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**Enhanced Cost Benefit  
Analysis of IDB Waste  
Water Treatment Projects  
with Special  
Consideration to  
Environmental Impacts  
Lessons Learned from a Review  
of Four Projects**

John A. Dixon

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This Discussion Paper was prepared under the direction of the Environmental Safeguards Unit of the Vicepresidency for Sectors and Knowledge (VPS/ESG) of the Inter-American Development Bank (IDB). ESG works to promote the environmental and social sustainability of Bank operations. It collaborates with project teams to execute the IDB's commitment of ensuring that each project is assessed, approved and monitored with due regard to environmental, social, health and safety aspects, and that all project – related impacts and risks are adequately mitigated or controlled. ESG also helps the Bank respond to emerging sustainability issues and opportunities.

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December 2012

## Acronyms

CBA	Cost-Benefit Analysis
CVM	Contingent Valuation Method
EIRR	Economic Internal Rate of Return
ESG	Environmental Safeguards Unit
FECASALC	Fondo Español de Cooperación para Agua y Saneamiento en América Latina y el Caribe
GDP	Gross Domestic Product
GNI	Gross National Income
GYD	Guyanese Dollar
IDB	Inter-American Development Bank
NPV	Net Present Value
OM	Operation and Maintenance
PPP	Purchasing Power Parity
TEV	Total Economic Value
VPS	Vicepresidency for Sectors and Knowledge
VSL	Value of Statistical Life
WTP	Willingness to Pay
WWT	Waste Water Treatment
WWTP	Waste Water Treatment Plant

## Table of Contents

1. Introduction.....	1
2. The Broad Approach – An Enhanced Economic Cost-Benefit Analysis .....	3
3. Analytical Approaches Used to Estimate Benefits in the Four Projects.....	4
3.1 Using Referendum CVM Studies to Estimate Benefits .....	5
3.2 Which is Better in Project Analysis? Project-specific Studies or Benefit Transfer? .....	6
4. What was Not Included in the Four Projects Studied for this Report.....	7
4.1 Valuing Health Impacts.....	8
4.2 Avoiding Double Counting .....	10
4.3 Valuing Environmental Externalities and Impacts on the Ecosystem .....	11
5. What Could be Done: Redoing the CBA with an Expanded Analysis.....	12
5.1 Trinidad and Tobago .....	12
5.2 Guyana .....	16
5.3 Paraguay .....	18
5.4 Uruguay.....	22
6. Conclusions and Lessons Learned.....	26
Appendix 1. Comparative Country Statistics.....	33
Appendix 2. Comparative Data for Country Case Studies .....	34
Appendix 3. Guyana .....	35
Appendix 4. Paraguay.....	37
Appendix 5. Trinidad and Tobago .....	39
Appendix 6. Uruguay.....	42
References.....	44

## **1. Introduction**

Development projects have a wider set of impacts than just direct project outputs. A hydropower dam, for example, produces electricity but also disrupts river flows and may affect biodiversity and the general aquatic environment. A new port development may affect coastal resources such as mangroves and coral reefs. Coal-fired power plants affect both the local and the global environments through emissions of ash and dust (affecting mostly the local environment) as well as greenhouse gases (affecting the global environment). Sewage and sanitation projects provide new services to consumers but also change the quantity and quality of wastewater released into the environment. An enhanced economic analysis allows this wider range of impacts—both benefits and costs—to be taken into account. This approach follows the IDB’s operational directives (OP 703, Directives B.5 and B.9) and is explained in an IDB Technical Note TN-428 (Dixon, 2012).

This paper builds upon existing analyses of four recent IDB projects to apply this approach. The projects selected for this study deal with the water sector and range in monetary value from US\$9.5 million (Guyana) to US\$246.5 million (Trinidad and Tobago), with Paraguay (US\$20 million) and Uruguay (US\$118.6 million) in between. These countries also vary considerably in population and socio-economic characteristics. Table 1 contains information on the size, year approved, and loan number of each project. Appendix 1 presents summary statistics that illustrate the differences in income levels, urbanization, water resource endowment, access to water and sanitation services, and electricity use in each of the four countries. Appendix 2 provides additional information on the projects and the resources valued and the valuation techniques employed. Appendixes 3 to 6 are fact sheets which summarize basic information on each project and apply the total economic value (TEV) approach to each project to identify potentially important environmental effects, the valuation techniques that have been applied, and those techniques that could potentially be applied.

**Table 1. Projects by Country, Loan Amount, and Approval Date**

<b>Project Nr.</b>	<b>Name</b>	<b>Country</b>	<b>Loan amount (US\$)</b>	<b>IDB Approval</b>
GY-L1025	Georgetown Sanitation Improvement Program	Guyana	9,500,000	Oct. 27, 2010
PR-L1060	Water and Sanitation Program for the Chaco Region and Intermediate Cities	Paraguay	20,000,000*	Oct. 3, 2011
TT-L1026	Multi-Phase Wastewater Rehabilitation Program-Phase I	Trinidad & Tobago	246,500,000	Dec. 12, 2012
UR-L1005	Montevideo Sanitation Program (PSU IV)	Uruguay	118,600,000**	Dec. 13, 2006

\* The project has an additional US\$60,000,000 non-reimbursable funding from the Fondo Español de Cooperación para Agua y Saneamiento en América Latina y el Caribe (FECASALC)

\*\* A supplemental financing of US\$42,800,000 was approved by IDB on October 26, 2011.

The four projects address different aspects of wastewater collection and treatment and potable water supply. Some of the projects fund new construction (Trinidad and Tobago, Paraguay) while one, in Guyana, is for the rehabilitation of a colonial system originally built in 1929. In Uruguay, the project funds expansion and improvements to an existing system.

Each project has an economic analysis that compares project investments (costs) and benefits. Each project also estimates project benefits by using information on willingness to pay by project beneficiaries for different levels of wastewater collection and treatment or potable water supply. Using a cost-benefit analysis (CBA) framework, project benefits are compared to project costs (investment and OM and R) to estimate net benefits and/or the internal rate of return for the project.

Indirect impacts of the projects on the broader environment (both benefits and costs) are usually not calculated. These external impacts are only explicitly considered in one analysis—the Uruguay project. This is true even though several of the projects (for example the Trinidad and Tobago investment in Malabar) have potential indirect impacts on the broader environment.



## 2. The Broad Approach – An Enhanced Economic Cost-Benefit Analysis

This paper applies the approach put forward in the IDB Technical Note *Economic Cost-Benefit Analysis (CBA) of Project Environmental Impacts and Mitigation Measures* (Dixon, 2012). Using these four projects as a sample of IDB investments in the water supply and sanitation area, we consider both what has been done and what more might be done to expand the economic analysis of environmental impacts in project analysis. As explained in the Technical Note (IDB-TN-428), the objective of the enhanced CBA is to explicitly include environmental costs and benefits in the economic analysis of projects. This basically consists of adding additional benefits and costs to the cash flow tables and then recalculating the net present value (or economic internal rate of return-EIRR) for the project. For more details on this approach, see Dixon (2011) and the IDB Technical Note TN-428 (Dixon, 2012).

