Yes 31-Dec-2021		Yes 31-Dec-2021

Comments (achievements against targets):
This indicator has been achieved.

237 tons of obsolete pesticides (Lindane, a POP chemical) at Al-Adabeya Port and 4 tons (DDT and Dicofol) at El Saf and Bahteem storage sites were successfully exported by August 2017 by an international firm for destruction by the Tredi Salaise incinerator in France. A second stockpile was identified (12.6 tons of high-risk OP (non-POPs)) at Al-Adabeya, which was removed and incinerated at the La Farge Holcim Cement Kiln in Egypt.

Component: Component 2: Decontamination of PCB-Containing Transformer Oils

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
PCB contaminated oils decontaminated	Metric ton	0.00 13-Jun-2014	1,000.00 31-Dec-2021		417.60 31-Dec-2021

Comments (achievements against targets):
The objective was only partially achieved: 42%

A total of 417.6 tons of PCB-contaminated oil was treated by June 2022 (see Table A1.8) and the remaining 582 tons is expected to be completed by the end of 2022. The reason for the shortfall was due to delays that can be divided into two periods - one prior to the delivery of equipment - and the second thereafter until project closing.

The main challenges prior to the equipment delivery included: i) identifying an international expert to conduct technical and economic feasibility study for the decontamination process, ii) signing the service contract due to the national regulations in signing contracts with foreign suppliers, iii) the COVID-19 pandemic delaying the transport of hazardous materials and on-site training activities, and iv) field level challenges in transporting transformers from site to site and requiring special procedures from local authorities, high toll fees, and servicing online transformers that require advance permission from the Electricity Regulation Authority.

The primary reasons for the shortfall in achieving the 1000-ton objective after the delivery of equipment was due to the: i) inability of the PMU/contractor to deploy the third decontamination unit for rent, (ii) the high levels of contamination that required a longer treatment period (weeks instead of days), and (iii) several maintenance/ repairs to equipment during this period.

The Ministry of Electricity and Renewable Energy, after project closure, has the demonstrated capacity and has also indicated their commitment to finalize the remaining targeted quantity of contaminated oil and their willingness to cover other industries in Egypt and at the regional level.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Tracking system for management of PCBs operational	Yes/No	No 13-Jun-2014	Yes 31-Dec-2021		Yes 31-Dec-2021

Comments (achievements against targets):
This indicator has been achieved.

A bar code system has been used for labeling identified PCB transformers at five selected storage/screening lab sites, The procedure for tracking and labelling is described in Annex 1 Outputs by Component under Component 2.

A project implementation unit has been established since January 2018 and a complete tracking system (see the mission AM Annex 3) on PCB transformers has been established in MOEE since March 2019. MOEE issued on June 23, 2018, a ban on sale of out-of-service transformers and oils without PCB testing, which would greatly help to reduce environmental and health risks of PCBs to the public.

Component: Component 3: Air Quality Monitoring and Laboratory Equipment

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
The equipment is operational and providing improved air quality information for decision making	Yes/No	No 31-Dec-2015	Yes 31-Dec-2021		Yes 31-Dec-2021

Comments (achievements against targets):
The objective was achieved.

This component is to purchase air quality monitoring and laboratory equipment and associated supplies for the collection and chemical speciation analysis of manual, filter-based fine particle air pollution from the Greater Cairo Area (GCA). A one-time procurement of capital goods was made to enable (a) the collection of manual, filter-based fine particle air pollution from the GCA and (b) chemical speciation analysis of the collected samples at Cairo University Center for Environmental Hazards Mitigation (CEHM). This supports the EEAA in the development, adoption and implementation of an Air Quality Management Plan for the GCA.

All 7 Lots were procured and the delivery of the equipment was completed by December 2021. In addition, training of EEAA and Cairo University on the operation of the equipment was completed. Data is now being generated for their air quality monitoring campaign and year-long exercise in developing their own source apportionment study.

b. KEY OUTPUTS BY COMPONENT

Objective/Outcome 1	
Outcome Indicators	POPs & POPs waste destroyed, disposed or contained in environmentally sound manner
Intermediate Results Indicators	**Component 1**: Destruction of High-Risk Stocks of Obsolete Pesticides 1. Obsolete pesticides including POPs pesticides disposed of in an environmentally sound manner 2. Tracking system for management of obsolete pesticides operational 3. Obsolete pesticides at El-Staff removed and disposed of 4. Obsolete pesticides at Al-Adabeya removed and disposed of **Component 2**: Decontamination of PCB-Containing Transformer Oils 5. PCB contaminated oils decontaminated 6. Tracking system for management of PCBs operational **Component 3**: Air Quality Monitoring and Laboratory Equipment 7. The equipment is operational and providing improved air quality information for decision making
Key Outputs by Component (Linked to the achievement of the Objective/Outcome 1)	**Component 1**: Destruction of High-Risk Stocks of Obsolete Pesticides **a. OP disposal** • 237 tons of obsolete pesticides (Lindane) at Al-Adabeya Port and 4 tons (DDT and Dicofol) at El Saf and Bahteem storage sites were successfully exported and destroyed by the Tredi Salaise incinerator in France. • **471 tons, mainly Ametryn, at the El Saf site with final incineration by Breman in Sweden. The PMU also completed a video story recording the process and the high satisfaction rate by surrounding communities.** • **86 tons of OPs removed from five Egyptian ports and incinerated at the La Farge Holcim Cement Kiln in Egypt: Alexandria Port, Adabeya Port – Suez**, **Nouabaa Port - Red Sea**, **Safaga Port - Red Sea**, El Ein El Sokhna Port – Suez

- 370 tons of OPs were collected from 65 additional storage sites across various locations in the Delta, Greater Cairo and Upper Egypt Governorates and incinerated at the La Farge Holcim Cement Kiln in Egypt**.**

b. Technical Upgrading the Performance of the Central Agriculture Pesticides Laboratory (CAPL) in MALR
Laboratory design and supply of equipment. The project supported the construction of a full floor of the MALR building dedicated to the pesticide laboratory including departments, management unit and associated services. The project also funded the supply and installation of state-of-the-art laboratory equipment, part of which was funded by the project grant and the rest by the MALR local contribution. This equipment was purchased to replace the old equipment and to increase the capacity of the MALR in detecting and analyzing samples for POPS.

c. Institutional Support of the MALR
Supported the MALR in establishing the Permanent Committee for Pesticides and trained its staff on its responsibility to sustain OPs/POPs safe management, including strengthened the committee's legal and regulatory framework and enforcement capacity on the use and disposal of OPs and in issuing a recommendation that any remaining OPs be disposed at the company's own expense, and in the case of a legal prosecution, at the expense of the accused party.

d. Training and Capacity Building
The project's scope included the enhancement of the environmental management system of the MoE / EEAA and Cooperating Ministries of MALR and MERE to promote the identification, packaging, removal, transportation and destruction of high-risk stocks of obsolete pesticides, as well as the decontamination of transformers oil, consistent with Egypt's international obligations under the Stockholm and Basel Conventions. The project supported a broad spectrum of capacity building, field training and awareness raising in cooperation with the stakeholders and is summarized in Table A1.1 below. A report including the full details of the project training and capacity building programs was prepared and submitted by the PMU.

Component 2: Decontamination of PCB-Containing Transformer Oils

a. Identification of Equipment Containing Contaminated Oil

PCB inventory developed with over 1000 tons of transformer oil contaminated with PCB concentrations above 50 mg/kg – found in 334 transformers with 821 tons and 185 tons stored in barrels. Contaminated transformer oil was found in both power production and transmission companies where large transformers exist. A number of out of service transformers containing contaminated oil were also detected.. A summary of the inventory's findings is contained in Table A1.2 below.

