



# **Water and Sanitation Systems Upgrade**

**(BA-L1015 / 2255/OC-BA)**

## **Project Completion Report (PCR)**

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### **Required Electronic Links**

1. [Development Effectiveness Matrix \(DEM\)](#)
2. [Final version of the Progress Monitoring Report \(PMR\)](#)
3. [PCR Checklist](#)

### **Optional Electronic Links**

1. [QRR Results and Procedures Report](#)
2. [Amendatory Contract: LEG/SGO/BA-36676115-12 Loan Contract No. 2255/OC-BA Amendment No. 1](#)

## Acronyms and Abbreviations

AOP	Annual Operating Plans
BWA	Barbados Water Authority
BWU	Barbados Workers Union
BWACWU	Barbados Water Authority Capital Works Unit
CBP	Corporate Business Plan
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
EIA	Environmental Impact Assessment
ESA	Environmental and Social Analysis
ESMP	Environmental and Social Management Plan
ESMR	Environmental and Social Management Report
FTC	Fair Trading Commission
GIS	Geographical Information Systems
GOB	Government of Barbados
HDPE	High-Density Polyethylene
ICAS	Institutional Capacity Assessment System
ICB	International Competitive Bidding
IDB	Inter-American Development Bank
IT	Information Technology
IWRM	Integrated Water Resources Management
MIS	Management Information Systems
NRW	Non-Revenue water
OC	Ordinary Capital
OM	Operations Manual
PEU	Project Execution Unit
PMR	Progress Monitoring Report
POD	Proposal for Operation Development
PSC	Project Steering Committee
SCADA	Supervisory Control and Data Acquisition
SCSTP	South Coast Sewerage Treatment Plan
TC	Technical Cooperation
UFW	Unaccounted For water
VFD	Variable Frequency Drive

## BASIC INFORMATION (US\$ AMOUNT)

PROJECT NUMBER (S): BA-L1015 TITLE: WATER AND SANITATION SYSTEMS UPGRADE LENDING INSTRUMENT: INVESTMENT LOAN COUNTRY: BARBADOS BORROWER: GOVERNMENT OF BARBADOS LOAN (S): 2255/OC-BA SECTOR/SUBSECTOR: AS (WATER AND SANITATION)
DATE OF BOARD APPROVAL: 2 DEC 2009 DATE OF LOAN CONTRACT EFFECTIVENESS: 21 MAR 2010 DATE OF ELIGIBILITY FOR FIRST DISBURSEMENT: 18 MAY 2011
<u>LOAN AMOUNT (S)</u> ORIGINAL AMOUNT: US\$50,000,000 CURRENT AMOUNT: US\$43,200,000 (DUE TO A US\$6.8 MILLION CANCELLATION) PARI PASSU: LOCAL COUNTERPART US\$5,320,000 TOTAL PROJECT COST: US\$48,520,000
<u>MONTHS IN EXECUTION</u> FROM APPROVAL: 79 FROM CONTRACT EFFECTIVENESS: 76
<u>DISBURSEMENTS PERIODS</u> ORIGINAL DATE OF FINAL DISBURSEMENT: 21 MARCH 2015 CURRENT DATE OF FINAL DISBURSEMENT: 21 JUL 2016 CUMULATIVE EXTENSION (MONTHS): 16 SPECIAL EXTENSIONS (MONTHS): <u>DISBURSEMENTS</u> TOTAL AMOUNT OF DISBURSEMENTS TO DATE: US\$43,200,000
<u>REDIRECTIONING</u> . HAS THIS PROJECT? RECEIVED FUNDS FROM ANOTHER PROJECT [No] WHICH? [PROJECT NUMBER] SENT FUNDS TO ANOTHER PROJECT [No] WHICH? [PROJECT NUMBER]
EX POST ECONOMIC ANALYSIS METHODOLOGY: COST BENEFIT ANALYSIS (CBA) EX POST EVALUATION METHODOLOGY: N/A  DEVELOPMENT EFFECTIVENESS CLASSIFICATION: Partly Successful.
STATEMENT OF THE DEVELOPMENT OBJECTIVES OF THE PROJECT/PROGRAM: Improve water resources management in Barbados and sustainable water and wastewater service provision by BWA. Specifically, the project would support the GOB efforts to modernize the institutional setting at BWA and improve the efficiency of operations.

## I. EXECUTIVE SUMMARY

Barbados (population of 285,000 people) is ranked among the top fifteen countries in the world in terms of water scarcity. The Barbados Water Authority (BWA) supplies potable water to the island's population through 115,000 connections from 21 water wells and two springs. These sources represent more than 80% of the volume entering the distribution system and are supplemented with purchases from a desalination plant. A distribution network consisting of approximately 3,200 km of pipes, 30 reservoirs, and 17 re-pumping stations, accomplishes this task. The BWA is also responsible for monitoring and protecting the island's water resources. Groundwater abstractions currently exceed sustainable aquifer yields, constraining various economic activities. Despite this limitation, unaccounted-for water (UFW)<sup>1</sup> escalated to 40 – 49% of production levels in the years before the project approval due to age and deterioration of the infrastructure, deferred maintenance, and inadequate systems. Energy costs were also identified as exceedingly high. Concurrently, wastewater discharges have become an important concern for public health for the protection of the island's environment, as less than 5% of the population is connected to the existing sewerage system.

The BWA's annual revenues were impaired by inefficiencies in the billings and collection system and by defective household meters. It was estimated that the BWA needed to replace at least 25,000 meters annually over four years. On the expenditure side, labor, energy and desalinated water were among the costliest items. This resulting financial situation limited the BWA's ability to realize its capital expenditures program. Thus, the need to improve billing and collection, increase operational efficiency, boost metering, reduce delinquency rates, and establish proper institutional regulation was considered necessary.

Given the interest of the GOB in increasing the BWA efficiency and the quality of services, the goal of the project was to improve water resources management in Barbados and to assure sustainable water and wastewater service provision. Specifically, the project was designed to modernize the institutional setting and improve the operational efficiency. It was comprised of the following three components:

- i. Reorganization and modernization of the BWA
- ii. Rehabilitation of the potable water supply infrastructure
- iii. Development of a wastewater treatment action plan and upgrades

**Relevance.** The operation's work concentrated on increasing the BWA's operational efficiency, reducing the levels of non-revenue water (NRW), decreasing energy expenditures, improving the quality of the services provided, and developing a strategy for wastewater collection and reuse. Thus, the program was consistent with the Government's plans for the sector and with the BWA's aspirations. The project was also consistent with the three IDB's Country Strategies developed between 2005 and 2015, that sought to support improvements in environmental infrastructure, as well as improvements in results-based management, accountability and efficiency.

**Vertical logic.** The sequence of actions included under each component constituted a clear cause-effect progression between the proposed outputs and the expected outcomes. Starting from the institutional and infrastructure problems, the three components were established to address those problems. From the various activities, two outcomes were determined: sustainable water and wastewater services and improved management of Barbados' water resources. However, due to cancellations of some activities, the outcomes were only partly accomplished.

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<sup>1</sup> The Loan proposal used the concept of Unaccounted for water (UFW) rather than Non-revenue water (NRW) NRW = UFW + water which is accounted for, but no revenue is collected (unbilled authorized consumption).

**Effectiveness.** This assessment was based on an evaluation of the achievement of the project objectives, as defined by the outputs and outcomes initially planned or modified during execution. In relation to Outcome No. 1, *“Sustainable water and wastewater utility services provided by the BWA”*, the Results Matrix shows an overall 83% completion rate. Outcome No. 2, *“improved management of Barbados Water Resources”*, was not strictly achieved by the project due to removal of the activity associated with this outcome and inaction on the part of BWA for additional support. With respect to the project’s outputs, of the three indicators under Component 1, *“Reorganization and modernization of BWA”*, two were satisfactorily completed and one, *“BWA corporate business plan prepared for implementation”*, has been assigned a 71% completion rate. Component 2, *“Rehabilitation of water supply system”*, had four output indicators. The first, *“Meters replaced and installed”* was unattained by the project due to a declaration of “misprocurement” by the IDB on the purchase of 98,800 meters. The second, *“NRW Program implemented – Water distribution mains replaced”*, was partially achieved (40%), as 49 km of mains were replaced out of 123 km initially planned. The length replaced could not have been any longer due to the project’s financial limitations<sup>2</sup>. The third, *“Water facilities upgraded”* was 25% achieved as one out of four *planned* facilities was upgraded, according to the PMR report. It should be noted that the BWA questions the current validity of this indicator, as water chlorination systems were upgraded at 20 existing facilities. The fourth, *“District/Production meters installed”*, was 72% achieved, according to the results matrix. Component 3, *Wastewater treatment action plan and upgrades*, had two output indicators, which this review considers having been only partly achieved. In the case of Output 3.1 *Wastewater treatment action plan prepared*, showed a completion rate of 25% due to the elimination of funding for this activity. Output 3.2, *South Coast emergency by-pass and odor control system improved*, yielded a completion rate of 33% due to a reduction of the resources allocated for its accomplishment.

**Efficiency.** Two major modifications that occurred during execution are noteworthy: (i) the cancellation of loan resources for an amount of US\$6.8 million allocated to household meter replacement (see Section 3.2b); and (ii) the requirement of adjustment in allocation of resources to address cost increases.

**Sustainability.** The assessment was based on a review of the institutional, financial, environmental, and sociopolitical risks that could pose obstacles to the continuation of the project’s benefits. One challenge identified has been the need for financial independence of the BWA and the GOB’s commitment towards the reorganization of the Authority. Others are principally related to water resources management. This review considers that the most important project achievements (greater water supply reliability, lower energy consumption and improved information and data management systems) are relatively robust and should last as long as the service life of the infrastructure and equipment. However, they will require proper operation and maintenance by qualified personnel. Considering that the BWA is currently aware of this requirement, the risks to sustainability are considered low.