In a formal sense, this approach adds both benefits and costs to the project analysis. In addition to what is referred to as Annual Costs A (normal project costs), there can also be Annual Costs B (project costs plus any unmitigated environmental costs). Annual Costs C are the additional costs of environmental intervention after project redesign, and Annual Costs D are any remaining environmental costs after project redesign. Similarly, on the benefit side we have Annual Benefits A (normal project benefits), Annual Benefits B (normal project benefits plus any positive environmental externalities), and project Benefits C (additional benefits after mitigation, if any).

Using these definitions of benefits and costs, there are three possible measures for a project CBA: CBA Result 1 (Annual Costs A plus Annual Benefits A, or a traditional project CBA that looks narrowly at the project's benefits and costs); CBA Result 2 (Annual Costs B plus Annual Benefits B, a fuller, enhanced accounting of the project but without any environmental mitigation measures being taken), and CBA Result 3 (Annual Costs A plus Annual Costs C plus Annual Costs D plus Annual Benefits B plus Annual Benefits C). The CBA Result 3 is an enhanced, comprehensive CBA that takes all impacts into account, including the benefits and costs of both project and non-project impacts.

The projects examined all have a core CBA equivalent to CBA Result 1. In some cases, attention is paid to ecosystem impacts (e.g. Uruguay; Trinidad partially). This paper examines these four projects to assess whether or not it makes sense (and is possible) to move from CBA Result 1 to CBA Result 3 and how far we can go with estimating the additional benefits and

costs with the data that are available. Moving from CBA Result 1 to CBA Result 3 implies, of course, that there are broader impacts of the project and these can be identified and quantified.

### **3. Analytical Approaches Used to Estimate Benefits in the Four Projects**

The four projects all applied some version of the contingent valuation method (CVM) to estimate project benefits. This approach uses surveys of consumers/water users to determine their “willingness to pay” (WTP) or, in Spanish, *disposición a pagar* (DAP), for a specified environmental good or service. These goods and services include improved water supply and improvements in wastewater collection, treatment, and disposal. The Uruguay project also estimated impacts on the coastal environment.

The underlying principle of the CVM approach is that if a sufficiently large number of beneficiaries are questioned about their willingness to pay for some improvement in water supply or sanitation services, the results will produce a range of monetary responses with some strong central tendency. This allows analysts to predict an average WTP number for the improvements, even though every individual respondent may have a different actual WTP.

CVM questions can take many forms. The surveys used here (with the exception of the one administered in the Chaco region in Paraguay) were all of the referendum type, whereby each respondent is asked a single, specific WTP “bid.” Another type of CVM approach uses open-ended questions (such as, “How much would you be willing to pay per month for service X?”), or a bidding game approach (which asks a series of structured questions to find the highest WTP value for each respondent). The survey done in the Chaco of Paraguay was of the open-ended type.

In addition to project details, Appendix 2 provides summary data on the CVM surveys for the four country case studies, including the number of people/households sampled, the environmental services being valued (and those not valued), and some representative WTP numbers. Each of the four studies valued a slightly different environmental good or service: household level sewage collection and disposal (Guyana); system sewage treatment and disposal (Trinidad and Tobago); water supply, sewage collection and treatment (Paraguay); and sewage collection, treatment, and coastal impacts (Uruguay).

### ***3.1 Using Referendum CVM Studies to Estimate Benefits***

Referendum-type CVM studies sample a large number of randomly selected potential beneficiaries, varying the amounts asked in the survey. For example, a typical survey might include a range of five different monetary values (amount paid per household per month). If each value is presented to 100 respondents, the final sample size would be 500 people surveyed. Each respondent is given the same information and asked if they are willing to pay a fixed amount per month for the service. Their reply is either yes or no. No further questions are normally asked. The survey responses enable an average (median or mean) WTP amount to be calculated.

Conducting a proper survey is not necessarily complicated, but it requires forethought and pre-testing of the survey instrument. To provide useful information, the range of values used should extend from a lower range where all or almost all respondents say “yes” to the WTP question, to an upper range where almost all respondents say “no.” In this way, the answers are “bounded” at both ends. Below some monetary amount all respondents say “yes” and above some monetary amount all or almost all say “no.” The average WTP amount can then be calculated using this information. (If everyone surveyed says “yes” to all amounts, we have a minimum value for WTP but no average or maximum value. Similarly if everyone says “no” to all amounts, we have no information on true WTP.) See Box 1 for some additional thoughts on the differences between “values,” “willingness to pay,” and actual payments when measuring changes in social welfare.

In the four projects included here, the number of respondents (people or households surveyed) ranged from 500 to 1500. In the case of Uruguay, the analysts did not conduct a survey, but rather used a technique called “benefit transfer,” whereby existing CVM results from already completed CVM studies in one country or location are applied to another location (in this case Montevideo). This approach may be appropriate when either time or financial resources are limited and an answer is needed quickly. In the case of the Uruguay project, the analysts based the benefit transfer WTP amounts on a meta-analysis of CVM studies from other IDB countries. This meta-analysis presented results from many CVM studies for sanitation and water services (IDB, 2001). Using their own judgment the analysts then chose a single value to use for each of the major benefits of the project in Uruguay. Values were expressed as payments of US dollars per household per month. Separate dollar values were used to value the addition of final

treatment, the value of adding collectors and final treatment, and the values associated with reduced pollution of the coastal and bay environments.

Several conditions must be met in order to successfully use “benefit transfer”:

- the environmental service/s being valued must be similar (e.g., potable water supply, improved wastewater treatment);
- the socioeconomic conditions of the original study population and the beneficiary population must be similar with respect to economic and cultural factors; and
- common sense must demonstrate that the numbers being used are reasonable.

In the Uruguay case, these conditions were largely met. The types of services (potable water/ sewage treatment and collection/ coastal habitat conservation) are appropriately matched, the studies included in the meta-analysis were largely from similar countries in Latin America, and the values chosen seem reasonable.

The advantage of basing the benefit transfer on a meta-analysis is that by including a number of different studies one can determine an average value or range of values; this is usually preferable to the alternative approach of transferring the values from an existing study. Note that there is an element of subjective judgment in the use of the benefit transfer approach.

In addition, in cases where the environmental good or service being valued is not yet in place (e.g. going from no potable water supply to having a potable water supply; or going from having a contaminated coastal environment to having a clean, swimmable coastal environment) it may be hard for respondents in that location to actually visualize the improvement being valued. Although people can be asked their WTP for outcomes that they have not experienced themselves, we know that people can best value changes that they have already experienced or know. Therefore we find that using benefit transfer from other locations where the changes have already been implemented may produce more credible results than asking the population where the change has not yet taken place.

### ***3.2 Which is Better in Project Analysis? Project-specific Studies or Benefit Transfer?***

As we have seen, there are tradeoffs between conducting project-specific, local studies (local studies tend to be more expensive, have smaller samples, and take more time) and using benefit transfer (it is quicker, cheaper, and may include a large number of examples in the sample). Even

given these tradeoffs, local data collection is always the first-best approach to estimating WTP numbers. Economists say that locally collected surveys tend to produce results that are more robust since they actually survey the population that will benefit from (and often will be asked to help pay for) the investments. Conducting surveys also incorporates local knowledge that may be important in influencing WTP. Local data collection, however, is more expensive and takes more time than using benefit transfer.