Table A1.2 Inventory of Transformers and PCB waste

Inventory of transformers and PCB waste	Number
Total number of transformers possibly contaminated by PCBs estimated in the power sector as estimated at project appraisal	22,000
Total number of transformers surveyed under the project	18,750
Total number of transformers sampled	13,310
Total number of transformers identified by analysis with PCB contamination	789
Total weight of in-service transformer PCB contaminated oil (tons)	789
Total weight of out-of-service PCB contaminated transformer oil (tons)	169
Total weight of scrap PCB contaminated oil (tons)	55.88
Total weight of contaminated oil (t)	1013.88

b. Feasibility Study - Identifying Options for In-Service and Out-Of-Service PCBs Transformer Oil Dechlorination

Feasibility Study (FS) completed to evaluate decontamination options that were environmentally sound, commercially, and reasonably available to dechlorinate PCB-contaminated oil and recommend a preferred option. The assessment considered technologies consistent with the requirements of CENELEC TR 50503/2010.[21] The study also considered technologies operating "on-site" to prevent cutting off services for online transformers. It was concluded that the *Dehalogenation process in continuous and closed-loop circuit*, and especially the mobile PCB decontamination system, had the advantage of treating oil on-site at reduced

[21] CENELEC, 2010. Guidelines for the inventory control, management, decontamination and/or disposal of electrical equipment and insulating liquids containing PCBs. European Committee for Electrotechnical Standardization.

environmental risks and this system allowed for online decontamination of large transformers with no draining of the insulating liquid and reducing the associated risk for workers, public health, and the environment.

The parallel use of mobile and stationary on-site decontamination techniques and the creation of the stationary batch decontamination centers were the best technical solution for each transformer scenario. This activity was unique, and necessary, for the sustainable decontamination of transformer oil belong to the MoERE and other engaged ministries. This technique minimized the risks and costs for the removal and transportation of large equipment containing hazardous liquids.

c. Oil Decontamination Equipment and Support to MoERE/EHC
Oil decontamination mobile units operational with supplies to dehalogenate and purify 1000 tons of PCB contaminated oil.

d. PCB Oil Decontaminated through the Dehalogenation Process
417.6 tons of PCB-contaminated oil treated as of June 2022 (Table A1.3) and the remaining 582 tons is expected to be completed by end 2022.

e. Capacity Building and the PCB Transformer Tracking System Procedures
The capacity of MoERE and EEAA were strengthened through a series of in person trainings to promote the identification and decontamination of PCB-contaminated oils, including training to track, monitor and decontaminate PCBs and PCB containing equipment, supporting project monitoring and evaluation and enhancing EEAA's system of tracking PCBs and PCB containing equipment. A list of trainings to MoERE and EEAA is supplied in Table A1.1 and the PCB tracking system description is below.

PCB Transformer Tracking System Procedures Applied by MoERE

1. All Electricity companies are obligated to put the red label on any transformer proven by analysis to be contaminated with PCB's above 50 ppm
2. The Ministry issued written instructions to all companies (distribution, transmission, and production) to assign a focal point in each company to control the contaminated transformers at that specific company and liaise with the PIU in the Ministry

	3. All companies were instructed by the Ministry not to deal with any contaminated transformer (whether oil changing, maintenance, put it out of service) without prior notice to the PCB PIU in the Ministry 4. Instructed all companies to provide the PCB PIU with the database of all sampled transformers so as to follow up on the status of transformers and periodically update the database 5. All companies were instructed to add the percentage of the PCB's found in the transformer to the GIS database of each company. The GIS database of each company is linked to a central database in the PCB PIU of the Ministry 6. All companies were instructed to take the following procedures when taking a transformer out of service: a. If the transformer is red labeled, the company is required to send notification to the PCB PIU of the Ministry b. If a bar code is found without a red label, the transformer deemed safely out of service c. If there is neither a bar code or red label found on the transformer, a sample should be sent for analysis and based on the result, the company can take either one of the two actions in a or b MoERE issued these instructions to all affiliated companies of the Ministry (Production, Transmission, and Distribution Companies) on PCB management as part of the PCB tracking system in the power sector. **Component 3**: Air quality monitors for 10 sites and laboratory equipment were delivered to EEAA and the University of Cairo and is generating data for improved decision making. The equipment is currently being used to develop EEAA's Integrated Climate - Air Quality Management ("Action") Plan, which will determine government actions for both climate and air quality.
Objective/Outcome 2	
Outcome Indicators	**1. Direct Project beneficiaries (female)**
Key Outputs by Component (linked to the achievement of the Objective/Outcome 2)	This indicator is achieved. A significant share of the obsolete POPs pesticides covered under this project were stored at the Adabeya port, located in the Ataka district, Suez Governorate which is an Industrial/Residential area of 8827 km^2 with total

population of 27,340 inhabitants including 40% women. Therefore, roughly 27,340 people were considered direct project beneficiaries from the removal of those POPs pesticides.

The El Saff site is located in a residential area of El-Saff Town – Giza Governorate about 52 Km to the south of Cairo. El Saff is a highly populated area of about 100 km^2 where 356,586 inhabitants exist. The OPs/POPs storage facility of 1000 m^2 area is situated close to a large barn storing grain of 15,300 m^2 owned by the Bank of Credit and Development. The site is surrounded by sensitive habitats of different types and is close to the store (from within the same area to 3.8km). These habitats were affected by the stored OPS/POPs for several decades and the removal of the OPs from the store reduced this population from an extremely high risk.

Similar to these two examples above, many of the sites were located near (or in) population centers throughout Egypt. Direct project beneficiaries were defined as those within 2km of storage sites for OPs and PCB sites and including the electrical workers at MoERE/EHC who regularly handle transformers containing PCB-contaminated oil. The below table summarizes the direct beneficiaries which in total came to approximately 3.1 million direct beneficiaries.

Project beneficiaries	**Population (thousand)**
OP sites	
Residents near El Saf and Al-Adabeya OP sites	41.6
Residents near Ports, Delta, Greater Cairo, Alexandria and Upper Egypt OP sites	261.5
PCB sites	
Workers at Egyptian power plants	0.5
Residents near PCB storage sites	2,754.5
Total	3,058.1

Table A1.1: Summary of Training and Capacity Building Programs

Topics	Training provided by	Participants	Number
Training Provided by The Ministry of Agriculture and Land Reclamation (MALR)			
- Environmentally Safe Management of OPs and POPs - BAT for OPs/ POPs Safe Disposal - Safe Management of OPs/POPs Stores and Seizure of Expired Pesticides - Track and monitor obsolete stockpiles - Control of Pesticide Circulation and Combating Fraud and Trafficking	- MALR trained senior staff that received the SPMP training - Senior Staff of the Central Laboratory for Pesticides of the MALR - SPMP Consultants and Experts in the field	- Oversight inspectors of the MALR directorates - Pest control engineers of the MALR - Guidance engineers of the MALR - Environmental workers in different MALR Directorates	1,680
On the Job and Field Training Concerning POPs/OPs			
Training on POPs repackaging during Lindane Removal from Adabeya.	POLYECO Contractor	- Egyptian repacking staff appointed for the Job - EEAA staff (Suez RBO) - Senior staff from the MALR - Port staff - PMU - NGO	24
Training on OPs and repackaging during OPs Removal El Saff Site.	POLYECO Contractor	- EEAA - MALR - NGO from the site vicinity - El Saff Site staff	22
Study Tours			
Visit to the best POPs incineration facility in France - Tredi's incineration facilities.	- Site Managers	Participants from different authorities:	11