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<sup>2</sup> One third of the pipes installed are High Density Polyethylene (HDPE) pipes, providing for: less joints, and therefore less water leaks, flexibility and therefore more resilience to soil movements (north east of the island), and allowing for trenchless installation. Installation was a mix combination of open cut installation, directional drilling and pipe bursting; although micro tunneling was used for part of the installation of the South Coast Sewerage Main in 1998/1999, directional drilling and pipe bursting were new to Barbados and offered some significant advantages over open cut on the routes where they were employed. Importantly, local company JADA is now experienced in the use of these technologies and has purchased the equipment.

## II. INTRODUCTION

Barbados, with a current population of approximately 285,000 people, is ranked among the top fifteen countries in the world in terms of water scarcity (World Resources Institute, 2014). It is also the 16th most densely populated nation. The Barbados Water Authority (BWA), a government-owned corporation established in 1981, supplies all the potable water to the island's population through over 115,000 connections. The BWA extracts water from the island aquifers through 21 water wells and two springs<sup>3</sup>. These groundwater sources represent more than 80% of the volumes entering the distribution system, and are supplemented with water purchased from a privately-owned desalination plant, commissioned through a Build-Own-Operate agreement. This water is distributed through a network consisting of approximately 3,200 km of water pipes, 30 reservoirs, and 17 re-pumping stations. 85% of the pipes are of either ductile iron or cast iron, and experience high rates of failure (Increasing pipe burst rate, superior to 2.4<sup>4</sup> breaks per km per year). The BWA has now approximately 830 employees.

The Authority is also responsible for monitoring, assessing, and protecting the island's water resources in the public's interest. Groundwater abstractions currently exceed sustainable aquifer yields and, as a result, development of tourist destinations and other economic activities are somewhat constrained by fresh water unavailability. Exacerbating this limitation, unaccounted-for water (UFW) escalated to 40 – 49% of production levels in the years before the project was approved<sup>5</sup>. This escalation was caused by age and deterioration of the infrastructure, deferred maintenance, and inadequate system operations. A high annual energy cost, of approximately US\$10 million, was also identified as a problem that needed addressing.

With increases in water demand, due to population and economic growth, wastewater discharges have also become an important concern, not only from a public health perspective but for the protection of beach water quality and the preservation of the island's coral reefs relevant for economic activities such as tourism and fishing. Currently, most of the wastewater is disposed via septic tanks and septic wells, as there are only 4,500 connections, which means that less than 5% of the population is connected to the existing public sewerage system<sup>6</sup>.

The BWA's annual revenues, of approximately US\$41.4 million in 2005-2006, were considered impaired by inefficiencies in the billings and collection system. This system was in turn hindered by household meters that were either stopped or under registering. To solve this problem, it was estimated that the BWA needed to replace at least 25,000 meters annually over a four-year period. On the expenditure side, annual expenses were estimated at US\$38.8 million, with labor, energy and desalinated water among the costliest items. This situation limited the BWA's ability to realize its capital expenditures program. A 60% tariff increase enacted by the Government of Barbados (GOB) in 2009 temporarily alleviated this imbalance, but the need to improve billing and collection, increase operational efficiency, boost metering, reduce delinquency rates, and establish proper institutional regulation (to assure discipline and accountability), were all considered necessary remedial measures<sup>7</sup>.

Given the interest of the GOB in increasing the BWA efficiency and the quality of services, the IDB and the GOB agreed in 2009 to structure an operation geared towards strengthening BWA in its mandates, financial viability and its capacity to execute the needed refurbishing works. The goal of the project, as stated in the Loan Proposal (2009), was to improve water resources

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<sup>3</sup> [http://barbadoswaterauthority.com/?page\\_id=58](http://barbadoswaterauthority.com/?page_id=58)

<sup>4</sup> More than twice the typical value. Halcrow, 2011. Preparation for the BA-L1015. Water and Sanitation Systems Upgrade Program. Aquafund BID. Report from the technical cooperation BA-T1010.

<sup>5</sup> [BA-L1015 Loan document](#)

<sup>6</sup> [BA-L1015 Loan document](#)

<sup>7</sup> Halcrow, 2011. Preparation for the BA-L1015. Water and Sanitation Systems upgrade program. Aquafund BID. Report from the technical cooperation BA-T1010.



management in Barbados and sustainable water and wastewater service provision by the BWA. Specifically, the project was designed to support the GOB's efforts to modernize the institutional setting of the water and sanitation sector and improve the operational efficiency of BWA. It was therefore proposed that the project be comprised of the following three components:

- i. Reorganization and modernization of the BWA
- ii. Rehabilitation of the potable water supply infrastructure
- iii. Development of a wastewater treatment action plan and upgrades

The project was financed through an ordinary capital loan from the Bank (US\$50 million) and a local contribution (US\$3 million), for a total amount of US\$53 million. During the implementation of the program US\$6.8 million were cancelled. The executing agency was the BWA, under the Ministry of Agriculture, Food, Fisheries and water Resources Management.

This report seeks to evaluate the project's achievements, as described by the output and outcome targets initially established, its alignment with Barbados development needs, the utilization of monitoring and evaluation procedures, the efficiency with which resources were used, the prospects for sustainability, as well as to formulate a set of recommendations resulting from its six years of execution.

### **III. CORE CRITERIA. PROJECT PERFORMANCE**

#### **3.1 Relevance**

Considering the need for improving the BWA's institutional efficiency and for rehabilitating the water and wastewater infrastructure, the BWA and the IDB, in consultation with the GOB, agreed that the operation's work would concentrate on increasing the BWA's operational efficiency, reducing the levels of non-revenue water (NRW), decreasing energy expenditures, improving the quality of the services provided, and developing a strategy for wastewater collection, disposal and reuse. The program was thus consistent with the BWA's aspirations for better management and a clear investment strategy, as well as with the urgent needs identified at the time by various utility evaluations<sup>8</sup>.

##### **a. Alignment with country development needs**

The project was in line with IDB's Country Strategy for Barbados (2009-2013), which iterated Bank support for improving water resources management, efficiency of water services, and the handling of wastewater. Expected results from the Strategy included the improved operational efficiency of the BWA and a reduced NRW.

Although not identified as a priority sector, the 2015-2018 Country Strategy with Barbados recognizes that a more efficient water supply and resource management is expected to support the tourism industry and protect the country from climate change through improved availability and quality of drinking water and the protection of the coastline from inadequate sewage treatment.

Based on a review of these considerations, this report concludes that the project constituted a warranted response to the needs for operational efficiency, restorative work, as well as to the necessity to assure long-term sustainability to the service. Thus, the original assessment of the pertinence of the program, of its potential contribution to the needs of the Barbadian residents,

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<sup>8</sup> The Loan Proposal, in its Environmental and Social Analysis Annex, lists several institutional reports on BWA as an organization, highlighting the following: Coopers and Lybrand Report (1995), the Stanley International Group Report (1998), the David Shorey Report (1999) and the WS Atkins Report (2000).

and of its alignment with the priorities of the country<sup>9</sup> and the BWA, was adequately conducted and well justified.

The agreement on the project components resulted from a prioritization of a more ambitious rehabilitation program, which would have required a much larger amount of financing, not considered feasible at the time. Thus, the works and activities included were expected to be complemented and expanded, with financing from the IDB or from other bilateral and multilateral sources, after the completion of this project. The relevance of the work planned and conducted is considered still valid by all stakeholders, as is the need to proceed with additional managerial activities, equipment upgrades, and civil infrastructure refurbishing work

## **b. Vertical logic**

The institutional and infrastructure problems identified at the outset (see introduction) demanded an integrated and coherent response, where both institutional modernization and infrastructure rehabilitation had to be simultaneously considered through a unified and interconnected approach. Since the investments initially identified required significant amounts of funding, greater than the resources available, the GOB, the BWA and the IDB agreed on the most immediate and impactful set of measures. The following three components include the activities, civil works and equipment upgrades that were jointly selected for this first operation, and thus begin the process of transformation and improvement of the water and wastewater services provided by the BWA.

**Component 1. Reorganization and modernization of the BWA.** Considering the institutional problems encountered at the BWA, this component sought to support the development of a long-term *Corporate Business Plan* (CBP) that could guide the BWA through a transition period towards a more effective, efficient and financially viable company. The CBP would also assist BWA in getting ready for regulatory supervision by the Fair-Trading Commission (FTC), the government agency in charge of utility regulation. To achieve this goal, the CBP comprised organizational and structural changes, a human resources strategy, performance standards and benchmarks, a customer information system, information technology systems, training activities, and public awareness campaigns. These activities sought to improve labor productivity, customer satisfaction, and financial viability, as shown by the outcome indicators identified.

**Component 2. Rehabilitation of the potable water supply system.** This component included the following activities: non-revenue water (NRW) reduction through meter replacement and installation, establishment of water management districts, the first phase of a water mains replacement project, a network management system such as a Supervisory Control and Data Acquisition system (SCADA), geographical information system (GIS), a hydraulic network model, and energy efficiency measures. These actions sought to decrease the level of non-revenue water (NRW), reduce energy consumption at the most critical facilities, and improve water quality, service continuity and water pressure.