Which, therefore, is better? Project-specific CVM studies are the first-best choice. However, if money and time are major constraints, then meta-analysis and benefit transfer can be a useful approach. As seen in Uruguay, it allows the analyst to “create” benefit values for a variety of environmental goods and services (e.g., sanitation, storm water control, and improvements to both the local and the coastal environment). The only negative is that benefit transfer is dependent on values estimated elsewhere. The analyst therefore has to trade off the robustness of locally generated estimates with the broader coverage, lower cost, and speed with which benefit transfer can be applied.

Even if a locally conducted CVM survey is implemented, it may be useful to compare those results with answers to similar questions asked elsewhere (as seen in a meta-analysis). If there is a large divergence between the local WTP responses and those found in the meta-analysis, the analyst must look carefully at what was done in the local CVM survey and see if some errors were present in the way the CVM question was formulated. Worldwide experience has confirmed that people often respond with fairly consistent answers to CVM questions if the good or service being valued is the same. One would expect some differences based on cultural and economic factors, but not usually a five-fold or ten-fold difference.

#### **4. What was Not Included in the Four Projects Studied for this Report**

As explained in the IDB Technical Note TN-428 standard project, CBA includes the direct benefits and costs of the project. The four projects examined here all estimated annual project costs and benefits (referred to as Annual Costs A and Annual Benefits A in the Technical Note, p. 11). In most cases, the benefits were largely confined to potable water supply or improved sanitation services. Trinidad and Uruguay were exceptions and did include some measure of indirect use benefits. However, the IDB Technical Note also called for the inclusion of other environmental costs and benefits created by or affected by the project.

These additional impacts often include health and/or ecosystem impacts, effects that are often not included in the analysis. Several of the projects did discuss the health impacts of improved wastewater collection and treatment and improved potable water supplies, but these were almost never explicitly valued. Health impacts that occur outside of the project area (usually via water quality changes) are almost never valued or included in the project analysis.

CVM questions, appropriately asked, often include an implicit health component. When people are asked what they are willing to pay for improved wastewater collection and treatment, the respondents usually consider various factors in their response: convenience, reduced smells and nuisance values, and potential health impacts. In Guyana, for example, the proposed project has important health impacts (benefits) from reducing urban sewage spills and contamination of ground water. Respondents most likely take these into account when asked their WTP for improvements in sewage and sanitation. These factors are also potentially important in Paraguay and, to a lesser extent, in Uruguay.

#### ***4.1 Valuing Health Impacts***

Health impacts, including both morbidity (sickness) and mortality (premature death) can be valued in economic terms. The logic is that health costs, if they occur, are a cost of the present situation and, if prevented, are measures of part of the benefit of the intervention. We take the present situation as the baseline from which additional costs or benefits are measured. As seen in Appendix 1, the baseline situation varies between countries.

Economists say that “a cost avoided is a benefit,” and there are many cost-side valuation approaches that provide a powerful set of analytical tools. There is an extensive literature on valuing both sickness and death. See Dixon (2011, 2012) for a review of these approaches.

In general, morbidity (sickness) outcomes are valued by looking at the costs associated with providing health care, including for hospitalization, doctor visits, treatment, drugs and other expenses, lost work time, lost work time by caregivers, and pain and suffering. Many of these costs can be quantified using locally observed quantities and prices and may be substantial (pain and suffering have to be measured using other approaches). They may also affect a large number of people.

Valuing mortality is more difficult. There is an extensive literature on valuing premature mortality, but there are also difficult moral issues. For example, many “value of human life”

studies use information on lost productivity (a form of the human capital approach) to estimate the loss to society of premature death. Income levels are very important in estimating these values. As seen in Appendix 1, the GNI per capita for the four countries varied greatly. Does this also mean that the value of a human life varies by a similar amount? Probably not, and this approach linking the “cost” of death to lost productivity has very uncomfortable policy implications. A number of approaches and adjustments have been used to calculate the value of a human life, but these will not be discussed here. Suffice it to say that valuing mortality, especially in cross-country comparisons, is a difficult issue that has to be handled carefully.

Another approach that has been used to value mortality is based on a meta-analysis of different “value of life” estimates using other valuation techniques (largely WTP measures). These studies produce a result that is referred to as the value of statistical life (VSL)—the value of an average statistical life saved (or death avoided), not any individual’s actual valuation. The VSL is estimated by observing people’s behavior and responses to different risks to infer an implicit value of avoiding an increased chance of premature death. This information is then used to compare the costs of preventing an additional death to the benefit of doing so. For example, if one thinks that a road safety program will reduce the death rates from accidents from 10 to 5 per million km travelled, this is a reduction in 5 statistical lives. Using information on the VSL, one can compare the benefits (death avoided) to the costs of the road safety investment (to prevent those accidental deaths).

Estimating the VSL may be the one exception to the “local is better” rule for estimating economic values. VSL studies tend to be complicated, relying on large data sets or large surveys to measure small changes in expected deaths and then use this information to estimate a value of a statistical life. In the United States and Europe, VSL figures are often in the range of US\$3 to US\$6 million per VSL. Carrying out a VSL study within the context of a typical water project may be too challenging in terms of data and resources.

VSL numbers are usually adjusted by purchasing power parity (PPP) factor to take into account not only different income levels in rich and poor countries, but also differences in what money will buy. For example, lower-income countries usually have lower prices, especially for services and locally produced products. Therefore, a direct comparison of GDP per capita between a rich and a poor country may overstate the difference between what one can actually buy in the rich country versus the poor country. The traditional measure of GDP per capita may

show a difference of 10 to 1 between two countries, say US\$25,000 per capita versus US\$2,500 per capita. When adjusted for PPP, however, the actual PPP-adjusted GDP value per capita may be reduced to a ratio of 5 to 1, or US\$ 25,000 versus US\$5,000 per capita. Thus, a VSL estimated at US\$1 million in a rich country would not be valued in the poor country as US\$100,000, but actually US\$200,000. This type of adjustment allows some limited use of benefit transfer of VSL studies from high-income countries to lower-income countries.

Regardless of income levels, WTP-based measures for premature mortality are always much higher than estimates based on the human-capital approach. In general, WTP-based measures of premature death are often 6 to 10 times larger than human capital-based estimates for the same country. Whereas the human capital approach looks at an individual as a “machine” producing products, other measures, such as WTP-based measures, capture much more: a person is a member of society and is “worth” more than just what he/she produces.

To avoid this problem, and the fact that economic values for mortality tend to be very large however they are measured, I prefer to include locally measured economic values of morbidity in the analysis of projects and alternatives, but avoid valuing mortality in dollar terms. There is no reason that estimates of mortality (or lives saved) cannot be presented in quantitative but not monetary terms. For example, one can say that the benefit of a project is \$100,000 in health care costs avoided and Y lives saved, although economists like to place all impacts in the same framework. Using a common monetary measure and adding together monetary measures of morbidity and mortality is one exception to this rule.

#### ***4.2 Avoiding Double Counting***

When measuring the benefits from wastewater projects, there is a danger of double counting. For example, if one added WTP measures for improvements from wastewater collection and treatment and then added in health costs avoided (both morbidity and mortality), there would probably be some double counting whereby the same benefit (for example, reduced sickness) is counted twice—once in the WTP measure and once in the health cost-avoided analysis. Double counting leads to overstating benefits from the project. If the project benefits extend to a broader population than the population included in the WTP survey, double counting can be avoided by carefully applying the different measures (WTP estimates, health care costs avoided) to the applicable population.