	- Health and Safety Mangers of each facility - transboundary shipment specialist - International logistics manager - International communication manager	- Central Laboratory of pesticides – MALR - Egypt Electricity Holding Company – MERE - SPMP Lead Consultant - EEAA Staff - WMRA Staff	
Visit to Polyeco premises and facilities in Greece	- Environmental Manager - Health & Safety Managers of the facilities - PR manager - International Affairs Manger	Participants from different authorities: - SPMP Director - Egyptian Media Representatives - EEAA Staff WMRA Staff	6
Training and Capacity Building of PCB-contaminated Transformer Oils			
Office Training: - Capacity building and awareness of the Stockholm Convention - Mechanism for selecting the transformer oil sampling - How to deal with POPs in transformer oils, and how to safely deal with Hazards substance. - Sampling and collection transformers oil. - Theoretical training on sampling and analysis of transformer oils.	Local Experts	MERE Holding Company and Its Company Staff: Engineers Chemists Technicians Health and Safety Officers	242
Practical Training: - Practical training on sampling and analysis of transformer oils	Local Experts	MERE Holding Company and Its Company Staff: Engineers	527

- Training on how to deal with personal protective equipment		Chemists Technicians Health and Safety Officers	
<u>Online Training:</u> with the supplier on (PCB Management Strategy - European regulation about PCB – PCB Analysis & Interpretation - Decontamination Technologies- main security aspects)	SEA Marconi Expert	MERE Holding Company and Its Company Staff: Engineers Chemists	9
<u>On the Job Training:</u> - Analysis of Polychlorinated Biphenyls in transformer Oils by L2000DX Analyzer - Polychlorinated Biphenyl analysis in transformer Oils with GC/MS - Gas chromatography - How to treat transformers oil contaminated by using decontamination unit	Group of international & National Experts	- MERE Holding Company and Its Company Staff: Engineers Chemists - EEAA Staff	123
Study Tours			
Visit to the best POPs incineration facility in France - Tredi's incineration facilities. To observe the PCBs contaminated oil treatment	- Site Managers - Health and Safety Mangers of each facility - transboundary shipment specialist - International logistics manager - International communication manager	Participants from different authorities: - Central Laboratory of pesticides – MALR - Egypt Electricity Holding Company – MERE - SPMP Lead Consultant - EEAA Staff - WMRA Staff	11

Table A1.3 PCB oil decontaminated through the dehalogenation process

#	Oil Weight	Name of Company	Name of Station	Data of sample	Status	Capacity M.V.A	Conc. before treat.	Conc. after treat.	% reduction
1	65.0	Electricity of Alexandria and West Delta	Abou El Matamir	power transformer No. (1)	Good	125	689	49	-1306%
2	8.9	Electricity of Alexandria and West Delta	Petrochemical Station	power transformer No. (3)	Good	25	84	47	-79%
3	11.0	Electricity of Alexandria and West Delta	Alexandria Petroleum	power transformer No. (1)	Good	25	96	49	-96%
4	11.0	Electricity of Alexandria and West Delta		power transformer No. (2)	Good	25	208	48	-333%
5	65.0	Electricity of Alexandria and West Delta	El Amreya - 220	power transformer No. (2)	Out of service	125	63	>10	-473%
6	65.0	Electricity of Alexandria and West Delta		power transformer No. (1)	Out of service	125	64	>10	-482%
7	35.0	West Delta Electricity Production	Damanhour steam	T01	Good	75	52	8	-550%
8	5.7	West Delta Electricity Production		T03	Good	8	95	11	-764%
9	36.0	West Delta Electricity Production		T02	Good	75	152	9	-1589%
10	60.0	West Delta Electricity Production		power transformer - unit 300	V.Good	422	488	48	-917%
11	2.5	West Delta Electricity Production	Damanhour El Morakaba	A	V.Good	4	115	38	-203%
12	50.0	West Delta Electricity Production		T5	Good	127	330	25	-1220%
13	2.5	West Delta Electricity Production		B	V.Good	4	100	45	-122%
	417.6	**Total**							

ANNEX 2. BANK LENDING AND IMPLEMENTATION SUPPORT/SUPERVISION

A. TASK TEAM MEMBERS

Name	Role
Preparation	
Alaa Ahmed Sarhan	Task Team Leader(s)
Ruma Tavorath	Co- Task Team Leader
Badr Kamel	Procurement Specialist(s)
Wael Ahmed Elshabrawy	Financial Management Analyst
Laurent Granier	Senior Environmental Specialist
Sherif Kamel F. Arif	Consultant
Chaogang Wang	Senior Social Development Specialist
Mariana T. Felicio	Social Development Specialist
Africa Eshogba Olojoba	Senior Environmental Specialist
Supervision/ICR	
Harinath Sesha Appalarajugari, Craig M. Meisner	Task Team Leader(s)
Craig Meisner	Co-Task Team Leader
Ashraf Ahmed Hasan Al-Wazzan	Procurement Specialist(s)
Wael Ahmed Elshabrawy	Financial Management Specialist
Marie A. F. How Yew Kin	Team Member
Layla Mohamed-Kotb Abdel Wahab	Team Member
Amal Nabil Faltas Bastorous	Social Specialist
Amer Abdulwahab Ali Al-Ghorbany	Environmental Specialist

B. STAFF TIME AND COST

Stage of Project Cycle	Staff Time and Cost	
	No. of staff weeks	US$ (including travel and consultant costs)
Preparation		
FY10	22.331	107,665.57
FY11	27.765	192,865.63
FY12	7.750	67,924.10
FY13	1.125	3,481.42
FY14	5.723	33,411.31
FY15	0	0.00
Total	**64.69**	**405,348.03**
Supervision/ICR		
FY12	7.318	91,346.47
FY13	0	- 647.20
FY15	6.670	50,426.68
FY16	5.525	39,934.22
FY17	19.300	71,872.58
FY18	8.612	59,035.26
FY19	10.627	73,831.87
FY20	13.332	93,998.71
Total	**71.38**	**479,798.59**

ANNEX 3. PROJECT COST BY COMPONENT

Table 1: Financing Plan of the project including the AF (US$ millions)[22]

Components	Government co-financing	GEF	Additional Financing	Total
Component 1: Destruction of High-Risk Stocks of Obsolete Pesticides	8.01	3.83	-	**11.99**
Component 2: Decontamination of PCB-Containing Transformer Oils	7.49	4.26	-	**11.75**
Component 3: Air Quality Monitoring and Laboratory Equipment	-	-	0.75	**0.75**
Total	**15.65 ***	**8.09**	**0.75**	**24.49**

* *Note*: The GOE contributed about $15.65 million (of which $12.1m is a cash contribution).

Table 2: Project costs at completion (US$ millions)

Components	Amount at Approval + AF (US$M)	Actual at Project Closing (US$M)	Percentage of Approval
Component 1: Destruction of High Risk Stocks of Obsolete Pesticide	11.86	11.99	101.1
Component 2: Decontamination of PCB-Containing Transformer Oils	11.74	11.75	100.1
Component 3: Air Quality Monitoring and Laboratory Equipment	0.75	0.75	100.0
Total	**24.35**	**24.43**	**100.3**

Government Co-Financing: At appraisal, the government was to provide co-financing of US$15.65 million, with US$5.84 million to MALR, US$5.33 million to MoERE and US$4.33 million to MSEA/MOE as indicated in Annex 6 of the PAD. At project completion the government provided co-financing of US$15.65 million, with US$6.04 million to MALR, US$5.29 million to MoERE and US$4.32 million to MSEA/EEAA. US$3.55 million was provided as in-kind support and US$12.1 million was a cash contribution.