**Component 3. Wastewater treatment action plan and upgrades.** As explained in the Introduction, with increases in water demand, wastewater discharges had become an important health and environmental concern, which was also connected with the wider topic of water scarcity and management of water resources in the island. Thus, this component included the development of a wastewater reuse master plan, the study of the viability of aquifer recharge, and improvements to the South Coast Sewerage System such as the design of an emergency bypass and of an odor control system. Although more limited in scope and funding, this component was aimed at improving operations at existing facilities and developing a wastewater treatment

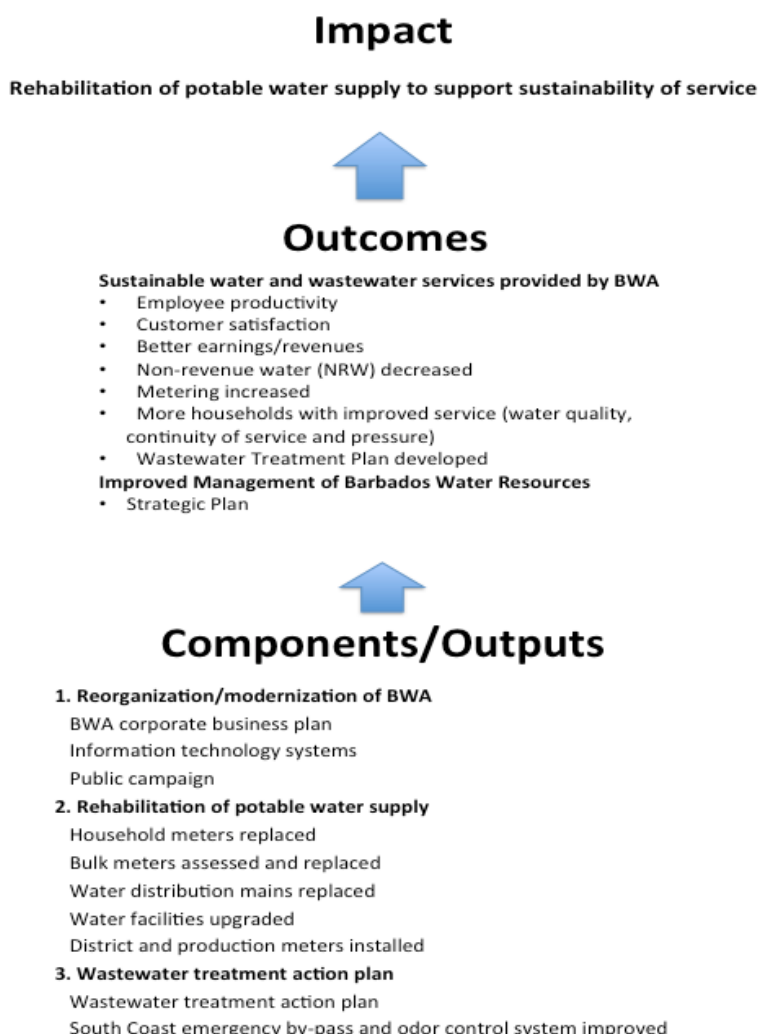
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<sup>9</sup> This importance has been revalidated by GOB with the signing of a MUS\$39.5 loan from the Caribbean Development Bank to the BWA to pursue those activities.

action plan that, in the future, could attract much needed private financing under public-private participation (PPP) arrangements.

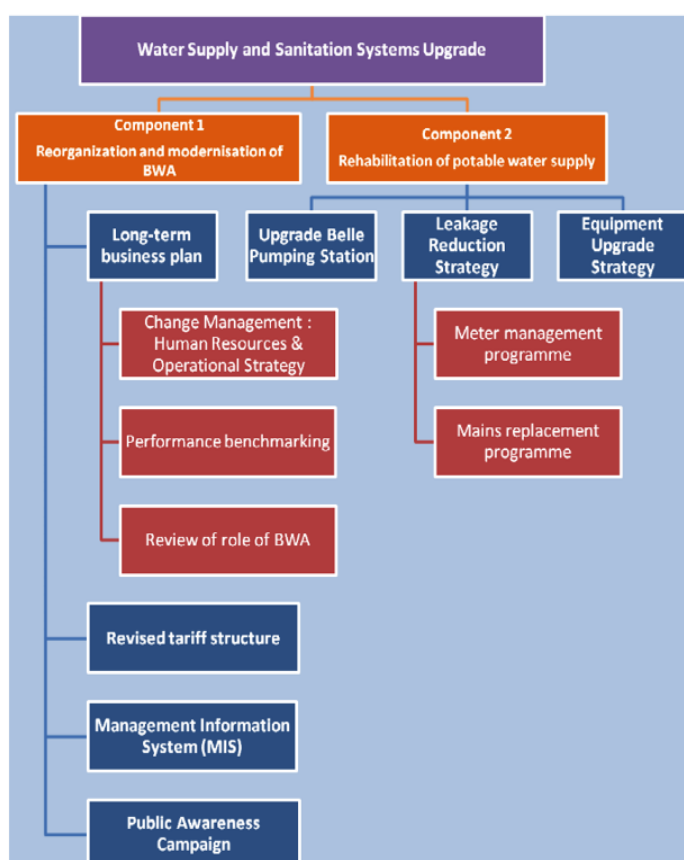
The sequence of actions described under each component constitutes a logical and valid cause-effect progression between the proposed outputs and the expected outcomes and impacts. Figure 1 summarizes this causal relationship: Starting from the institutional and infrastructure problems, the three components and their respective outputs were established to address those problems. Figure 2, extracted from the Loan Proposal (see Environmental and Social Analysis, electronic link #3), reflects the vertical logic envisioned at project approval. From the various activities, two outcomes were determined: sustainable water and wastewater services, and improved management of Barbados' water resources. However, due to cancellations of some activities and outputs (see Section 3.3 on project efficiency), the outcomes were only partly accomplished. It should be noted that, besides planning for wastewater reuse in Component 3, the project did not include financing for water resources management. This was an expected intervention by BWA. The overall 'impact' of the project was identified as the rehabilitation of potable water supply system to support sustainability of service.

**Figure 1. Project's Cause-Effect Progression**



Indicators “# of Production Meters replaced” and “NRW Program Implemented (Completion of Relevant Procurement)” should have been categorized as outputs (products) rather than outcomes (results). The impacts indicators should have been linked with the final problems that the program is trying to overcome, such as sustainability of the system, environmental and health concerns for the lack of sewerage or economic constraints for the lack of clean water. The reorganization and modernization of the BWA (component 1), including the development of business plans, tariff structure, Management Information System and Public Awareness Campaigns, as well as the Rehabilitation of potable water supply (component 2) including the upgrade of the Bell Pumping Station, the Leakage reduction and the equipment strategies, and the Wastewater treatment action plan and upgrades (component 3), contribute to the sustainability of the system (better management and infrastructure), that would have effects on better services and, consequently, better conditions for the population.

**Figure 2. Hierarchical Logic of Components 1 and 2**



## 3.2 Effectiveness

### a. Project development objectives.

The goal of the Water and Sanitation Systems Upgrade Project was to improve water resources management and sustainable water and wastewater service provision by the BWA. Specifically, the project sought to support the Government of Barbados’s efforts to modernize the institutional setting of the water and sanitation sector and improve the efficiency of the operations of the BWA. The evaluation of the project’s effectiveness was based on a factual appraisal of the degree to which these objectives were fulfilled.

## **b. Results Achieved**

As stated, the effectiveness assessment was based on an evaluation of the extent to which the program achieved its intended objectives, as defined by the outputs and outcomes initially planned or modified during project execution. To adhere to this precept, a review of the changes introduced to the Results Matrix after project approval was first conducted. This review compared the Progress Monitoring Report (PMR) from January-June 2011, established within 60 days of the project eligibility date (May 18, 2011), and the January-June 2016 PMR, at the project's closing. Table 1 summarizes these changes, which consist of eight relevant modifications: (i) the addition of the project "Impact", which had not been included in the original matrix; (ii) the removal or modification of three outcome indicators; and (iii) the elimination or modification of four output indicators. These changes, as can be observed in Table 1, did not significantly alter the basic project objectives, nor modified the essence of the three components, but were made to reflect changes to the project resulting from the ineligibility for financing of a key activity, due to misprocurement, and the lack of funding for some project activities, due to an increase in the estimated costs for one key activity and the consequential redistribution of project resources. These modifications were agreed with the Project Executing Unit at the BWA to better reflect the project's adjustment and alterations. The events associated with these modifications will be explained in more detail below. As a general comment, however, this review considers that the addition of the *impact* to the Results Matrix, the way it was stated, did not significantly contribute to the advancement or clarification of the project's broader purpose or wider repercussions. Moreover, the two indicators ascribed to the impact do not seem adequate for this level of the hierarchy of results, and conflict with some of the project's outputs.<sup>10</sup>

Table 2 shows the achievements with respect to *impacts*, *outcomes* and *outputs*, by comparing the values originally planned, revised, and obtained. As previously stated, the addition of a project impact did not seem to advance the definition of the project's broader purpose. With respect to the two impact indicators, the table reveals that only 48% of the target describing the "*number of production meters replaced*" was achieved. This review, however, found a discrepancy with output indicator 2.4, which suggests that the original target could have been decreased from 75 to 50 production meters, yielding a 72% completion rate. The impact indicator has also a weak definition as it could be mistaken with output 2.1 Meters replaced and installed. However, the meters of the impact indicator is linked with macrometers and the meters of the product indicator is linked with micrometers. The second indicator, related to the NRW Program, reveals that this activity has been satisfactorily completed as detailed in 3.3. As happened with the other impact indicator, this indicator could be mistaken with product indicator 2.2 NRW Program implemented – water distribution mains replaced. As indicated in the results matrix, the impact indicator was achieved, although some additional activities, as the one presented in output indicator 2.2, has not been fully completed, lacking financing to replace all the mains.

In relation to Outcome No. 1, "*Sustainable water and wastewater utility services provided by the BWA*", the Results Matrix shows that out of nine indicators, six were fully completed, two partially achieved, and one unattained within the project's execution period. This is equivalent to an overall 83% completion rate. Outcome No. 2, "*improved management of Barbados Water Resources*", was not strictly achieved by the project as there was no funding for any activity associated with this outcome; the development of a Strategic Plan for Management of Barbados' Water Resources would have been financed directly by the BWA.