### ***4.3 Valuing Environmental Externalities and Impacts on the Ecosystem***

Environmental externalities are present when a project produces benefits for both those immediately affected as well as others who are not part of the decision making process. In the Trinidad project, for example, the Malabar component is designed to improve wastewater management in the Malabar area but also produces potential downstream benefits to the Caroni Wetlands. These externalities are seldom included in traditional project analysis.

Ecosystem impacts were largely not included in the estimation of benefits in the four case study projects. This could be true because of two possible reasons: first, the external impacts of any given project might be small, or second, the external ecosystem impacts were not clearly identified in the EIA process. In addition, these two factors could combine to exclude external environmental impacts: small individual impact and lack of understanding.

Although the Guyana project referred to the problems of urban contamination from sewage spills, the impacts of sewage disposal on the river and coastal ecosystem were not included in the analysis. Similarly, the impacts of sewage disposal in Trinidad on both the Caroni wetland and the San Fernando coastal area were not explicitly valued. Only in Uruguay was an effort made to explicitly assign some value to a cleaner coastal/ bay environment. The Uruguay analysis used the benefit transfer approach and applied a modest per person value based on studies from other locations. The Paraguay project largely ignored broader ecosystem impacts.

There is an expanding literature on valuing ecosystem impacts and including them in the analysis of projects (Dixon, 2008, 2011, 2012; Watkins and Hawken, 2011). Although most wastewater collection and treatment projects recognize that they will have an impact on the broader ecosystem, these impacts have rarely been explicitly valued (other than what people express as part of their WWT to help improve their immediate environment, as in the Guyana project).

There is a practical reason why many studies ignore the broader environment. Whereas people can relate directly to (and value) improvements in potable water supply, or wastewater collection and treatment, the impacts of wastewater disposal usually occur at some distance and affect other people. Many people do not care very much where or how wastewater is disposed of, just as long as it is far away! Consequently, when people are asked their WTP for improvements created by potable water supply and wastewater treatment projects, we consistently find the highest values for potable water supply, and immediate wastewater

collection and transport. There is usually much less willingness to pay for more treatment, as it is seen as “someone else’s problem.” However, as called for the IDB’s OP-703, operational directives B.5 and B.9, these external impacts should be included in the analysis of projects.

## **5. What Could be Done: Redoing the CBA with an Expanded Analysis**

In theory, an expanded CBA of each project could be carried out by applying the approach outlined in the IDB Technical Note TN-428 *Economic Cost-Benefit Analysis (CBA) of Project Environmental Impacts and Mitigation Measure* (Dixon, 2012). This requires looking at the analysis for each project to see which benefits were included and which environmental benefits and costs could be added to create an enhanced, broader CBA. As explained in the Technical Note, this means moving from CBA Result 1 to CBA Result 3. It is not possible to say ex-ante if the enhanced CBA is needed (or justified). One must look at each project and apply the broader analytical framework to answer this question – are there potentially important and measureable external environmental impacts? In the following sub-sections, each project is reconsidered using this approach.

### **5.1 Trinidad and Tobago**

*What was done:* Trinidad is a medium high-income, quite developed country. There is an expectation of delivery of public services and a realization that there are costs associated with those services and a need to help pay for them. These factors are reflected in the WTP survey that was done in support of the project. See Map 1 for the location of the two project components: the Malabar component near Arima in the north, and the San Fernando component in the south.

A referendum-type CVM survey was carried out in which respondents were asked their willingness to pay a fixed monthly amount for a specified level of service. The survey included 1,500 respondents divided between three types of households:

1. those who were already connected to the system –WTP1 (these households already had collection and basic wastewater treatment)
2. those households who had a collection system but no treatment – WTP2, and

3. those households without any type of service – WTP3 (these households had neither collection nor treatment of wastewater).

Not surprisingly, WTP1 (\$TT 19.2 per household per month, just over US\$3) is less than WTP 2 (\$TT 31.5, slightly more than US\$5) and is much less than WTP3 (\$TT 100, about US\$16).<sup>1</sup>This is not surprising since moving from WTP1 to WTP3 reflects a major change in the services provided. The jump from WTP2 (existing collection but no treatment) to WTP3 (currently no service at all) shows a 3 fold increase—those without any service value new service (especially collection) very highly. [Note that the exchange rate was about US\$1.0 equals TT\$ 6.1]

Treated wastewater was also valued. It was estimated in San Fernando that some of the treated wastewater could be sold as an input to a local desalinization plant for TT\$12 per cubic meter (m<sup>3</sup>), or about US\$2 per m<sup>3</sup>. In Malabar, treated water is released into surface sources that are used for irrigation and finally as an input into the Caroni Wetland. No information was collected in Malabar on the benefits of improved surface water quality. The analysts applied the benefit-transfer approach and used the same TT\$12 per m<sup>3</sup> value from San Fernando. This value was then applied to all wastewater produced and was labeled the “economic value of treated water.”

A third benefit—avoided costs—was also identified. These appear to be the costs avoided in operating and maintaining old infrastructure after the new facilities are constructed. The size of these avoided costs is especially large in the first year of operation and has a major role in making both components profitable.

Therefore, two of the main benefit categories used in the project CBA—sale of treated water and “costs avoided”—are questionable. First, it is never shown that there is a market for treated wastewater or how large it is. Assigning the value from San Fernando for some purchases of treated wastewater to all wastewater produced involves a strong assumption. Moreover, costs avoided by replacing old infrastructure can be part of the overall analysis, but must be handled carefully. There is no doubt that replacing old infrastructure (e.g. a waste water treatment plant, a car, or an airplane) can lead to cost savings, but that information should be used to make the decision about keeping the old infrastructure (hardware) or replacing it with new investment. The

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<sup>1</sup> The correct WTP amount for WTP 3 is about US\$16 per household per month, a revision noted at the December 2012 seminar. A different, higher value was used in the original project economic analysis.

new investment, however, should be analyzed as such, starting with costs and benefits from the first year of the investment. These are two separate analyses and decisions. It is important to avoid double counting and inflating benefit estimates.

In Trinidad, to carry out the traditional project CBA (CBA Result 1), the different WTP values were applied to the appropriate populations in both San Fernando and Malabar. The residual value of treated wastewater was set as TT\$ 12 per m<sup>3</sup>. “Costs avoided” were also added as a benefit, with a large value for the first year of operation followed by a smaller annual value thereafter. The different investment costs were also considered. These included investments in new treatment plants as well as development of the collection network and related infrastructure. These numbers were then used to estimate the costs and benefits and estimate the economic rate of return of the projects.

The CBA of the Trinidad and Tobago project demonstrates that the projects are socially profitable and generate net social benefits. However, from a financing perspective, especially if government expects that the projects will pay for themselves from revenues collected from beneficiaries, both projects will fall below the 12 percent rate of return necessary to pass the private, financial CBA test. In fact, if only the WTP values are included as benefits, both projects have negative NPVs. Of course, this is the very reason that governments get involved in financing such projects—the divergence between net social benefits and net private returns on investment.