[22] These are the total costs of the project and include the Government's contribution. The Government contribution in Annex 6 of the Project Appraisal Document has US$3.1 million under "Project Management Support and Institutional Strengthening", and this is included under Components 1 and 2 in Table 1.

ANNEX 4. EFFICIENCY ANALYSIS

The efficiency analysis is divided in two parts: (a) economic analysis; and (b) implementation efficiency.

a. Economic analysis

At project preparation, a benefit-cost analysis was not conducted due to a lack of reliable baseline data as well as data on related health impacts. Instead, the project adopted 'maximum risk reduction' as the criterion to prioritize POPs activities to benefit segments of the population, such as workers in the power sector and those in residential areas close to pesticide storage sites. It was anticipated that with increased awareness and managed use of pesticides, there would be a net positive impact on the health of women, in particular. In the power sector, it was expected that the training on safe handling, testing and treatment of high-concentration PCBs would lower the exposure risks to workers in the power sector.

The following ex-post efficiency analysis is organized around three types of project benefits: 1) a benefit-cost analysis of health risk reduction from exposure to POPs and PCBs, 2) a cost-effectiveness analysis of OP/PCB treatment and disposal options, and 3) the administrative and managerial efficiencies gained through the project.

(i) Benefit-cost analysis of health benefits

The project generated important occupational, local, and global benefits. The destruction of obsolete pesticides and PCBs has benefits to several different groups. The beneficiaries of reduced exposure to hazardous pesticides (including those containing POPs) and PCBs include: i) workers handling those substances, ii) local communities who may be exposed through contact or from contaminated water or food and iii) the global environment from reduced accidental exposure from the release of dioxins and furans into the atmosphere. Each of these benefits (or avoided costs) are described below:

Occupational health and safety. The project improved the occupational health and safety of workers who collected, packaged, and stored obsolete pesticides (OPs) and those handling PCB contaminated equipment or oils in the power sector. This included the provision of personal protective equipment for handling OPs and PCBs and the removal and disposal of these hazardous substances to prevent future exposure. To understand whether there is an increased risk of mortality among occupational workers than the general population, the ICR undertook a literature review to understand the most recent evidence.

No studies in Egypt have been conducted on the dose-response relationship between worker's health and PCB exposure in the electrical sector, however studies conducted elsewhere have shown increased risks of cancer, with malignant melanoma and other specific forms of cancer being of particular concern in this industry.[23,24,25] For all-cause mortality, the evidence is more mixed and in some cases prevalence rates cannot be shown to be higher

[23] Dana Loomis, Steven R Browning, Anna P Schenck, Eileen Gregory, David A Savitz, 1997. Cancer mortality among electric utility workers exposed to polychlorinated biphenyls, *Occupational and Environmental Medicine* **54**: 720-728.

[24] Mary M Prince, Misty J Hein, Avima M Ruder, Martha A Waters, Patricia A Laber and Elizabeth A Whelan, 2006. Update: cohort mortality study of workers highly exposed to polychlorinated biphenyls (PCBs) during the manufacture of electrical capacitors, 1940-1998, *Environmental Health: A Global Access Science Source* **5**:13 doi:10.1186/1476-069X-5-13.

[25] Avima M. Rudera, Misty J. Hein, Nancy B. Hopf, and Martha A. Waters, 2014. Mortality among 24,865 workers exposed to polychlorinated biphenyls (PCBs) in three electrical capacitor manufacturing plants: A ten-year update, *Int J Hyg Environ Health*. March; 217(0): 176–187. doi:10.1016/j.ijheh.2013.04.006.

than national averages, which leads us to believe that occupational long-term high-level airborne and dermal exposure to commercial PCB mixtures is probably not associated with increased overall risk for cancer, but an elevated risk of rare cancers.[26] For the purposes of the benefit-cost analysis, this uncertainty leads us to assume that the occupational exposure risk is no larger than the environmental risk posed to the local community.

Local community. The project contributed to local public goods by averting potential illnesses such as cancer and other detrimental health impacts arising from environmental exposure around contaminated sites. Local communities may be exposed by breathing air near sites where hazardous waste is stored or drinking contaminated ground water. OP stockpiles and PCB liquid leaking from transformers can enter the water table or the food chain and can induce various adverse health effects in humans and animals. Studies in Egypt have found evidence of OPs and PCBs infiltrating water systems and contaminating food, [27,28] polluting residential areas,[29] ports,[30] irrigation canals[31], and found in coastal sediments[32] and fish.[33]

Environmental exposure to OPs and PCBs has been associated with liver, kidney, endocrine, and neurodevelopmental adverse effects. Furthermore, PCB exposures of vulnerable populations, such as pregnant women, infants, and children are of particular concern because of heightened sensitivity during this period of brain development. In Egypt, there is a rich body of literature on the exposure of agricultural workers to the hazards of pesticide spraying and to neighboring communities,[34,35,36,37,38] however, these studies did not elicit the effect on

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[26] Ellen Bøtker Pedersen, Peter Jacobsen, Allan Astrup Jensen, Charlotte Brauer, Lars Gunnarsen, Harald W. Meyer, Niels E. Ebbehøj, Jens Peter Bonde, 2013. Risk of disease following occupational exposure to Polychlorinated Biphenyls, Technical Report · June, University Hospital of Copenhagen Department of Occupational and Environmental Medicine.

[27] Amir El-Shahawy and Lubomir I. Simeonov, 2013. Environmental and Health Situation with Obsolete Pesticides in Egypt, Chapter 19 *in* L.I. Simeonov et al. (eds.), **Environmental Security Assessment and Management of Obsolete Pesticides in Southeast Europe**, NATO Science for Peace and Security Series C: Environmental Security, DOI 10.1007/978-94-007-6461-3_19.

[28] N. Loutfy, M. Fuerhacker, C. Lesueur, M. Gartner, M. Tawfic Ahmed & A. Mentler, 2008. Pesticide and non-dioxin-like polychlorinated biphenyls (NDL-PCBs) residues in foodstuffs from Ismailia city, Egypt, *Food Additives & Contaminants*: Part B, 1:1, 32-40, DOI: 10.1080/19393210802236885.

[29] Ramy H. Abd-elkhalik; Ashraf S. Hassanin; Mohamed R. Abd-elmootaal, Sherif M. Taha, M. E.Moustafa, G. O. El-Sayed, 2021. A two year study of dioxin-like polychlorinated biphenyls (dl-PCBs) in mother's milk in Qalyubia governorate, Egypt, *Egyptian Journal of Chemistry*, Vol. 64, No. 2: 573 – 579.

[30] Assem O. Barakat, Moonkoo Kim, Yoarong Qian, Terry L. Wade, 2002. Organochlorine pesticides and PCB residues in sediments of Alexandria Harbour, Egypt, *Marine Pollution Bulletin* **44**: 1421–1434.

[31] I.N. Nasr, M.H. Arief, A.1 2 3 H. Abdel-Aleem, 1F.M. Malhat, 2009. Persistent Organic Pollutants (POPs) in Egyptian Aquatic Environment, *Journal of Applied Sciences Research*, **5**(11): 1929-1940.

[32] Dalia M.S. Aly Salem, Azza Khaled, Ahmed El Nemr, 2013. Assessment of pesticides and polychlorinated biphenyls (PCBs) in sediments of the Egyptian Mediterranean Coast, *Egyptian Journal of Aquatic Research* **39**: 141–152.

[33] Saad M. 2017. The Persistent Organic Pollutants of Dioxins in Egypt. *Agri Res & Tech: Open Access J*., **6**(2): 555683. DOI:0038 10.19080/ARTOAJ.2017.06.555683.