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<sup>10</sup> Measuring "*production meters replaced*" or the degree of implementation of a particular study within the project is best done at the output level, as can be seen under Outputs 2.2 and 2.4 (see Table 2), which measure the same parameters.

With respect to the project's outputs, Table 2 shows that of the three indicators under Component 1, "*Reorganization and modernization of BWA*", the last two were satisfactorily completed. The first one, however, "*BWA corporate business plan prepared for implementation*" has been assigned a 71% completion rate although it has been reported as completed in the Jan-Jun 2016 PMR. This lower completion value is based on the fact that five out seven milestones were actually completed, while the Strategic Business Plan 2016-2021 has not been presented by the BWA.

Component 2, "*Rehabilitation of water supply system*", had four output indicators, which require separate explanations, as this was the component with the highest allocation of loan resources. The first indicator, "*Meters replaced and installed*" was unattained by the project due to a declaration of "misprocurement" by the IDB on May 13, 2013, on the purchase of 98,800 meters. This purchase (US\$6.8 million) was therefore considered ineligible for financing under the Loan. The procurement method used was international competitive bidding (ICB) with ex-ante review by the Bank. Four (4) suppliers submitted bids by the deadline of June 4, 2012. The declaration of misprocurement also resulted, on March 6, 2014, in the cancellation of the resources allocated to this activity and the consequent reduction of the loan from US\$50 million to US\$43.2 million.

The second indicator, "*NRW Program implemented – Water distribution mains replaced*", was partially achieved (40%), as 49 km of mains (6" to 16" in diameter) at 19 locations were replaced out of a total planned length of 123 km. It is worth noting, however, that the 49 km were replaced, at a total cost of US\$25.8 million, significantly above the *planned* amount of US\$14.7 million. Therefore, the length replaced could not have been any longer due to the project's financial limitations. These cost adjustments are discussed under Section 3.3 (Efficiency) of this review.

The third indicator, "*Water facilities upgraded*" was 25% achieved as one out of four *planned* facilities was upgraded, according to the PMR report. The BWA questions the current validity of this indicator, as water chlorination systems were upgraded at 20 existing facilities.

The fourth indicator, "*District/Production meters installed*", was 72% achieved, according to the results matrix. This, however, generates a discrepancy with the impact indicator as discussed above (discrepancy with output indicator 2.4, original target 50 instead of 75).

Component 3, *Wastewater treatment action plan and upgrades*, had two output indicators, which this review considers having been only partly achieved, despite the values of 'one' reported for both indicators in the Jan-Jun 2016 PMR. In the case of Output 3.1 *Wastewater treatment action plan prepared*, only one of four milestones was completed, the contract for the preparation of the plan, resulting in completion rate of 25%. Under Section 3 of this review, the elimination of funding for this activity will be discussed. With respect to Output 3.2, *South Coast emergency by-pass and odor control system improved*, one out of three milestones was completed, the design of the odor control system, yielding a completion rate of 33%. As in the previous case, the resources allocated to the design of the emergency by-pass system and to the upgrade of the odor control system were transferred to other more pressing activities under the project.

**Table 1. - Changes to the Results' Matrix**

Section of the Results Matrix where change took place	Name of the change	Type of change	Baseline Target	Original Target	Formally revised target (if applicable)	Reasons for change	Date of change	Date of change agreed with Executing Agency
Impact	Rehabilitation of Potable Water Supply to support sustainability of the service	Added				Introduced to accurately describe the expected project's impact.	2010	2010
Outcome indicator	1.5 Metering (percentage of customers billed have validated water meters less than 5 years old)	Removed	10%	70%		Associated activity was declared ineligible for financing under the project due to unacceptable procurement procedure (See Section 3.2b).	May 2013	May 2013
Outcome indicator	1.10 Financing for the Wastewater Treatment Action Plan identified	Removed	0%	100%		Activity associated with this indicator was eliminated due to insufficient availability of funding (See Section 3.3)	Nov.2014	Nov.2014
Outcome indicator	2.0 Strategic Plan for Management of Barbados Water resources	Target changed to 0	0	1	0	Activity to be financed outside the loan.	Nov. 2014	Nov.2014
Output indicator	1.1 Barbados Water Authority corporate business plan prepared for implementation	Indicator definition adjusted	0	1		Lack of budget to implement	Dec.2014	Dec.2014
Output indicator	1.3 Public campaign adopted	Indicator definition adjusted	0	1		Implementation will occur during the project's execution period while the original indicator only referred to the preparation of the campaign.	Jan.2016	Jan.2016
Output indicator	2.4 District/Production meters installed	Indicator definition modified				To more accurately describe intended project output	2010	2010
Output indicator	3.3 Public/Private partnership (PPP) agreement to finance Wastewater Treatment Action Plan	Indicator turned into a milestone supporting indicator 3.1				To better take into account the hierarchy and interdependence of these activities	2010	2010

**Table 2. Results Achieved Matrix**

Impact/Indicator	Unit of Measure	Baseline value	Baseline year	Targets and actual achievement		% Achieved	Means of verification
Impact #1 Rehabilitation of potable water supply to support sustainability of service							
Number of production meters replaced	Meters	0	2011	P		48%	Reports from PEU
				P(a)	75		
				A	36		
NRW Program implemented	Program	0	2011	P		100%	Reports from PEU / BWA
				P(a)	1		
				A	1		

Outcome/Indicator	Unit of Measure	Baseline value	Baseline year	Targets and actual achievement		% Achieved	Means of verification
Outcome #1 Sustainable water and wastewater utility services are provided by the BWA							
1. Employees per 1000 connections	Employees	7.8	2009	P	7.2	100	Inspection visits and progress reports
				P(a)	7.2		
				A	7.2		
2. Customers qualifying BWA's services as good or very good	%	70	2012	P	76	100	Survey results, inspection visits and progress reports
				P(a)	76		
				A	92		
3. EBITDA / total operating revenues	%	0	2009	P	10	100	Inspection visits and progress reports
				P(a)	10		
				A	10		
4. Non-revenue water (NRW)	%	49	2009	P	47	100	Inspection visits and progress reports
				P(a)	39		
				A	40		
5. Water turbidity (percentage of non-compliant turbidity samples in a month) at Bowmanston Well	%	40.00	2009	P	10.00	0	Inspection visits and progress reports
				P(a)	20.00		
				A	40.00		
6. Water disinfection (non-compliant samples in a month)	%	40.00	2009	P	20.00	100	Inspection visits and progress reports
				P(a)	20.00		
				A	15.00		
7. Continuity (customers with no service available at some hours in a month)	%	70.00	2010	P	10.00	92	Inspection visits and progress reports
				P(a)	30.00		
				A	15.00		
8. Pressure (percentage of customers with water pressure below BWA standards per month, i.e. 25psi)	%	70.00	2011	P	20.00	100	Inspection visits and progress reports
				P(a)	20.00		
				A	15.00		
9. Households with upgraded water supply	Households (#)	0.00	2011	P	20,000.00	56	Inspection visits and progress reports
				P(a)	20,000.00		



Outcome/Indicator	Unit of Measure	Baseline value	Baseline year	Targets and actual achievement		% Achieved	Means of verification	
				A	11,200.00			
Outcome #2 Improved management of Barbados' water resources								
Strategic Plan for Management of Barbados Water resources	Plan	0	2009	P		0	Progress report from BWA	
				P(a)	0			
				A	0			
Output			Unit of Measure	Baseline value	Baseline year	Targets And Actual achievement	% Achieved	Means of verification
Component 1. Reorganization and modernization of BWA								
1.1 Barbados Water Authority corporate business plan prepared for implementation (Baselines indicators Management and operations Audit)	Plan			P	1	100	Business plan accepted by BWA	
				P(a)	1			
				A	1			
1.2 Information technology (IT) systems integrated	System			P	1	100	Report from BWA	
				P(a)	1			
				A	1			
1.3 Public campaign adopted	Campaign			P	1	100	Report from BWA	
				P(a)	1			
				A	1			
Component 2. Rehabilitation of potable water supply								
2.1 Meters replaced and installed (Only initial assessment of needs and specifications)	Meters			P	98,800	0	Report from BWA	
				P(a)	0			
				A	0			
2.2 NRW Program implemented - Water distribution mains replaced	Km			P	123	40		
				P(a)	49			
				A	49			
2.3 Water facilities (power generators, pumps, Chlorination equipment, well) upgraded	Facilities			P	4	75		
				P(a)	1			
				A	1			
2.4 District/Production meters installed	Meters			P	0	72		
				P(a)	50			
				A	36			
Component 3. Wastewater treatment action plan and upgrades								
3.1 Wastewater treatment action plan prepared (Studies only)				P	1	100		
				P(a)	1			
				A	1			
3.2 South Coast emergency by-pass and odor control system improved (Studies and minor upgrades only)				P	1	100		
				P(a)	1			
				A	1			

Where: P = Start-Up Plan; P (a) = Revised Annual Target; A = Actual.

### **c. Analysis of the Results Attribution**

This results attribution analysis is based principally on empirical evidence, since no impact evaluation for this project was conducted.

The vertical logic, as explained in previous sections, presents a valid analysis and a valid cause-effect progression between the proposed outputs and the expected outcomes and impacts. Starting from the institutional and infrastructure problems, the three components and their respective outputs were established to address those problems. It's important to note that the impacts indicators should have been linked with the final problems that the program is trying to overcome, such as sustainability of the system, environmental and health concerns for the lack of sewerage or economic constraints for the lack of clean water.

The three most identifiable and consequential improvements resulting from the investments completed were: (a) the upgrades in the water supply service's quality and reliability, (b) the decrease in non-revenue water, and (c) the reduction in energy consumption. These were all outcomes resulting from activities conducted under the "*Rehabilitation of the potable water supply*" component, which used nearly 80% of the project's financial resources. Since no parallel investment activities, external to the project, were simultaneously carried out by the BWA, it is clear that these improvements are the consequence of: (i) the replacement of 49 km of transmission mains that were in extremely poor condition, causing water losses, water flow restrictions, and lower than desirable water pressures in the distribution system, (ii) the installation of 94 variable frequency drives (VFD) at practically all pumping stations, decreasing energy consumption, (iii) the installation of 36 production/district meters, allowing better handling and better informed routine operations, and (iv) the installation of Supervisory Control and Data Acquisition (SCADA) system for proper management of the most critical BWA facilities.