*What could be done: adding additional benefits.* This is an ex-post analysis. Since a redesign of the project is not being proposed, one can only compare CBA Result 1 (the traditional project CBA) with CBA Result 2 (the expansion of the analysis to add in environmental benefits and costs). There are downstream users (the Caroni Wetland and coastal areas in Malabar, the coastal zone in San Fernando) that will benefit from improved wastewater collection and treatment upstream. These benefits, while not explicitly quantified, are presently subsumed in the TT\$12 per m<sup>3</sup> for treated water. In fact, this TT\$12/m<sup>3</sup> value is the largest component of project benefits, accounting for 62 percent or 63 percent of total project benefits, as seen in Table 5.1 of the project’s socioeconomic analysis. For the Malabar component, the annual value of treated wastewater ranges from just under TT\$100 million per year initially to over TT\$124 million per year in the last year of the project analysis. This is what we call a “strong assumption,” that is, it assumes a lot and has a major impact on the project CBA based

on limited data. The value of treated wastewater used in the CBA of Malabar quickly dominates the resulting CBA.

In order to estimate CBA Result 2—the economic analysis taking environmental impacts into account—we could add a new benefit based on the WTP of citizens of the region for improvements to the Caroni Swamp and coastal waters. This is also based on the strong assumption that the Malabar project will have a measureable impact on downstream water quality. If this is true, we can estimate a back-of-the-envelope value for this improvement. We assume that the population in this part of Trinidad is about 280,000 people, with an assumed average family size of 3.5 people. This equals about 80,000 households. If we assume that an average household has a willingness to pay of US\$1 per household per month for external environmental improvements to the Caroni Swamp and coastal environment, this represents a total annual benefit of just under US\$1 million, or roughly TT\$6 million. This amount is then added to the previously calculated willingness-to-pay results for improved sanitation services to estimate Annual Benefits B. (Annual Costs A and B are the same). This adjustment increases the present value of benefits by TT\$ 42 million – not a huge increase but one that is still substantial.

Note that this result is based on a small per household per month value for those families living in this part of Trinidad. If the monthly value were higher, say, US\$2 or US\$3, the benefits would increase. Increasing the environmental service value to US\$3 per household per month would increase the PV of benefits by another TT\$ 85 million. A CVM study could easily be done of the greater Port-of-Spain population to determine whether they value these ecosystem impacts. Note that even if the per person or per household values are small, when these values are applied to a large population, the cumulative impact could be substantial. Still, these numbers appear to be at most a few percentage points of the values assumed in the project analysis as the value of treated waters.

There may be other benefits that can be added to the analysis. If improved water quality in surface waters resulted in increased fish catch or recreational benefits, these could be added as part of Annual Benefits B. Without more information, however, it is impossible to say how large these benefits might be and what additional project investments would be required to cause these changes.

*Bottom line:* The analysis presented for the project used unreasonably high estimates of the value for treated water and costs avoided. An alternative approach (assuming that the

Malabar project has a measureable impact on surface water quality) based on a wider population's WTP for improved water quality in the Caroni wetlands and the coastal area would produce a smaller total benefit from the treated water, but one that might be more credible. If the number of households affected was larger, or the WTP per household were larger, the measured benefits of the project would increase. Handling "costs avoided" is still an issue. One must carefully consider what part of avoided costs can be ascribed to the project as a benefit.

## ***5.2 Guyana***

*What was done:* Guyana is the poorest of the four countries studied, and Georgetown has an aging wastewater treatment infrastructure with major nuisance and public health problems related to sewage backups and spills. The CVM survey, which included about 500 respondents, was standard and asked respondents about WTP for the proposed project that will help alleviate sewage backups in the home, spills, and other public nuisances. Map 2 shows the project area in Georgetown, the capital of Guyana.

The CVM survey was straightforward and mechanical. As in Trinidad, a referendum-type survey was used to interview 500 respondents; the survey used four price levels (GYD 100, 300, 700, 1000, and 1500 equal to about US\$0.50, \$1.50, \$3.50, \$5.00 and \$7.50). A logit model was used to analyze the data and a final WTP estimate of GYD 1423 (mean value) and GYD 1239 (median value) were obtained. (The exchange rate was roughly US\$1 = GYD 200.)

Although not entirely clear in the documentation reviewed, it appears that the analysts then added the newly estimated WTP value (a mean value of GYD 1422, or about US\$7) to existing payments of about GYD 420 to estimate a total WTP value of GYD 1843 per household per month. This amount was then multiplied by the number of households in the area served to estimate benefits from the project.

These assumptions are strong assumptions. The newly estimated WTP numbers are a threefold increase over the present level of payments. It is entirely possible, even likely, that those respondents viewed their WTP answers as representing their total WTP for the improved sewage services, not their additional WTP for the improvements. To avoid this double counting, a single, lower WTP number might be suitable. Also, the CVM questionnaire might explicitly explain that the amounts being bid on would be added to their present payments.

If we assume that total WTP is actually closer to GYD 1400 per household (not GYD 1843) and this value is multiplied by the number of households affected, the total benefits of the project will be decreased and the CBA analysis of the project will yield a lower EIRR. The original EIRR estimated was 13.02 percent (CBA Result 1), just 1 percent above the 12 percent discount rate. Even with the downward revision in the WTP numbers (and the uncertainty inherent in these estimates), the project is still attractive.

*What could be done: adding additional benefits:* After carefully examining the project description, it is not clear if anything else should be done. The project investments are aimed at fixing an existing system and avoiding sewage spills in the urban core. No additional treatment is planned and there is no change in final wastewater disposal—the same river outfall will be used. Hence, there will be no change in the river or marine environment other than a potentially very small increase in volume discharged at the outfall if spills and groundwater leakages in the urban core are reduced. This change should have no measureable impact on the coastal environment. It appears that one would expect CBA Result 1 to very similar to CBA Results 2 and 3.

In theory, there could be a small impact on the urban environment. The CVM survey should have already captured in the WTP estimates avoidance of spills and local groundwater contamination. The one remaining potential impact is on property values in the project area and on nearby properties. If improved wastewater collection and transmission reduces spills and nuisances, one would expect an increase in property values. The *property value approach* (an example of a hedonic analysis) could then be used to assess this contribution to the overall benefits from the project. It is important to avoid double counting. If the WTP figures from those directly benefited by the project include some assumption about increases in property values after the project is implemented, then this benefit should not be counted twice. The situation is clearer if property values increase for those who live nearby but are not within the project area. These increases in property values (a positive externality of the project) should be included as part of the benefits from the project. These would be included in Annual Benefits B—project benefits plus positive environmental externalities.<sup>2</sup>

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<sup>2</sup> One participant at the December 2012 IDB seminar pointed out that the environmental improvements in central Georgetown might make it a more attractive shopping and business destination, both effects having a positive impact on property values (and government tax revenues?). Hedonic valuation approaches would allow the analysts to estimate these values in a with-project and without-project scenario.

To determine if this is a potentially important factor in the analysis, we can use one of two approaches: questioning those affected indirectly by the project (primarily people adjacent to the project area), or interviews with key informants (e.g., estate/property agents; government land value assessors). Either approach should enable a determination of whether a positive spillover property value impact exists and how large it is. With the limited data available, it is not possible to add in either of these impacts here.