[34] Sania Amr, Rebecca Dawson, Doa'a A. Saleh, Laurence S. Magder, Diane Marie St. George, Mai El-Daly, Katherine Squibb, Nabiel N. Mikhail, Mohamed Abdel-Hamid, Hussein Khaled, and Christopher A. Loffredo, 2015. Pesticide, Gene Polymorphisms and Bladder Cancer among Egyptian Agricultural Workers, *Arch Environ Occup Health* January 2; **70**(1): 19–26. doi:10.1080/19338244.2013.853646.

[35] Clémentine Dereumeauxa, Clémence Fillola, Philippe Quenelb, Sébastien Denysa, 2020. Pesticide exposures for residents living close to agricultural lands: A review, *Environment International* **134**: 105210.

[36] Hana-May Eadeh, Ahmed A. Ismail, Gaafar M. Abdel Rasoul, Olfat M. Hendy, James R. Olson, Kai Wang, Matthew R. Bonner, Diane S. Rohlman, 2021. Evaluation of occupational pesticide exposure on Egyptian male adolescent cognitive and motor functioning, *Environmental Research* **197**: 111137.

[37] Sarah S. Jacksona, Diane Marie St. Georgea, Christopher A. Loffredob, and Sania Amr, 2017. Nonoccupational exposure to agricultural work and risk of urinary bladder cancer among Egyptian women, *Arch Environ Occup Health* May 04: **72**(3): 166–172. doi:10.1080/19338244.2016.1169155

[38] Nevin E. Sharaf, Nagat M. Amer, Khadiga S. Ibrahim, Eman M. El-Tahlawy and Khaled S. Abdelgelil, 2013. Pesticides Usage in Agriculture

mortality. For the benefit-cost analysis, the ICR makes use of study from Sweden that investigates the mortality risk of community members with elevated levels of PCB in the blood.

A study in Sweden found that persistent organic pollutants were associated with an increased mortality risk.[39] In a population-based cohort study of 992 individuals, 18 persistent organic pollutants were measured in plasma at two occasions. Elevated levels of highly chlorinated polychlorinated biphenyls (PCBs) were associated with increased mortality risk, mainly from cardiovascular diseases, during 10 years of follow-up. The study showed that the individuals with the highest PCB levels with many chlorine atoms in the blood had 50% excess mortality, especially from cardiovascular disease, compared with the other groups. Overall, elevated levels of PCB in the blood corresponded to 7 excess deaths during the 10-year follow-up period.

Global environment. The project provided global public goods by reducing the risk of accidental exposure to POPs and PCBs with the potential of forming dioxins and furans in the atmosphere. Persistent organic pollutants (POPs) are toxic chemicals that adversely affect human health and the environment around the world. Because they can be transported by wind and water, most POPs generated in one country can and do affect people and wildlife far from where they are used and released.[40] The removal and safe disposal and destruction of POPs and PCBs reduces the likelihood of these substances being released through accidental fire or dispersion. The ICR does not attempt to quantify the global benefits from POPs and PCB reduction – however below we provide an estimate of the avoided air emissions of dioxins, furans and other air pollutants as a consequence of safely disposing the amounts of POPs and PCBs from the project. These are the avoided air emissions if these materials were released into the air from an accidental fire or open burning. Estimates show that the avoided emissions are several orders of magnitude above the allowable limits for POPs, OPs and PCBs (Table A4.1). For example, if the 241 tons of POPs were openly burned it would release 8.435 grams of POPs (in Toxic Equivalent Quantity) into the atmosphere, while the allowable concentration limit is 0.1 nanograms per m^3. While the emissions estimate does not tell us the released concentration – the difference in the orders of magnitude between emissions and limits shows that the disposal of these hazardous substances clearly avoids a very hazardous air quality situation. In addition to the hazardous release of POPs, OPs and PCBs, there are significant avoided emissions of more conventional air pollutants such as CO2, CO, NOx, HCN, and HCl (Table A4.2).

Table A4.1 Estimated UPOPs released in case of open burning of POPs and PCBs stockpiles in Egypt

Material	Quantity (tons)	Emissions factor (µg TEQ/ton)	UPOPs released to air (gm TEQ)	Allowable limit (ngm/m^3)
POPs (Lindane, DDT)	241	35,000	8.435	0.1
OPs	841	35,000	29.435	0.1
PCBS	1000	300,000,000	30,000	0.1

Note: TEQ – toxic equivalent quantity; UPOPs – Unintentional POPs; µg – microgram; gm – gram; ngm – nanogram; 1 gm = 1,000,000,000 ngm

among Rural Women in Egypt: Association Between Serum Organo-Chlorine Pesticide Residues and Occurrence of Diabetes, *World Journal of Medical Sciences* **9** (1): 08-15.

[39] P. Monica Lind, Samira Salihovic, Jordan Stubleski, Anna Kärrman, Lars Lind, 2019. Association of Exposure to Persistent Organic Pollutants With Mortality Risk, *JAMA Network Open*, 2(4):e193070. doi:10.1001/jamanetworkopen.2019.3070.

[40] WHO, 2002. Health Risks of Persistent Organic Pollutants from Land-range Transboundary Air Pollution, Joint WHO/Convention Task Force on the Health Aspects of Air Pollution.

Table A4.2 Estimated air emissions released in case of open burning other than POPs

Emissions	Emissions factor (mg/gm)	Emissions released to air (tons)			
		POPs (Lindane, DDT) (241 tons)	OPs (841 tons)	PCBs (1000 tons)	Total
CO_2	1,136	273.8	955.4	1,136.0	2,365.2
CO	68	16.4	57.2	68.0	141.6
NO_x	25	6.0	21.0	25.0	52.1
HCN	13	3.1	10.9	13.0	27.1
HCl	160	38.6	134.6	160.0	333.1

Note: HCN - hydrogen cyanide; HCI - hydrogen chloride

Scope of BCA Analysis

The primary quantifiable benefits of the project are assumed to be the prevention of lost productivity due to excess mortality by the workforce in the electricity sector and the population surrounding contaminated sites. Other lost productivity costs related to occupational exposure, such as disability-adjusted life years, other health-care costs related to environmental exposure, as well as accidental exposure during clean-up, are not included in the analysis.

To provide an estimate that is consistent with the 10-year longitudinal study by Lind et al. (2019) above, we assume that the benefits from reduced excess mortality would start 10 years from project completion (i.e. when the hazards have been eliminated). A total of 712 tons of OPs from El Saff and Bahteem (at Al-Adabeya Port) were shipped to France and Sweden to be incinerated in 2018-20 and 370 tons of OPs were co-processed in cement kilns in Egypt in 2021. PCB decontamination of 418 tons was completed in 2021 and is currently ongoing. For the purposes of this analysis, we use a baseline year of 2021 and assume benefits will begin to accrue in 2031 for ten years until the residual effects of OP/PCB exposure have been eliminated. Thus, a death in 2031 will result in the loss of annual GDP per capita in each year from 2031 to 2040 (ten years inclusive); whereas a death in 2040 will only result in the loss of annual GDP per capita in 2040, the end of the benefit horizon.