The rehabilitation of the water supply (pipes, equipment and other accessories) is key to improve the level of services and, consequently, the environmental and social indicators (health) of the population<sup>11</sup>. Furthermore, the improvement of the management of the BWA has also positive impacts on the efficiency of the service<sup>12</sup>. It should be noted, however, that the reductions in energy use and NRW, as well as the increases expected in revenues by the BWA, will require more time to measure and quantify, although they are clearly closely tied with the facilities rehabilitated or replaced by the project.

### **d. Unanticipated outcomes**

The successful use of trenchless technologies and HDPE pipe material for mains replacement has been considered an unexpected project result (see section 5.1). This technology had not been initially considered within the project and had not been used in Barbados before. It proved to be advantageous under certain traffic and soil conditions.

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<sup>11</sup> WHO (2015). *Improving nutrition outcomes with better water, sanitation and hygiene: practical solutions for policies and programmes*; Hutton G, Rodriguez UE, Napitupulu L, Thang P, Kov P. (2008) *Economic impacts of sanitation in Southeast Asia*. World Bank, Water and Sanitation Program.

<sup>12</sup> Andres, Luis A.; Schwartz, Jordan; Guasch, J. Luis. (2013). *Uncovering the drivers of utility performance: lessons from LAC on the role of the private sector, regulation, and governance in the power, water, and telecommunication sectors*. *Directions in Development: Infrastructure*. Washington DC; Hankte-Domas, Michael y Andrei Jouravlev (2011). *Lineamientos de política pública para el sector de agua y saneamiento*. CEPAL. Junio; Lobina, Emanuele y David Hall (2008): *The Comparative Advantage of the Public Sector in the Development of Urban Water Supply*. *Progress in Development Studies* 8, 1 (2008), pp. 85-101; Sjodin, Johanna (2006): *Determinants of the performance of public water services in Chile, 1977 – 1999*. CEPAL; World Bank (2008b): *Reducing Water Loss in Developing Countries Using Performance-Based Service Contracting Water P-Notes*. Issue 4, June.

### 3.3 Efficiency

An important aspect in assessing the efficiency of project execution is the examination of the actual use of loan and counterpart resources. Two major modifications that occurred during execution are noteworthy:

#### a. Cancellation of loan resources.

As explained before (see Section 3.2b), due to a non-acceptable procurement process, US\$6.8 million allocated to household meter replacement (Output 2.1) were cancelled by the IDB, reducing the loan from US\$50 million to US\$43.2 million.

#### b. Adjustments in allocation of resources to address cost increases

Due to an increase in costs associated with the replacement of water distribution mains (Output 2.2 - procurement packages A, B and C), reductions had to be made to the allocation of resources to other outputs not yet procured or contracted. The results and the impact of these modifications were summarized in a report submitted by the BWA on November 11, 2014. Its main conclusions were:

(i) The principal reason for the financial shortfall was that the project's budget, from its inception, could not have accommodated all the desired activities included in the procurement plan. The purpose of the reevaluation was to try to preserve the activities that would have the greatest positive impact on the service, based on more realistic and updated price estimations.

(ii) To be able to transfer the necessary funds to Output 2.2, 10 pending procurement processes, associated with other project outputs, were eliminated from the project:

- Implementation of recommendations from the management and operations audit (US\$922,000)
- Tariff study (US\$350,000)
- Preparation of BWA's Corporate Business Plan (US\$200,000)
- Change management contract (US\$750,000)
- Independent oversight of the preparations for regulation by FTC (US\$90,000)
- Designs associated with increasing chlorination contact time (US\$200,000)
- Assessment of nitrate problems at the Ashton Hall Well (US\$200,000)
- Wastewater Treatment and Reuse Master Plan (US\$250,000)
- Design of an emergency by-pass for the South Coast Sewerage System (SCSS) (US\$100,000)
- Upgrade of the odor control system at the SCSS treatment plant (US\$310,000)

The first five activities were part of Component 1 (*Reorganization and modernization of the BWA*), thus weakening the project's achievements under this component. Some of these activities are being addressed by the BWA with its own resources. Of particular importance was the excision of the Corporate Business Plan, a key element in defining the strategy for organizational change and financial viability. Another important element removed from the project, this one associated with Component 3, was the Wastewater Treatment and Reuse Master Plan, which included an environmental evaluation of aquifer recharge, and which had already been reduced from US\$1.5 million to US\$250,000 in May 2014 to transfer funds to Output 2.2. The removal of these 10 activities freed approximately US\$3.37 million.

(iii) In addition, the funds allocated to two project activities were reduced: The rehabilitation of Bowmanston Well was lowered from US\$820,322 to US\$300,000, and the upgrade of chlorination systems at all stations was decreased from US\$1,5 million to US\$250,000. These reductions

generated changes in the scope of these activities, allowing only the completion of their initial phases.

To partly compensate for this cost increases, the local counterpart was also increased from US\$3.0 million to US\$5.32 million, resulting in a total budget of US\$48.52 million for all remaining project activities.

Table 3 shows the planned, revised, and actual costs by output and component. It is clear from the figures that the main 'outputs' affected by reductions in allocated funding were: the BWA Corporate Business Plan (1.1), the household meters replacement (2.1), the upgrading of water facilities (2.3), the Wastewater Treatment Action Plan (3.1), and the improvements to the South Coast Sewerage System. On the opposite end, the mains replacement program (NRW water program) benefitted from an increase in funding from other planned activities from US\$14.7 million to US\$25.8 million. The installation of district/production meters (output 2.4) constituted a special case, although of much smaller scale, in which no funding had been individually allocated to its execution even though it was an expected project output.

A cost-benefit analysis was performed for all components by the IDB project team at the time of project analysis and before loan approval. The program was considered economically viable, showing an economic rate of return (ERR) of 15% using a discount rate of 12% and a time horizon of 10 years. To estimate the projected benefits of the program related to the savings in energy use, the difference in energy costs between the scenario without project and the scenario with project was used, to provide the energy savings associated to the implementation of the mains replacement program. It has however not been possible to run the corresponding ex-post cost benefit analysis because of the difficulty in obtaining consistent data, particularly relating to water production (deficient macro-metering and effects of the 2014 to 2016 Caribbean drought), and because the initial model hypothesis of an increase in energy price was proven wrong by the effect of the oil price drop on energy costs in Barbados.

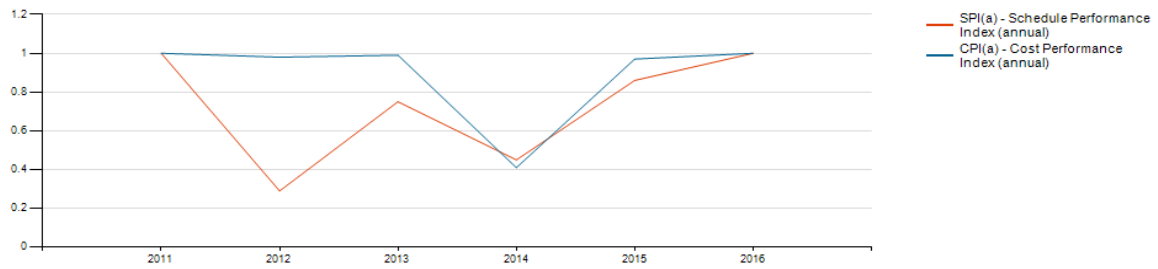
A simple calculation of the evolution of consumption of energy by unit of water supplied to the system performed between the baseline March to March year of 2010-2011 and last information available 2016-2017 indicates a decrease of 15% in the kwh/m<sup>3</sup> consumption, related to energy efficiency gains.

	<b>M<sup>3</sup> of Water produced</b>	<b>kwh consumed</b>	<b>kwh/m<sup>3</sup></b>
2010-2011	53,500,989	40,558,960	0.76
2016-2017	57,477,493	37,503,868	0.65

The NRW reduction from 49% to 40% obtained by BWA, although only partially attributable to the Project (Mains replacement essentially) as the individual meters are no longer part of this project, would also have contributed to the economic benefits of the Project.

The analysis of the relevant monitoring indexes (Cost Performance Index CPI (a), Schedule Performance Index SPI (a), CPI and SPI, and disbursements performance indicator) calculated during the execution period indicate a slow start of the project in 2012, with an improvement in 2013 followed-up by a stalling corresponding to the misprocurement activities. Execution improved once again in 2015 with the execution of the mains relaying activities. (See table below). Disbursement curve (Figure 3) demonstrate a good execution rhythm.