### ***5.3 Paraguay***

*What was done:* The US\$82 million Paraguay project is designed to extend potable water supply and basic sewage services to poorer indigenous peoples in the Chaco and to implement improved wastewater collection and sewage treatment systems in the intermediate cities in the eastern part of the country. A CBA was done for the Central Chaco and in two cities in the Eastern Region: Itaugua and San Juan Bautista. The analysis examined both private benefits (increase in family welfare due to improved quality of life and positive health impacts) and public benefits (improvements to and preservation of the environment). Benefits were quantified using water demand models, examination of the costs of alternative approaches to supply the specific benefits, and a CVM study.

The CVM survey was carried out in three intermediary cities (Itaugua, Areagua, and San Juan Bautista) using 900 surveys (300 in each city). The referendum “take-it-or-leave-it” type approach was used, and people were asked whether or not they were willing to pay a given amount for installation of sanitary sewers and wastewater treatment. Six different “bids” were used, from 34,000 Guaraní (Gs) to Gs 132,000 per household per month. The estimated mean WTP value was about Gs 75,000 Gs a month per household; this is equivalent to about US\$18.77 per household per month (at an exchange rate of US\$ 1 = Gs 4000; the exchange rate is now approximately US\$1 = Gs 4,500).

These amounts were then compared to the capacity to pay of the surveyed families. The World Health Organization standard states that potable water supply and sewage collection and treatment should not exceed 3 percent of family income. For many families, the average WTP amount met this test. However, about 19 percent of all families in the intermediary cities would need to receive some subsidy in order to keep their costs for improved sanitation below 3 percent of household income.



The mean WTP value of US\$18.77 per household per month was then used to estimate the total benefits of the project in intermediary cities and calculate the CBA for this component of the project. The calculated EIRR was about 14.6 percent (and the B/C ratio was 1.18). As discussed earlier one should not confuse WTP values with amounts actually (or easily) collected. The WTP measures help the analyst decide if the social benefits of a project exceed the social costs. These figures should not be confused, however, with a financing plan for the project as implemented by a local water supply or wastewater treatment utility.

A second note on the CVM survey—the highest bid used (Gs 132,000)—was accepted by about 30 percent of the respondents (70 percent said no to this amount). This means that there is a higher amount that some of these people would be willing to pay. Therefore, the survey results were not “bounded” at the upper end, and the true mean or median WTP value is larger than the reported Gs 75,000. From the available data it cannot be determined how much more some people would be willing to pay.

Although not a focus here, in the Chaco region of Paraguay a different approach was used. A simulation model for water demand was applied and differentiated by whether the period was the rainy period (5 months) or the dry season (7 months). The population was divided into five different socioeconomic groups. Benefits were estimated using the SIMOP model. A CVM survey was carried out using an “open-ended” type question. About 300 respondents were asked their WTP for improved and reliable water supply and basic sanitation services. Different WTP numbers were estimated for indigenous and non-indigenous populations with a separate questionnaire for higher-income Mennonite communities. These results were used to estimate willingness to pay and also to assess the ability to pay of the different groups.

*What could be done: adding additional benefits.* The project has fairly localized impacts in both the Chaco and the intermediary cities, and the benefit estimation focused on those directly affected by the proposed investments. This is entirely appropriate and gives useful information. If the projects had an impact on the broader environment, these other benefits or costs could be identified and perhaps valued using some version of the CVM approach, or perhaps a property value approach.

Let us examine the project component for Itaugua. The treated wastewater is released into a small river that flows north into a lake, Lago Ypacarai, located about 20 km away in a protected area. Ypacarai is a shallow lake (average depth of 3 meters) and covers some 90 km<sup>2</sup>.

It is a major recreational resource for the capitol region (it is located about 25 km east of Asuncion. See Map 3 for the location of Lago Ypacarai in relation to the project sites.). The lake has three nearby communities: Aregua (approximately 70,000 inhabitants), Ypacarai (approximately 30,000 inhabitants), and San Bernardino (approximately 10,000 year-round inhabitants). Aregua is located on the lake's western shore and San Bernardino is located on its eastern shore and is a major holiday resort area and recreational destination. In the summertime, San Bernardino's population increases tenfold to 100,000 or more people. San Bernardino has extensive luxury housing, both lakeside (estimated at 300 or more) and in areas near the lake, plus hotels, restaurants, and other tourism infrastructure.

Without more information on the broader ecosystem impacts of the project, however, it is not possible to specify whether the impacts are positive (improved water quality entering the lake) or negative (degraded water quality entering the lake). After identifying the physical impacts and potential size of the Itaugua project on the lake's ecosystem, it would then be possible to determine the economic impacts (costs) of these changes. (It should also be recognized that the impact of just one investment (e.g. Itaugua) on the lake's water quality may not be measurable).

With this information, it is then possible to consider whether a higher level of treatment of the wastewater is justified in order to avoid these costs. This enhanced CBA of the Itaugua project (CBA Result 3), therefore, would help identify a wider range of impacts (taking into account the impacts on Lago Ypacarai) and assess design alternatives for the wastewater treatment plant. Given the lack of site information and data, it is not possible at this time to move from CBA Result 1 to CBA Results 2 or 3.

It is possible, however, to discuss the questions that need to be answered and the analytical techniques that can be used. To estimate CBA Result 2, we would need to estimate the economic costs of damage to the lake's water quality. These impacts could affect the recreational uses of the lake, lakeshore property values, and other uses of the lake's water (e.g. irrigation, potable water supply, and fishing). Without more information on the changes in the lake's water quality and the numbers and types of uses, it is not possible to say a priori which of these impacts is the most important.

The following techniques could be applied to estimate Annual Costs B.

*Changes in recreational use:* Changes in recreational use (and associated consumer surplus) can be measured using either the Contingent Valuation Method (CVM) or the Travel Cost Technique. Negative environmental impacts on the lake ecosystem can result in reduced numbers of users and reduced willingness to pay for that use. It is estimated that lake users per year number over 300,000 people, including both short-term visitors and multi-day visitors. It is not possible to estimate the number of total visitor days per year with much more information.

*Changes in lakeshore property values:* Changes in water quality and the lake ecosystem will have an impact on property values near the lake. To value these changes one can use the Hedonic (property value) Approach. An alternative method to produce the same information is to use what is sometimes called the Delphi technique that relies on the informed opinion of realtors or property value assessors. Hedonic approaches rely on observed property prices and their changes, whereas the Delphi approach relies on the informed opinion of experts. These impacts can be substantial. In San Bernardino, for example, the price of land is around \$120 per m<sup>2</sup>, and new homes cost around \$400 per m<sup>2</sup>.<sup>3</sup>

*Productive uses of the lake's water (e.g. fishing, irrigation, potable water supply):* The Change in Production technique could be used if there was a measureable change in production (e.g. of an irrigated crop, or of a fishery). The Cost of Prevention technique could be used to value deterioration of water quality that results in additional treatment costs to supply potable water from the lake.

*Bottom line:* Without much more data on the potential impacts of the Itaugua project (and other proposed projects) on the quality and quantity of water entering the lake, it is not possible to go beyond the present CBA Result 1. If carried out, CBA Result 2 would indicate the potential costs of water quality changes in the lake, and then CBA Result 3 would assess the benefits and costs of additional wastewater treatment measures. This case illustrates the importance of taking a longer-term view of multiple project impacts on the ecosystem. Any individual project may not have an identifiable impact, but many investments over time may result in major ecosystem impacts.