To evaluate the benefits of avoided mortality we use the value of a statistical life (VSL) as a proxy. The VSL is the local tradeoff rate between fatality risk and money. When the tradeoff values are derived from choices in market contexts the VSL serves as both a measure of the population's willingness to pay for risk reduction and the marginal cost of enhancing safety.[41] It is the cost of reducing the average number of deaths by one – and is normally measured through local surveys of individuals. Estimates for the VSL are published and used in practice by various government agencies. In Western countries, estimates for the value of a statistical life typically range from US$1 million - US$10 million; for example, the United States FEMA estimated the value of a statistical life at US$7.5 million in 2020. In Egypt, a recent study on traffic fatalities estimated the VSL to be approximately EGP 5,900,000 or about $US 320,000 and we use this value in the analysis below.[42] We also adjust this value over time according to the growth rate of real Gross Domestic Project (GDP) per capita.

Real GDP per capita has varied considerably with the global pandemic and the relative traction of economic

[41] Thomas J. Kniesner and W. Kip Viscusi. 2019. The Value of a Statistical Life at https://law.vanderbilt.edu/phd/faculty/w-kip-viscusi/368_Value_of_Statistical_Life_Oxford.pdf.

[42] Nasser M. Abdallah*, Ahmed S. El Hakim, Abdallah H. Wahdan, Mohamed A. El Refaeye. 2016. Analysis of Accidents Cost in Egypt Using the Willingness-To-Pay Method, *International Journal of Traffic and Transportation Engineering* **5**(1): 10-18.

recovery programs. Egypt entered the global pandemic with reserve buffers rebuilt and macroeconomic vulnerabilities reduced. Real GDP grew by 5.6 percent in 2019, up from an average rate of 4.6 percent in the previous three years. The pandemic interrupted this progress, putting a significant strain on the health system and the economy. Real growth declined to 3.6 percent in 2020, although remained higher than in many other economies. Real GDP per capita was US$3,548 in 2020 and using IMF forecasts is expected to increase to above 5 percent from 2022 forward.

Summary of Assumptions:

- Value of Statistical Life (VSL) is $US 319,742 in 2020 and adjusted annually by real GDP per capita growth
- GDP per capita in 2020: US$3,548 (World Bank data)
- Real GDP growth and forecasts (IMF)
  - 2020: 3.57%
  - 2021: 2.80%
  - 2022: 5.90%
  - 2023: 5.64%
  - 2024: 5.59%
  - 2025: 5.80% and beyond
- The local community population is forecasted for each year from 2020 onwards (United Nations - World Population Prospects)
- Mortality rate of 0.7 percent among all project beneficiaries:

Table A4.3 List of project beneficiaries by type of site

Beneficiaries	**Population (thousand)**
OP sites	
Residents near El Saf and Al-Adabeya OP sites	41.6
Residents near Ports, Delta, Greater Cairo, Alexandria and Upper Egypt OP sites	261.5
PCB sites	
Workers at Egyptian power plants	0.5
Residents near PCB storage sites	2,789.4
Total	3,093.0

- Benefits accruing from reductions in excess mortality begin 10 years after project closure.
- A discount rate of 6 percent per annum.

Sensitivity Analysis:

- Mortality rates are varied from 5 to 10 deaths per 1000.
- The internal rate of return is estimated in 10, 15 and 20-year intervals to show how benefits change over time.
- Project costs are presented both with and without Government co-financing to demonstrate the robustness of the results.

Results

The analysis shows a positive net present value around $US 7.0 billion which far exceeds the investment costs of $US 8.85 million (GEF) and $US 24.35 million (GEF plus Government contributions) (Table A4.5). The calculated Internal Rate of Return (IRR) is positive, and significantly above the require social rate of return of 6-12 percent, and across all mortality rate assumptions ranging from 43.5 percent in year 10 (mortality of 5/1000; GEF costs only) to 66.4 percent in year 20 (mortality rate of 10/1000; GEF costs only) (Table A4.5). The results are robust if the Government's contributions are included.

Table A4.5 Internal rate of return (IRR) under alternative mortality rates and project costs

GEF costs only ($US8.85 million)	**Mortality rate per 1000**					
Mortality rate	**5**	**6**	**7**	**8**	**9**	**10**
IRR-10 (years)	43.5%	45.9%	48.0%	49.8%	51.4%	52.8%
IRR-15	56.1%	58.5%	60.5%	62.2%	63.8%	65.3%
IRR-20	57.4%	59.7%	61.7%	63.4%	65.0%	66.4%
GEF + Government's contribution ($US24.35 million)	**Mortality rate per 1000**					
Mortality rate	**5**	**6**	**7**	**8**	**9**	**10**
IRR-10	30.8%	33.0%	34.9%	36.5%	38.0%	39.3%
IRR-15	43.7%	45.8%	47.6%	49.3%	50.7%	52.0%
IRR-20	45.4%	47.5%	49.3%	50.8%	52.2%	53.5%

Conclusion

The economic analysis shows large net positive social benefits under conservative assumptions and on a limited set of quantifiable benefits – namely the lost productivity (income) through excess mortality from POPs/PCB exposure. Relaxing some of the assumptions would yield even greater benefits, such as: i) counting potential benefits prior to year 10; ii) extending the benefit horizon beyond year 10; iii) including other forms of disability resulting from occupational exposure and a greater economic cost on the household; and iv) including the reduction in the probability of an accidental disaster that impacts the community and a wider regional population; and v) GDP growth is faster than assumed.

(ii) Cost-effectiveness analysis

CEA of OPs at appraisal: During project preparation it was concluded that, for the tonnages involved and given that no suitable disposal facility existed in Egypt, the most cost-effective solution would be to repackage the materials and export them for destruction in an accredited incineration facility. An average cost of US$ 3,400/ton (including contingencies) was estimated, and which compared with the average cost experienced under the Africa Stockpiles Program (i.e., US$ 3,103/ton). For materials which were to be repackaged and securely stored, a cost of US$ 465/ton (including contingencies) was estimated. Although not specifically mentioned in the PAD, local incineration options were also to be explored from a longer-term and cost perspective. This would require a technical feasibility study of existing incineration facilities – namely cement kilns that could use the OPs as a feedstock.

CEA of PCB oils at appraisal: At project preparation, the assumption was that the most cost-effective method for PCB oil elimination would be dechlorination and would produce an oil which is non-toxic and suitable for reuse as fuel, followed by a second stage of purification (with a Fuller's Earth facility), to produce an oil which can be reused in transformers. These assumptions were to be re-examined through a technical feasibility study of options and depending on the number of transformers needing decontamination, the average level of contamination, and the unit costs of various technical options.[43] It was assumed that over the life of the project, the total quantity of transformer oil processed would be about 1,000 tons and resulting in the destruction of about 150 to 300 kg of PCBs. This seemingly low amount reflects the fact that, in Egypt, high-concentration PCBs had already been eliminated, and the remaining problem was one of low levels of contamination (but >50 ppm) and widespread throughout the entire power system and thus expensive to correct. The overall cost was estimated to be about US$ 6,600/ton of oil treated and would be partly offset by the continuing value of the project equipment and buildings and the value of the 1,000 tons of purified transformer oil which would be produced.

CEA at project completion

CEA of OPs at project completion: By 2019, 712 tons of OPs were collected, repackaged and exported internationally for incineration in France with a cost of US$1,914/ton for the first batch of Lindane from Al-Adabaya Port and $1,239/ton for the second batch stored in El Saff (Table A4.6). These costs were lower than those originally estimated at appraisal. The international export of OPs was one of the only options available to the country at the time, until the feasibility of local options could be assessed, and the institutional and legal arrangements made with private operators in the cement industry (i.e. cement kilns were known to be a local option, but the regulatory and legal arrangements were not in place). The implementation of local options also became more urgent when the price for exporting OPs for incineration in France rose by 40% prompting the PMU to expedite the processing of the last batches (totaling 370 tons) via co-processing in cement kilns in Egypt. In 2017, an assessment was conducted by the International Consultant TAUW on four local cement kilns for their capabilities of incinerating OPs in accordance with UN requirements and Industrial Emission Directive and UNEP Basel Convention technical guidelines on the environmentally sound co-processing in cement kilns (UNEP BC TG). The four cement plants were:

- Ain El Sokhna cement plant owned by Arabian Cement Company (ACC)
- Beni Suef cement plant owned by Titan Cement Egypt (TCE)

[43] The Feasibility Study for PCB decontamination was to analyze: (i) the technical, market options and business models for such decontamination facilities (e.g. dechlorination and purification facilities), (ii) the technical specifications, (iii) required consumables, chemicals, power, staff and other operating costs; and (iv) environmental and social safeguards requirements for operation, including licensing and permitting of operating the facilities.