	2011	2012	2013	2014	2015	2016
SPI						
CPI						
SPI(a)	1	0.29	0.75	0.45	0.86	1
CPI(a)	1	0.98	0.99	0.41	0.97	1



**Table 3 Costs of the Project**

<b>Result Matrix</b>								
<b>Outputs Financial Progress</b>								
	Component Revised Cost							
<b>1 Reorganization and modernization of the BWA</b>	\$6,753,000.00							
Outputs		2011	2012	2013	2014	2015	2016	Cost
1.1 Barbados Water Authority corporate business plan prepared for implementation (Baselines indicators Management and operations Audit)	P		\$855,556.00	\$1,026,667.00	\$1,026,667.00	\$941,111.00		\$3,850,001.00
	P(a)		\$855,556.00	\$350,000.00	\$669,000.00		\$0.00	\$390,000.00
	A			\$0.00	\$390,000.00	\$0.00		\$390,000.00
1.2 Information technology (IT) systems integrated	P		\$1,956,200.00	\$2,500,000.00	\$2,304,000.00	\$744,800.00		\$7,505,000.00
	P(a)		\$1,956,200.00	\$3,000,000.00	\$2,304,000.00	\$2,965,000.00	\$1,061,000.00	\$6,263,000.00
	A		\$183,000.00	\$9,000.00	\$3,056,000.00	\$1,954,000.00	\$1,061,000.00	\$6,263,000.00
1.3 Public campaign adopted	P		\$46,154.00	\$53,846.00				\$100,000.00
	P(a)		\$46,154.00	\$74,000.00	\$90,000.00	\$63,000.00	\$30,000.00	\$100,000.00
	A		\$0.00	\$10,000.00	\$17,000.00	\$43,000.00	\$30,000.00	\$100,000.00
	Component Revised Cost							
<b>2 Rehabilitation of potable water supply</b>	\$34,160,000.00							
Outputs		2011	2012	2013	2014	2015	2016	Cost
2.1 Meters replaced and installed (Only initial assessment of needs and specifications)	P		\$1,188,443.00	\$3,254,838.00	\$3,254,838.00	\$3,450,366.00		\$11,148,485.00
	P(a)		\$1,188,443.00	\$0.00		\$0.00		\$142,000.00
	A		\$0.00	\$60,000.00	\$82,000.00	\$0.00	\$0.00	\$142,000.00
2.2 NRW Program implemented - Water distribution mains replaced	P	\$190,770.00	\$339,358.00	\$4,379,961.00	\$4,379,961.00	\$4,379,961.00	\$1,049,989.00	\$14,720,000.00
	P(a)		\$339,358.00	\$3,000,000.00	\$4,379,961.00	\$14,911,168.00	\$2,395,000.00	\$25,824,000.00
	A	\$190,770.00	\$166,000.00	\$5,444,000.00	\$4,831,230.00	\$12,797,000.00	\$2,395,000.00	\$25,824,000.00
2.3 Water facilities (power generators, pumps, Chlorination equipment, well) upgraded	P		\$0.00	\$5,000,000.00	\$2,880,000.00	\$3,000,000.00		\$10,880,000.00
	P(a)		\$0.00	\$170,000.00	\$2,880,000.00	\$2,382,000.00	\$1,320,000.00	\$7,433,000.00
	A		\$43,000.00	\$53,000.00	\$4,955,000.00	\$1,062,000.00	\$1,320,000.00	\$7,433,000.00
	P							\$0.00

2.4 District/Production meters installed	<b>P(a)</b>			\$550,000.00	\$64,000.00	\$650,000.00	\$210,000.00	\$761,000.00
	<b>A</b>			\$55,000.00	\$56,000.00	\$440,000.00	\$210,000.00	\$761,000.00
	Component Revised Cost							
<b>3 Wastewater treatment action plan and upgrades</b>			\$684,000.00					
<b>Outputs</b>		<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>Cost</b>
3.1 Wastewater treatment action plan prepared (Studies only)	<b>P</b>		\$0.00	\$500,000.00	\$1,000,000.00			\$1,500,000.00
	<b>P(a)</b>		\$0.00	\$0.00	\$88,000.00	\$190,000.00		\$581,000.00
	<b>A</b>		\$0.00		\$391,000.00	\$190,000.00	\$0.00	\$581,000.00
3.2 South Coast emergency by-pass and odor control system improved (Studies and minor upgrades only)	<b>P</b>		\$150,000.00	\$800,000.00	\$150,000.00			\$1,100,000.00
	<b>P(a)</b>		\$150,000.00	\$800,000.00	\$1,124,000.00		\$0.00	\$103,000.00
	<b>A</b>		\$0.00	\$10,000.00	\$93,000.00	\$0.00	\$0.00	\$103,000.00
<b>Other Cost</b>		<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>Cost</b>
Project Execution Unit (Counterpart), Contingency, and Financial Charges	<b>P</b>							
	<b>P(a)</b>		\$2,000,000.00	\$1,542,000.00	\$1,168,000.00	\$990,340.00	\$165,340.00	\$5,523,340.00
	<b>A</b>		\$786,576.00	\$1,032,000.00	\$2,337,424.00	\$1,202,000.00	\$165,340.00	\$5,523,340.00
<b>Total Cost</b>		<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>Total Cost</b>
	<b>P</b>	\$190,770.00	\$6,535,711.00	\$18,615,312.00	\$16,195,466.00	\$13,516,238.00	\$1,049,989.00	\$56,103,486.00
	<b>P(a)</b>		\$8,535,711.00	\$9,486,000.00	\$12,766,961.00	\$22,151,508.00	\$5,181,340.00	\$48,520,000.00
	<b>A</b>	\$190,770.00	\$2,578,236.00	\$6,673,000.00	\$16,208,654.00	\$17,688,000.00	\$5,181,340.00	\$48,520,000.00

### 3.4 Sustainability

The assessment of sustainability is based on a review of the institutional, financial, environmental, and sociopolitical risks that could pose obstacles to the continuation of the project's benefits into the future. These potential risks could be both exogenous and endogenous. The Loan Document identified few potential risks or challenges, highlighting the need for financial independence of the BWA and the GOB's commitment towards the reorganization of the Authority. Considering that the outcome "*reorganization and modernization of the BWA*" was partly achieved and the outcome "*improved management of Barbados' water resources*" was unattained under the project (see Table 2), these concerns remain valid although largely out of reach of the modified project. The project incorporated some mitigation measures to ensure the sustainability of the results. On one hand, the increase of the tariff would help to reduce the financial risks linked with the project. The improvement of the procedures in billing and collection through the implementation of organizational plans also help to mitigate these risks. As stated in the loan document, "*Long term solutions for the BWA to which the project will contribute includes the reduction in fixed costs through efficiency gains in water delivery, which will in turn reduce energy costs, water losses and eventually personnel costs. This is in part achieved by rehabilitating or replacing existing assets managed by the BWA, including booster pumps, pumping stations, water mains and water treatment facilities*".

The PMR (Jan-Jun 2016) identified 10 risks, of which seven were related to project execution and three to the post-execution period: lack of capacity in the BWA to successfully manage new systems, increase in consumption level and the cost to consumers following installation of meters, and ineffective results from the implementation of the IT systems (SCADA and GIS), related to the acceptance of those technologies. From these risks, only 2 were active and the rest already mitigated. The two active risks were "lack of capacity in the BWA to successfully manage new systems" and "ineffective and inefficient results from implementation of the IT systems due to lack of capacity to use the system". Although several activities developed during the program were focused to mitigate these risks, the effort has not been enough, and the BWA still shows weakness to be able to manage effectively and efficiently the new systems.

This review considers that the most relevant project achievements are those associated with: (i) greater water supply reliability and significant leak reduction derived from transmission mains rehabilitation, (ii) lower energy consumption resulting from upgrading pumping facilities and introducing VFDs, and (iii) improved operations obtained from the introduction of information and data management systems. The first is a rather robust accomplishment that should last as long as the service life of this buried infrastructure. The other two will require proper operation by qualified personnel and periodic maintenance. Considering that the BWA is currently aware of the need to properly operate and maintain this new equipment, the risks to sustainability are considered low. In addition, the BWA will have to enhance public education, metering and tariff setting to adequately control water demand, especially during periods of water scarcity.

## IV. NON-CORE CRITERIA

### 4.1 Strategic Alignment

Through the construction works and the implementation of institutional strengthening activities oriented towards better management and conservation of water as a natural resource, the program enhanced sustainable practices in natural resource management, thus contributing to the IDB's Ninth General Capital Increase (GCI-9) lending target related to "*Climate Change, renewable energy and environmental sustainability*". In addition, the program contributed to the lending target "*support development to small and vulnerable countries*" and the second GCI-9



regional development goal: *Infrastructure for competitiveness and social welfare*. The program was also well in line with the Government's commitment to achieve the Millennium Development Goals by 2015 on reliable access to drinking water. Furthermore, the program was consistent with the IDB's Water and Sanitation Initiative as it contributed to the goals set under the programs "100 Cities" and "Efficient and Transparent Utilities" (GN-2446-2).

## **4.2 Monitoring and Evaluation**

The Project's Loan Proposal indicated that the BWA would designate appropriate staff to the Project Executing Unit (PEU), including a Project Manager, to carry out all tasks directly related to project execution. Among these tasks, progress monitoring throughout the five-year execution period was one of the most central activities of this unit. An assessment of the adequacy of the monitoring and evaluation (M&E) mechanisms is presented in the following subsections.

### **a. M&E Design**

Project monitoring was based on the Results Framework originally prepared, periodic evaluations of the Progress Monitoring Reports (PMR), and reviews of the Annual Operation Plans (AOP), the annual Procurement Plans, and the annual audited financial statements. A comprehensive Results Framework was assembled at the outset of the project in 2009, which included output and outcome indicators<sup>13</sup>. A few changes were introduced when it was adapted to the IDB's Progress Monitoring Report (PMR) system in 2010. With the exception of the Impact indicators, the indicators selected generally enabled reliable measurement of outputs, necessary to monitor progress and the efficacy of results. The Results Framework, the original procurement plan (PP) and the program implementation plan, contributed to conforming a reasonably organized sequence of activities. Furthermore, the Loan Proposal recommended the creation of a Project Steering Committee (PSC) chaired by the Ministry of Environment, Water Resource and Drainage (MEWD)<sup>14</sup>, with representatives from the BWA, the Ministry of Finance and other stakeholders. The purpose of the PSC was to ensure inter-institutional coordination, facilitate the work of the PEU, and monitor project performance.

The Operations Manual, prepared as part of a Technical Cooperation (BA-T1010), described in detail the eligible activities, the project management structure, contractor selection criteria, project cycle, and the financial and environmental guidelines, among other key execution aspects<sup>15</sup>. This manual, however, did not consider the need to coordinate and comply with the output and outcome indicators established in the Results Framework, thus not contributing to proper monitoring. In addition, the activities listed in Section 4 of the manual did not include all the outputs listed in the PMR report.