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<sup>3</sup> Local information on land values, housing costs and recreational users was provided by Oscar Came in the IDB's Asunción office.

## 5.4 Uruguay

*What was done:* The Uruguay project (a total loan of US\$118.6 million plus a substantial line of credit) was designed to support improvements in the sanitary services of Montevideo, the capital and largest city of Uruguay. Building on a series of past investments, the project focused on selected sanitation and drainage investments (including storm water drainage) in Montevideo plus improved institutional services and management of the wastewater treatment system. (Map 4 shows the location of Montevideo and some of the project's major infrastructure components.) The analysts decided not to do original survey work in Montevideo to estimate ETP values. Instead, they used the benefit-transfer approach based on a meta analysis of past studies from the Latin American region.

The analysts identified a wide range of impacts from the project (including both individual impacts within the city and ecosystem impacts in the bay environment where treated wastewater is disposed). The impacts were valued using WTP estimates drawn from the meta-analysis. The WTP values selected were then applied to the different populations affected; these ranged from the number of households in one area of the city (e.g. Cerro Norte) that would receive sewer connections, to the entire population in that area that would benefit from improved storm water collection and disposal. The broadest measure (small in terms of US\$ per household per month, but large in total numbers of households) was the value of improvements in the Montevideo Bay ecosystem.

The WTP values used in Montevideo were based on the values of many WTP studies surveyed in the 2001 IDB publication *Investing in Water Quality* (plus additional analysis done earlier in Montevideo). The final WTP figures that the Montevideo study selected were as follows (US\$ per household per month, updated to 2006 prices). These values were applied to the population affected by each impact, as noted in the parentheses:

Sanitary connection	US\$22.5/hh/month (Cerro Norte; Casabo populations)
Drainage works (storm water)	US\$ 16.7/hh/month (Cerro Norte; Casabo populations)
Local environmental benefits	US\$ 2.4/hh/month (beach and coastal area population, Casabo population)
Environmental improvements in the Bay	US\$ 2.4 to 3.4/hh/ month (Montevideo population)

The values used in the Carrasco Norte component for sanitation and storm water drainage were similar. The WTP figures are substantial and imply large welfare benefits from the project. Those values for local or bay environmental benefits are smaller in absolute size but are applied to many more people—the entire population of Montevideo, over 1.2 million people in 450,000 households.

To analyze the project, the analysts identified different goods and services, the numbers of people affected, and the different values for the WTP for each good and service. Both direct benefits (sewer connections, improved wastewater treatment, storm water collection) and indirect benefits (improvements in coastal and Bay waters) were identified and valued. These were then used to estimate the overall benefits from the project in a CBA framework.

*What could be done: adding additional benefits.* The existing analysis has already included a wide range of different benefits from the proposed investments—both direct benefits to those who received improved sanitary services and local and Bay-wide environmental benefits from improved treatment and management of wastewater and storm waters. The project did not consider major upgrades in the level of treatment.

Higher levels of treatment are much more expensive for both initial investment and operation and maintenance. In the Montevideo project, it has been argued that because of the very large receiving water body and the use of outfalls, there is little danger of measureable impacts on the river and Bay environment. This is a testable hypothesis and illustrates why environmentalists have to work closely with project engineers and project economists to identify and value potentially important ecosystem impacts. An enhanced CBA of the project would require data on the likely impacts on the river and Bay environment and on the consequences of those impacts for different user groups: fishermen, recreational users, and others who use or extract water from these bodies. For example, the *corvina rubia* fishery is an important national, and regional, resource. How would it be affected by different levels of wastewater treatment? Once these impacts are identified and quantified, economists can use various valuation techniques to measure the economic size of these impacts. This information, in turn, can be used to analyze different treatment (or disposal) options to compare tradeoffs between benefits and costs of alternatives.

The existing analysis is a good example of CBA Result 1 and CBA Result 2. Major environmental impacts have been taken into account. Table 2 presents this information for the PSU-IV component. CBA Results 1 and 2 are the same, since both include a value for improvements to the coastal environment. Rather than redo the table, we added an additional US\$5 million per year as Annual Benefit C to represent potential benefits to the *corvina rubia* fishery (this value is meant to be a place holder and not a real number) should be added to Annual Benefits B column). This additional value from the fishery increases the NPV significantly, from US\$ 19.5 million to US\$47.7 million.

**TABLE 2.**

<b>ASSUMPTIONS:</b>	Uruguay -- PSU IV		
<b>Discount Rate</b>	12%	Time horizon: 40 years	30 Years US\$
<b>Annual Costs A</b>	normal project costs		
<b>Annual Costs B</b>	project costs with environmental costs, unmitigated costs of environmental intervention after project re-design		
<b>Annual Costs C</b>	design		
<b>Annual Costs D</b>	remaining environmental costs after re-design		
<b>Annual Benefits A</b>	normal project benefits		
<b>Annual Benefits B</b>	project benefits plus any positive environmental externalities		
<b>Annual Benefits C</b>	additional benefits after mitigation, if any		
<b>CBA Result 1</b>	Costs A + Benefits A		
<b>CBA Result 2</b>	Costs B + Benefits B		
<b>CBA Result 3</b>	Costs A + Costs C + Costs D + Benefits B + Benefits C		