- Sokhna cement plant owned by Lafarge Holcim (LH)
- Kattameya cement plant owned by Suez Cement

The assessment found that the four plants were deficient and not ready to receive OPs for environmentally sound incineration and needed to take corrective actions to accommodate OPs.[44] A comprehensive checklist was prepared including the recommended corrective actions and provided to the plants. In 2019, a subsequent follow up performance assessment of the plants was conducted and found two of them to have undertaken the recommended actions and in compliance. Ultimately, the Lafarge Holcim cement kiln was selected to receive the remaining 370 tons of OPs for incineration. The final cost of disposal varied between US$261-418/ton, due to differences in repackaging and transport costs and the nominal fee for incineration, making this option 5-6 times cheaper than the international export options with the first batches of OPs and 10 times cheaper than the estimated cost at appraisal (Table A4.6).

Table A4.6 Cost-effectiveness of disposal options

OPs/PCBs eliminated	Unit cost ($US/ton)		Amount (Tons)	
	Appraisal	Actual	Appraisal	Actual
OPs	3,400		1,000	
Lindane and Associated Wastes Stored at Al-Adabaya Port (exported)		1,914		241
Pesticides and Associated Wastes Stored at El Saff (exported)		1,239		471
OPs in the rest of Egypt (local incineration)				
Ports		261		86
Delta		304		106
Greater Cairo		261		118
Upper Egypt		418		60
PCBs	6,600		1,000	
Decontamination units, customs, PCB analysis, training (CAPEX)		5,935		418

CEA of PCB decontamination at completion: The project identified about 1000 tons of transformer oil contaminated with PCBs, with concentrations above 50 mg/kg, in 334 transformers (821 tons) and 185 tons stored in barrels. The transformer oil was found in a diversity of places among the power production and transmission companies including several out of service transformers. Since some transformers contained a considerable amount of oil to decant, mobilize and decontaminate, this required a feasibility study to evaluate and recommend options to dispose oil in an environmentally sound manner and be commercially available. The preferred option was then specified in the bidding document for supply, installation and operational training.

[44] Evaluation of the Cement Kilns for the Purpose of Incinerating the Obsolete Pesticides Stored in Many Locations Scattered all over Egypt, September 2019.

Among the four options assessed[45], the *Dehalogenation process in continuous and closed-loop circuit* was selected (especially the mobile PCB decontamination system) since it had the advantage to treat the oil on site at a reduced environmental risk, moreover, this system allows online decontamination of large transformers with no draining of the insulating liquid reducing the associated risk for workers, public health and the environment.[46] The parallel use of mobile and stationary on-site decontamination technique and the creation of the stationary batch decontamination centers were proposed to achieve the project goal to decontaminate 1,000 tons of oil using the best technical solution for each transformer scenario (which were driven by decanting and transport logistics). This activity was distinctive for the sustainable decontamination of transformer oil belonging to the MoERE and other engaged ministries.

The project costs of PCB decontamination included the acquisition of two dehalogenation units and associated analyzers, reagents and chemicals for 1000 tons, customs clearances, PCB analysis and the training of workers in procedures, safe handling and operating the decontamination units (i.e. CAPEX). The Government co-financed the laboratory equipment for PCB testing and the MoERE covered the labor costs of decontaminating transformer oils (i.e., OPEX). This resulted in a dramatic cost savings than if it were to be paid all through private operators. At project completion only 417.6 tons of oil had been treated and this resulted in a disposal cost of US$5,935/ton – which is below the original estimate at appraisal ($US6,600/ton). However, since all capital expenditures have been paid, including reagents and chemicals to treat 1000 tons, and the MoERE is committed to treating the remaining 582 tons – once completed this would result in a treatment cost of US$2,478/ton.

The cost-effectiveness of disposal methods compares favorably to other POPs and PCB cleanup projects. Other projects focusing on the repackaging, transport and disposal of POPs and treatment of PCBs include the Moldova POPs Stockpiles Management and Destruction Project (P090037) in which the cost per ton of PCBs eliminated was US$4,200, the China PCB Management and Disposal Demonstration Project (P082993), where each ton of eliminated PCB cost US$4,100 and the Lebanon PCB Management in the Power Sector Project where the average cleanup cost was US$2,125 per ton.

b. Implementation efficiency:

The project demonstrated administrative and implementation efficiencies through inventorying, laboratory testing and competitive bidding. As part of the design, inventorying OP stockpiles and PCB-containing transformers helped to prioritize the most hazardous materials and locations. For example, the results from the inventorying and laboratory testing of PCB transformer oils fed directly into the feasibility study of treatment technologies and to the decision to use the dehalogenation process. – a more cost-effective and sustainable solution. It also led to the decision to procure mobile decontamination units to service online transformers in different locations (i.e. transformers that cannot be decommissioned and moved to another site for treatment). In the case of OPs, the tracking system developed by MALR identified stockpiles that required repackaging for safe handling and disposal

[45] The four options were: 1) Refilling (replacement of contaminated insulating liquid), 2) Dehalogenation processes with sodium, lithium and derivatives, 3) Dehalogenation process with polyethylene glycol and potassium hydroxide (KPEG), and 4) Dehalogenation process in continuous and closed-loop circuit.

[46] The continuous and closed loop dehalogenation process was also considered the best regarding: 1) consumption of resources and environmental eco-balance, 2)emissions into the atmosphere and noise, 3) production of wastes, and 4) economic aspects.

(i.e., those stored near sensitive and highly populated areas). The competitive bidding process for the safe transport of OPs to the Lafarge Holcim incinerator also saved money. Finally, the capacity built through the procured equipment for POPs and PCBs and the training received by MALR and MoERE enables the country to continue to address remaining stockpiles of OPs and to continue the dehalogenation process of PCB transformer oils.

PMU continuity. While several positions in the PMU experienced frequent staff turnover during implementation, the last two years were stable and with a Project Manager who was with the project during the entirety of implementation.

ANNEX 5. BORROWER, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

Comments from the Project Management Unit

1. According to Project Appraisal Document (PAD), the exchange rate is CURRENCY EQUIVALENTS (Exchange Rate Effective February 28, 2014) Currency Unit = US$ EGP 6.94 = US$1 US$0.14 = EGP1) in contrary to the rate mentioned in page 2 of the report.