During execution, the BWA was required to submit semi-annual progress reports, which should include reviews of the project's implementation status, issues and actions taken during the respective periods, financial progress, contract compliance, procurement plan updates, lessons learned, and results matrix updates. In addition to the documents mentioned, the consulting firm hired to supervise the replacement of the water mains was required to submit periodic progress reports and a final close-out<sup>16</sup> report to keep track of this central activity.

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<sup>13</sup> See Results Framework in IDB Loan Proposal for Water and Sanitation Systems Upgrade (BA-L1015). 2009.

<sup>14</sup> The parent ministry of the BWA later became the Ministry of Agriculture, Food, Fisheries, and Water Resources (MAFFW).

<sup>15</sup> Halcrow, Inc. Operations Manual. March 2011.

<sup>16</sup> The PEU also produced a series of Close-out reports for several activities of the project (Installation of SCADA system, Information technology Systems, and metering), as well as for the financial administration of the project.

Besides the monitoring mechanisms described, the project also stipulated that two independent evaluations had to be carried out: (i) a mid-term evaluation to be conducted at the end of 30 months, or after 50% of the loan resources had been committed, and (ii) a final evaluation to be conducted at the end of the project, or when more than 90% of the resources had been committed. The purpose of these evaluations was to assess: (i) the degree of attainment of project objectives; (ii) the organization established for project execution; (iii) the implementation and acceptance of procedures and systems developed for the project; (iv) the sustainability of the activities funded under the project; and (v) the lessons learned that could be applied to future public-sector projects. The results of these evaluations were considered as input for the preparation of this Project Completion Report (PCR).

#### **b. M&E Implementation**

Overall, the BWA developed an adequate system for gathering and maintaining information related to the various indicators included in the Results Framework, as well as for collecting and retaining updated documentation on the performance indicators and implementation plans. Although the system could have been more robust, the output and outcome indicators were acceptably monitored in order to follow progress and discern difficulties encountered under each component.

As stated before, during execution, the BWA submitted semi-annual progress reports, which included reviews of the project's implementation status, issues and actions taken, financial progress, contract compliance, and results matrix updates. Similarly, the consulting firm hired to supervise the replacement of the water mains submitted periodic progress reports and a final close-out report<sup>17</sup>.

Following M&E recommendations, external consultants conducted mid-term and final evaluations in December 2014 and September 2016, respectively. The evaluations examined the organization established to execute the project, the level of progress in attaining the project objectives, the level of acceptance of IDB procedures, the effectiveness of the M&E mechanisms, the lessons learned, and the sustainability of results in the long term. Audited financial statements were also conducted, in compliance with contractual obligations. These reviews and audits contained information that was useful in the preparation of this PCR report.

#### **c. M&E Utilization**

In general, the M&E tools described above have been adequately utilized during project execution. The Results Framework, in conjunction with the project's procurement plan, and the PMR contributed to defining a sequential plan of activities that, with the exceptions generated by resource cancellations and funds reallocations, has been conducted.

### **4.3 Use of Country Systems**

The project did not intend to use country systems.

### **4.4 Environmental and Social Safeguards**

The main stakeholders of this operation were the all residents of Barbados, as well as the commercial establishments, and public and private institutions whose water is supplied by the

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<sup>17</sup> The PEU also produced a series of Close-out reports for several activities of the project (Installation of SCADA system, Information technology Systems, and metering), as well as for the financial administration of the project.

BWA. These stakeholders had been negatively affected by the problems encountered by the improperly maintained water supply system and had a great interest in supporting improvements to its operation. The Environmental and Social Assessment (ESA) prepared before approval considered measures to minimize construction impacts, which were generally applied. The main environmental and social difficulties encountered by this type of infrastructure intervention commonly occur during the construction phase, which entailed street closings, trench excavation, dirt removal, noise, dust, pipe and equipment installation, and other potentially disturbing activities to a relatively urban and sub-urban environment. These temporary impacts were addressed through the construction contract, by requiring adequate mitigation measures, among which the use of 'trenchless excavation' methods, to minimize 'open cuts' on public roadways, is noteworthy. The two trenchless methods used were 'pipe bursting' and 'horizontal directional drilling', were competitively priced. Approximately 18% (9 km) of the mains replaced used this methodology, which significantly diminished impacts on traffic and pedestrians, reduced soil disturbances, and avoided conflicts with other utilities<sup>18</sup>. Their disadvantage is the need for specialized equipment, contractor expertise, and for bypass piping during construction to maintain the service.

The mid-term and final evaluations conducted did not identify the occurrence of serious construction complications or conflicts with stakeholders, based on the reports reviewed and the interviews conducted<sup>19</sup>. The protection of the workers' health and safety was another project concern, which received frequent and adequate attention. Despite this commitment to safety, four injuries among contractor personnel working on mains replacement were reported. Some properties near excavation works, where jack-hammering equipment was used, experienced structural cracking. The absence of detailed pre-construction surveys at these locations made it difficult for an investigation to reliably determine the origin of the structural cracking.<sup>20</sup>

## **V. FINDINGS AND RECOMMENDATIONS**

Based on the aforementioned considerations, this report concludes that, with the exception of the activities that were cancelled during execution, the project constituted an adequate response to the institutional weaknesses of the service and the deteriorated conditions of the water supply system, that were identified in 2009. The precariousness of the distribution network would have gotten increasingly worse had the project not been implemented. The needs of the beneficiaries, as well as the BWA priorities, were considered in defining the scope of the project within the limits defined by the financial resources available. In addition, a review of the factors that contribute to project sustainability reveals that no insurmountable risks exist that could undermine long-term benefits, or that the problems identified could not be properly mitigated. It was recognized during project preparation that BWA needed a much larger loan to finance its investment needs and this project would have been only a start towards a longer-term relationship between IDB and BWA. Table 4 and the following sections summarize the main findings and recommendations.

### **5.1 Technical-Sectorial Dimension**

It is clear that this project encountered two stumbling blocks during the execution period, which made it nearly impossible to reach its stated objectives, as measured by the output and outcome indicators. One was the cancellation of US\$6.8 million from the loan resources due to the use of nonconforming procurement procedures on the purchase of 98,800 household meters. The other

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<sup>18</sup> Amec Foster Wheeler and Adams Consulting International. Design and Oversight of the Replacement Mains (Procurement # 2.13.2). Close Out Report submitted to the BWA. June 28, 2016.

<sup>19</sup> See Mid-Term and Final Evaluations conducted in 2014 and 2016, respectively.

<sup>20</sup> BWA. Project Executing Unit. Replacement of 49 km of Water Mains. Close-Out Report. Oct. 5, 2016.

was the excision and/or reduction of an additional 10 proposed activities to transfer US\$5.14 million to water mains replacement, whose total cost had increased to US\$25.8 million from the initially planned amount of US\$14.7 million. The absence or reduction of these activities negatively affected vital elements of the modernization strategy, such as the support to develop a Corporate Business Plan, a crucial factor in defining the strategy for BWA's organizational change and financial viability, and the preparation of a Wastewater Treatment and Reuse Master Plan, which included an environmental evaluation of aquifer recharge and other aspects needed for the adequate management of the Barbados water resources<sup>21</sup>.

The need to reallocate resources, due to higher prices, suggests that more attention should have been placed on defining the scope of work and developing solid cost estimates during the planning phase<sup>22</sup>. The cost of replacing 123 km of water mains was clearly underestimated, as it had been based on preliminary assumptions relative to pipe diameter, type of material, and cost per linear meter, and not on final engineering designs.<sup>23</sup> The identification of the segments, their size and their routing, was carried out as part of the project in 2012. Part of these cost increases (on a per linear meter basis), was the consequence of higher-diameter transmission mains having been prioritized over smaller distribution mains. Despite the cost increases, the replacement of the mains turned out to be the most transforming and consequential activity of the project.

The use of 'trenchless excavation' methods, to minimize 'open cuts' on public roadways, is noteworthy as measure to mitigate impacts on surrounding communities. The two methods used were 'pipe bursting' and 'horizontal directional drilling', applied to approximately 18% of the mains replaced. This technology significantly diminished impacts on traffic and pedestrians, reduced soil disturbances, and avoided conflicts with other utilities<sup>24</sup>. Its disadvantage was the need for specialized equipment and contractor expertise, and for bypass piping during construction. These methods were often coupled with the use of HDPE pipes.

The fact that the project cost estimates were based on preliminary estimates should have led to an increase in the project contingency allowances, which in this case were only equivalent to 5% of the total cost.

No direct outcome, such a "energy saved" or "decrease in the energy index", was included in the Results Framework to account for the activities related to energy efficiency. Their inclusion could have elevated the importance of this sub-component and encouraged a closer examination of its progress and potential benefits.

The formation of 'district metered areas' (DMA) should be carried out in conjunction with bulk meter installation and mains replacement. Since the later activity was conducted in a separate manner, a closer analysis of the work carried out is recommended to optimize results.

The acquisition of pipes, fittings and appurtenances was carried out prior to the completion of final detailed designs for the mains replacement works. This course of action resulted in the ordering of additional fittings to accommodate new elements on the project and created delays in delivery and on the installation processes.

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<sup>21</sup> Those activities would have been included in the foreseen follow-up IDB operation. In 2014 at receipt of the PEU report on the excision of those activities from the scope of the Program, the IDB proposed to include the most relevant output in TC BA-T1037, which was initiated but could not progress further as no official request was placed.

<sup>22</sup> BA-L1015 preparation TC BA-T1010 was delayed in its implementation by difficulties in obtaining information, and its results were incorporated after Project approval.

<sup>23</sup> See Annex 1 in Halcrow, Inc. Operations Manual. March 211.

<sup>24</sup> Amec Foster Wheeler and Adams Consulting International. Design and Oversight of the Replacement Mains (Procurement # 2.13.2). Close Out Report submitted to the BWA. June 28, 2016.

## **5.2 Organizational and Managerial Dimension**

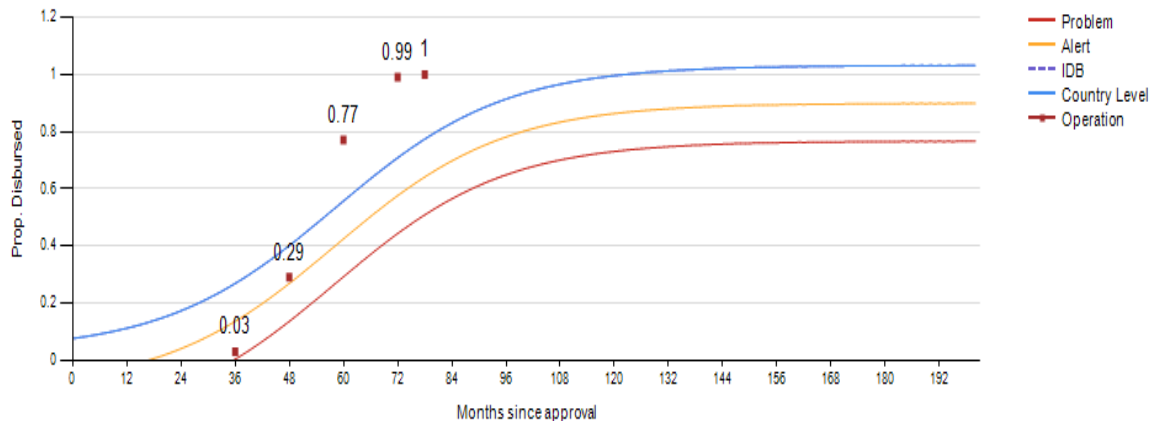
Because the excised activities were such a crucial part of the strategy for organizational change and financial viability, and given the fiscal constraints experienced by the GOB, these activities merit special consideration for future financing by the IDB. In terms of priorities, the development of a comprehensive Corporate Business Plan and a detailed Wastewater Treatment and Reuse Master Plan rank at the top of the list. These plans would provide direction to the BWA restructuring program in terms of enhancing revenue generation, improving institutional efficiency, and determining the best course of action to advance Barbados' water resources management.

The Operations Manual, prepared as part of a Technical Cooperation (BA-T1010), did not consider the need to coordinate and comply with the output and outcome indicators established in the Results Framework and the PMRs, thus not contributing to proper monitoring. In addition, the activities listed in Section 4 of the manual did not include all the outputs listed in the PMR report.

The overall execution of the project components can be considered satisfactory, as shown in the Figure 3, which depicts accumulated disbursements as a proportion of the total amount (red dots). Comparatively, the 'project disbursement curve' started very slow, disbursing only 3% during the first 36 months, but increasing rapidly during the following three years, which placed it above the curves that represent typical IDB and country projects, as well as those classified as "alert" or "problem" projects. Thus, the project revealed a relatively quick execution, driven by its most capital-intensive components.

**Figure 3. Project Disbursement Curves**

Accumulated disbursements as proportion of the total amount



### 5.3 Public Processes and Actors Dimension

The Project Steering Committee, as highlighted by the Mid-Term Evaluation, was active during the early part of project implementation, but did not meet regularly after 2011, probably due to the high demands on the agendas of its members.

### 5.4 Fiduciary Dimension

As previously stated, the cancellation of US\$6.8 million from the loan resources due to the use of nonconforming procurement procedures on the purchase of 98,800 household meters constituted an unfortunate event in the project's experience. However, its occurrence is not attributed to lack of knowledge of the IDB procurement processes and procedures but rather to a disagreement on evaluation criteria and on the required moment to introduce modifications to the bidding process.

### 5.5 Risk Management

The Environmental and Social Analysis (ESA) identified the following challenges to the proper management of Barbados water resources: fragmented approach to IWRM resulting from poorly defined institutional responsibilities, absence of sound and comprehensive national policies on water resources, poor management of water supply and demand, inadequate land use planning, poor pollution prevention and control, and limited public awareness and education. Considering that the outcome "*Improved management of Barbados' water resources*" was unattained under the project, these concerns remain valid and out of reach of the modified project.

The PMR (Jan-Jun 2016) identified 10 risks, of which seven were related to project execution and three to the post-execution period: (i) lack of capacity in the BWA to successfully manage new systems, (ii) increase in consumption level and the cost to consumers following installation of meters, and (iii) ineffective results from the implementation of the IT systems (SCADA and GIS). Perhaps the most effective way for the IDB to diminish these three risks is by remaining collaboratively engaged in the BWA's future investment plans.

**Table 4**  
**Findings and Recommendations**

Findings	Recommendations
<b>Dimension 1: Technical – Sectorial</b>	
<p>Finding # 1 The excision or reduction of 12 pending activities to free resources needed to support water mains replacement, negatively affected several vital elements of the modernization strategy and the preparation of a Wastewater Treatment and Reuse Master Plan, including its emphasis on improving water resources management.</p>	<p>Recommendation # 1 Because the excised activities were such a crucial part of the strategy for organizational change and financial viability, and given the fiscal constraints experienced by the GOB, these activities merit special consideration in future financing by the IDB.</p> <p>Recommendation # 2 Priority should be given to the development of a comprehensive Corporate Business Plan and a detailed Wastewater Treatment and Reuse Master Plan.</p>
<p>Finding # 2 The need to reallocate resources, due to higher prices, indicates that more attention should have been placed to developing solid cost estimates during the planning phase. The final identification of pipe replacement segments was carried out as part of the project in 2012.</p>	<p>Recommendation # 3 The needs for rapid intervention, to address urgent and clearly recognized problems, must be properly balanced against the importance of conducting studies that carefully consider various solutions, estimate costs, and contribute to a minimum level of project maturity.</p>
<p>Finding # 3 The use of ‘trenchless excavation’ to minimize ‘open cuts’ on public roadways, as a measure to mitigate impacts, was successfully applied to approximately 18% of the mains replaced. This technology significantly diminished impacts on traffic and pedestrians, reduced soil disturbances, and avoided conflicts with other utilities.</p>	<p>Recommendation # 4 Considering the need to extend the pipe replacement activities beyond the project’s scope, the use of trenchless excavation technologies should continue to be used, taking advantage of the practical experiences gained.</p>
<p>Finding # 4 The fact that the project costs were based on preliminary estimates should have led to an increase in the amount assigned to the project contingency category, which in this case was only equivalent to 5% of the total cost.</p>	<p>Recommendation # 5 Project contingencies should carefully consider the level of detail and analysis of the various components, especially the most critical and capital intensive.</p>

Findings	Recommendations
<b>Dimension 2: Organizational and Managerial</b>	
Finding # 5 The disagreement with the Ministry of Agriculture, Food, Fisheries, and Water Resources (MAFFW), the parent Ministry of the BWA, on the procedure for evaluating the residential meter bids, constituted an unfortunate critical event in the project's execution process, that led to the cancellation of a portion of the loan resources.	Recommendation # 6 To avoid this type of disagreements, the use of high-level coordinating mechanisms is recommended to discuss the various points of view. Perhaps a functioning Project Steering Committee (PSC) could have avoided this discrepancy and the ensuing cancellation of loan resources.
Finding # 6 The Operations Manual did not take into account the need to coordinate and comply with the output and outcome indicators established in the Results Framework and the PMRs.	Recommendation # 7 Progress monitoring is always more effective if there is sufficient agreement, from the beginning on the output and outcome indicators, and on the importance of keeping track of the indicators evolution.
Finding # 7 The overall execution of the project resources was satisfactory. Comparatively, the project disbursement curve started slowly, disbursing only 3% during the first 36 months, but increased rapidly during the following three years, driven by its most capital-intensive component.	No recommendation made
<b>Dimension 3: Public Processes / Actors</b>	
Finding # 8 The Project Steering Committee (PSC) was active during the early part of project implementation, but did not sustain its supervisory and facilitating role during the following years.	Recommendation # 8 Proactive and persuasive Project Managers, coupled with supporting and influential Management team, are recommended to actively engage and sustain the assistance of high-level inter-institutional committees.
<b>Dimension 4: Fiduciary</b>	
Finding # 9 As stated above (Finding #3), the cancellation of the loan resources, due to misprocurement on the purchase of household meters, constituted a regrettable event in the project's experience. However, its occurrence is not attributed to lack of knowledge of IDB procurement procedures but to a disagreement between the Borrower's different agencies (Ministry and BWA) on evaluation criteria.	Recommendation #9 A lot of effort should be directed towards training executing agencies, at all possible levels, on Bank's policies and procurement procedures, including evaluation criteria and restrictions to bidding process changes.



Findings	Recommendations
<b>Dimension 5: Risk Management</b>	
Finding # 10 The fragmented approach to Integrated Water Resources Management (IWRM) resulting from poorly defined institutional responsibilities, the absence of comprehensive national policies on water resources, inadequate land use planning, insufficient pollution prevention and control, and limited public awareness and education, pose significant risks to water resources management.	Recommendation # 10 Considering that the outcome “ <i>Improved management of Barbados’ water resources</i> ” was unattained by the project, these environmental concerns remain valid and should be addressed in future IDB projects.
Finding # 11 The PMR identified three risks for the post-execution period: (i) lack of capacity in the BWA to successfully manage new systems, (ii) increase in consumption level and/or costs to consumers following installation of meters, and (iii) ineffective results from the implementation of the IT systems.	Recommendation # 11 Perhaps the most effective way to diminish these three risks is for the IDB to remain collaboratively engaged in the BWA’s future investment plans.