2. The outcome of the project is rated as moderately satisfactory while the project achieved several outcomes behind the original PDO's. Component 1 has achieved results above the target. The delay in completing the 2nd PDO was justified as it was out of control. In spite that, component 2 achieved many other results including sustainability, circular economy, great achievements in capacity building to make inventory of PCB's, laboratory analysis, and operating the decontamination units. Also, the calculated economic and environmental return of Component 2 is very high. For both components, the project was able to benefit much larger number of beneficiaries than was planned-for and also covered larger area of the country than planned. For instance, disposal of OP's was planned for 32 sites over the country, while the actual number of cleared sites were around 69 sites. The Project also contributed to major legislative issues including the ministerial decree that enforce producers of OP's to dispose them on their own cost and ministerial letter of Ministry of Electricity that enforce belonging electricity companies not to sell waste oils or out of service transformers before testing of PCB's contamination. The project also supported the government efforts during disposal of OP's from ports which was not planned during project preparation. In addition to that, national capacity on safe disposal of OP's was noticeable, even the Ministry of Agriculture conducted more than 80 training sessions all over the country to raise the capacity of their employees on safe handling of OP's based on the knowledge acquired through the project. Finally, the impact figured-out by the beneficiaries was noticeable based on un-biased surveys at least one of them made by WB team.

3. Estimate of PCB's decontamination as stated in the report looks very high. The cost of the two units are around USD 1.4 M and the cost of material are around USD 0.7 M. The Units are supposed to have a lifetime of 10 years. The cost estimate at the report apparently consider that the units are used for decontamination of only 1000 tons. The units can decontaminate at least 1000 tons per year multiplied by 10 years lifetime. Calculation will lead to a cost of decontamination of USD 980 to 1000 per ton considering also a proactive maintenance for the units of 10% yearly.

4. Procurement was rated as *Moderately Satisfactory:* I would expect higher rate since the procurement and contract management were done efficiently as described in the report despite the situation that the project had around 5 specialist who lift the project (reasons related to the salary scale of the project compared to other projects). The Project was able to manage the procurement efficiently and changed the procurement strategy, market approach, method of bidding, etc. during the course of project to achieve the principals of procurement including efficiency, economy, transparency, etc. For instance, the project cancelled a couple of bids when found signs for front loading of unit prices or signs of monopolizing. Also, the project reacted immediately to changes in the local and international markets and changed the procurement methodology immediately. In all cases, the cancelled bids were re-tendered on timely basis effectively.

5. Lessons learned: I would like to point to few other lessons that can benefit other projects. Social and environmental safeguards need to be counted in project set-up especially time and money-wise. ESIA/ESMP's took considerable amount of time especially that sampling and analysis requires re-agents and standards not normally available on-the-shelf and needs to be imported from outside the country. Engagement of citizens and beneficiaries also talks time especially with COVID's restrictions. Online engagements is a good option but not when you need to reach specific type of populations that are not familiar with online meeting applications. Cost of studies are very high when you involve site characterization which is very important by the way. Investing in capacity building at the early stage of the project is highly desirable in similar projects and will be cost effective especially training on GC analysis for PCB's and OP's (OP's analysis is easier and could be available in agriculture research centers in any countries but PCB's analysis is rare). Inventory of contaminated transformers can be outsourced if allowed by legislations and will safe time considering that electricity companies are normally loaded with heavy work.

ANNEX 6. SUPPORTING DOCUMENTS

Documents and reports

Government of Egypt. 2005. Implementation of the Stockholm Convention, National Implementation Plan – Egypt. GEF/EGY/02/022. *http://www.eeaa.gov.eg/en-us/mediacenter/reports/projectstudies/nipp.aspx*

Arab Republic of Egypt. 2017. The Ministerial Decree of Regulating Agricultural Pesticides in Egypt. The Agricultural Pesticide Committee, Ministry of Agriculture and Land Reclamation. Available at: *http://extwprlegs1.fao.org/docs/pdf/egy170788.pdf*

Integral Consult. 2017. Utilization of Coal/Petcoke Annual Performance Report, Lafarge Cement Egypt.

Lafarge. 2021. OP Destruction Certificates.

Lafarge. 2021. Dioxin/Furan and Heavy Metal measurements from incineration

Lupi, C. 2020. Short Comment Note on Bidding Documents and Annexes for the Procurement of PCB Decontamination Technologies and Services.

Polyeco SA. 2018. Lindane Destruction Certificates.

Polyeco SA. 2020. El Saff Destruction Certificates.

Pompili, M. 2019. Feasibility Study for Options for In-service and Out of Service PCBs Transformers Oil Dechlorination and Preparation of Bidding Documents.

S. Mostafa El Gammel. 2017-2022. External audit reports of the Sustainable POPs Management Project (SPMP)

SPMP. 2017. Evaluation of Egyptian cement kilns for disposal by co-processing of Obsolete Pesticides (OPs) - Part of task I of Contract No. EEAA/SPMP/2, October 2017.

SPMP. 2019. Evaluation of the Cement Kilns for the Purpose of Incinerating the Obsolete Pesticides Stored in Many Locations Scattered all over Egypt. Egypt Sustainable Persistent Organic Pollutants (POPs) Management Project (SPMP). September.

Sea Marconi. 2021. Remote training, Decontamination units commissioning, on-job training, and demonstration phase report

Tauw. 2017. Evaluation Egyptian cement kilns for disposal by co-processing of Obsolete Pesticides (OPs)

Tauw. 2018. Assessment of Egypt's training add capacity building needs on sound POPs and obsolete pesticides management

Tauw. 2018. Assessment of Egypt's training and capacity building needs on sound PCBs management

Tauw. 2018. Assessment of Egypt's training and capacity building needs on the issue of unintentional and new industrial POPs

Tauw. 2018. Sustainable POP-Pesticides Management - Annex 3 of the Pesticide NGO's Capacity Building Assessment Workshop Report

Project Dissemination

A video documentary was produced in 2017 on the destruction of Lindane stored in the port for more than 18 years and which demonstrates a major achievement for Egypt to properly repackage, export and destroy hazardous POPs in line with Best International Practice: *https://www.youtube.com/watch?v=KDiFw6n8YL4*.

Egypt Feature Story - **A Cleaner Environment Leads to Better Health for the Residents of El-Saf City** published to record the second key milestone for removal and disposal of obsolete POPs and POPs-like chemicals at the El-Saf site. (February 3, 2020)

https://www.worldbank.org/en/news/feature/2019/12/05/egypt-a-cleaner-environment-leads-to-better-health-for-the-residents-of-el-saf-city

https://www.albankaldawli.org/ar/news/feature/2019/12/05/egypt-a-cleaner-environment-leads-to-better-health-for-the-residents-of-el-saf-city

Egypt gets rid of 2K tons of Persistent Organic Pollutants through international funding (April 10, 2022)
https://www.egypttoday.com/Article/1/114723/Egypt-gets-rid-of-2K-tons-of-Persistent-Organic-Pollutants

Egypt disposes of dangerous pesticide shipment after 19 years (August 24, 2017)
https://www.worldbank.org/en/news/feature/2017/08/24/egypt-disposes-of-dangerous-pesticide-shipment-after-19-years

Media events on project website

http://www.popsegypt.com/English/ProjectInMedia.aspx
http://www.popsegypt.com/English/Videos.aspx

http://www.polyecogroup.com/news/repackaging-shipment-disposal-lindane-associated-wastes-stored-a1-adabeya-port-egypt/
http://www.polyecogroup.com/news/polyeco-group-successfully-completes-lindane-associated-waste-disposal-project-egypt/
http://www.polyecogroup.com/news/completion-of-pesticide-waste-management-project-in-egypt/

Example pictures

Site workers wearing PPEs in the project site

Bags of Lindane loaded into clean containers with the floor covered by HDPE sheet

Loading of repacked, labelled big bags into containers

Overview of 'zone 1' of the site showing repackaging tents and repacked bags

General view of the yard showing the different zones, new blue drums and white bags that are used for the repackaging of OPs

Main lab of South Cairo Electricity Distribution Co.

Sampling and testing the oil

Safety signs inside the lab site

Internal signboard inside the PCB storage location

Restricted access to contaminated PCB transformers