Year (time=T)	COSTS A	COSTS B	COSTS C	COSTS D	BENEFITS A	BENEFITS B	BENEFITS C	PV ANALYSIS 1 at time T	PV ANALYSIS 2 at time t	PV ANALYSIS 3 at time t	
1	(\$15.90)	(\$15.90)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	(\$14.20)	(\$14.20)	(\$14.20)	
2	(\$25.50)	(\$25.50)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	(\$20.33)	(\$20.33)	(\$20.33)	
3	(\$22.30)	(\$22.30)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	(\$15.87)	(\$15.87)	(\$15.87)	
4	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$13.40	\$13.40	\$5.00	\$6.74	\$6.74	\$9.91	
5	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$13.60	\$13.60	\$5.00	\$6.13	\$6.13	\$8.97	
6	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$13.90	\$13.90	\$5.00	\$5.62	\$5.62	\$8.16	
7	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$14.10	\$14.10	\$5.00	\$5.11	\$5.11	\$7.37	
8	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$14.40	\$14.40	\$5.00	\$4.69	\$4.69	\$6.70	
9	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$14.60	\$14.60	\$5.00	\$4.26	\$4.26	\$6.06	
10	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$14.90	\$14.90	\$5.00	\$3.90	\$3.90	\$5.51	
11	(\$2.80)	(\$2.80)	\$0.00	\$0.00	\$15.10	\$15.10	\$5.00	\$3.54	\$3.54	\$4.97	
12	(\$3.00)	(\$3.00)	\$0.00	\$0.00	\$15.40	\$15.40	\$5.00	\$3.18	\$3.18	\$4.47	
13	(\$3.00)	(\$3.00)	\$0.00	\$0.00	\$15.70	\$15.70	\$5.00	\$2.91	\$2.91	\$4.06	
14	(\$3.00)	(\$3.00)	\$0.00	\$0.00	\$16.00	\$16.00	\$5.00	\$2.66	\$2.66	\$3.68	
15	(\$3.00)	(\$3.00)	\$0.00	\$0.00	\$16.30	\$16.30	\$5.00	\$2.43	\$2.43	\$3.34	
16	(\$3.00)	(\$3.00)	\$0.00	\$0.00	\$16.50	\$16.50	\$5.00	\$2.20	\$2.20	\$3.02	
17	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$16.80	\$16.80	\$5.00	\$2.00	\$2.00	\$2.72	
18	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$17.10	\$17.10	\$5.00	\$1.82	\$1.82	\$2.47	
19	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$17.50	\$17.50	\$5.00	\$1.67	\$1.67	\$2.25	
20	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$17.70	\$17.70	\$5.00	\$1.51	\$1.51	\$2.03	
21	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$18.10	\$18.10	\$5.00	\$1.39	\$1.39	\$1.85	
22	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$18.40	\$18.40	\$5.00	\$1.26	\$1.26	\$1.68	
23	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$18.70	\$18.70	\$5.00	\$1.15	\$1.15	\$1.52	
24	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$19.10	\$19.10	\$5.00	\$1.05	\$1.05	\$1.38	
25	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$19.40	\$19.40	\$5.00	\$0.96	\$0.96	\$1.25	
26	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$19.80	\$19.80	\$5.00	\$0.88	\$0.88	\$1.14	
27	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$20.10	\$20.10	\$5.00	\$0.80	\$0.80	\$1.03	
28	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$20.50	\$20.50	\$5.00	\$0.73	\$0.73	\$0.94	
29	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$20.80	\$20.80	\$5.00	\$0.66	\$0.66	\$0.85	
30	(\$3.10)	(\$3.10)	\$0.00	\$0.00	\$21.20	\$21.20	\$5.00	\$0.60	\$0.60	\$0.77	
<b>NPV at 20 years</b>			at 30 years						<b>\$19.45</b>	<b>\$19.45</b>	<b>\$47.71</b>

To properly carry out the enhanced CBA and move to CBA Result 3, however, is a major undertaking requiring both substantial scientific information and monetary valuation of a wide range of affected users and uses of the coastal waters. Cost information is also required to assess different levels of wastewater treatment and their impact on marine water quality, both now and over time. Cumulative environmental impacts may be very important. It is not possible to do this with the available data. In sum, the existing analysis has the correct framework and looks at the correct array of issues. Any enhanced analysis would build on this base and add additional information from those who use and are affected by the coastal and river waters.

## **6. Conclusions and Lessons Learned**

At the request of ESG, four wastewater treatment projects were examined to see which project benefits were valued and how, and what other environmental and/or social benefits or costs could be added to an enhanced economic analysis of these projects. While the direct project benefits (usually wastewater collection and treatment and/or potable water supply) of these investments are routinely identified and included in the project CBA, other benefits or costs, often related to the environment, are often not included.

This is not a criticism of the way these projects are analyzed. There is a clearly established best-practice approach to valuing the benefits produced. However, the range of what is included as “benefits” is fairly narrow. It is increasingly recognized that there are often additional environmental (and social) impacts, both benefits and costs, of large infrastructure investments in the water sector. Of the four projects studied, the Uruguay project does the best job of trying to identify and value these additional benefits, but even in that case more could be done, especially in assessing different levels of wastewater treatment. It should also be pointed out that external environmental benefits and costs have to be identified and quantified in a with-project/ without-project framework. This is a major responsibility of the EA process, and this information needs to be provided in a timely and useable format for these external impacts to be included in the CBA process.



Based on this review, the following general observations are offered.

1. The use of willingness-to-pay (WTP) estimates to measure the increase in social welfare for the improved water and sanitation services being provided is both the standard approach and entirely appropriate. In most cases, WTP is estimated using some form of survey of project beneficiaries applying the contingent valuation method (CVM). This is a well-tested approach that produces robust results.

In some cases, WTP estimates are derived from other existing studies using the benefit-transfer (BT) approach. BT is particularly strong when the benefit estimate being transferred has been estimated for a directly consumed good or service from a population with similar socioeconomic characteristics. The Uruguay project is a good example of this approach.

While the BT approach is commonly used today, it should be applied with care. Without some double checking on the reasonableness of results, it can lead to problems. This is particularly true when BT is used to value goods and services such as environmental quality and broader ecosystem services. In the Trinidad case, the use of BT to value treated wastewater resulted in a very large number that might be questioned.

2. Although WTP measures can capture a broad array of benefits at the level of the respondent—the direct consumer or beneficiary of improved water supply or wastewater treatment—it does not capture well other more distant impacts. Consequently, the important questions surrounding the optimal level of wastewater treatment and impacts on receiving water bodies (both good and bad impacts) are usually not included in the analysis of water projects. Although the IDB’s operational directives (OP 703, B.5 and B.9) call for this broader analysis, it is rarely done.
3. There are several possible reasons for this: first, the marginal impact of a project on the receiving water body or the environment may be so small as to not make any measureable change. In this case there is no change in the CBA. Second, “actionable” environmental impact data may not be available due to lack of baseline data, or lack

of measurement. Third, cumulative impacts may also be ignored either due to long time horizons involved, or the fact that any individual project/investment has only a small or undetectable marginal impact on the environment, even if the cumulative impact of many individual actions might be quite large. In the sample of projects included here, only the Uruguay project explicitly considered the question of external impacts, and then in a general way using the benefit-transfer approach. Different levels of wastewater treatment were not explicitly considered. In order to respond to the ESG mandate and the IDB's operational directives, a broader, enhanced analysis could be carried out within the project CBA framework. This is illustrated in the Technical Note (TN-428) that describes going from CBA Result 1 to CBA Result 3. As illustrated in the Technical Note, the use of the Total Economic Value approach helps guide the analytical process to include a larger number of benefits and costs associated with any project.

Valuation techniques can be used to measure and quantify many of these benefits and costs. However, the question of broader environmental and social impacts from projects still has to be explicitly asked, preferably as part of project preparation. Ex-post analyses are much more difficult to carry out and are less likely to produce robust results.

4. By explicitly asking these broader questions on environmental and social benefits and costs at the time of project preparation, it should be possible to add this information with a minimum of additional resources. This should produce a strengthened, enhanced project CBA (CBA Result 3) that meets the guidelines set out in the IDB's operational directives and should allow countries to make better investment decisions in the water and sanitation sector.
5. A strong lesson from this review is the importance of WSA and ESG working together closely in project preparation in order to share information and insights into what are realistic design options that need to be considered in project identification and what types of environmental and/or social data are needed to inform the CBA

process. The constant pressure to speed up project preparation and reduce time (and costs) for project preparation do not help this process of integration.

A second finding is that there may be a fundamental disconnect between the project side (as seen in WSA) and ESG if there are major issues of long-term or cumulative impacts. Projects are projects and are identified, analyzed, and funded as discrete operations. Longer-term, or system wide impacts may not be well captured by the project process. This potential disconnect may require more system-wide planning and analysis, such as considering the impacts on the river or coastal ecosystem of both individual projects as well as a longer term series of investments in, for example, wastewater treatment plants (WWTP). This is similar to the difference between “chronic” and “acute” impacts of air pollution. Even if no single WWTP investment is large enough to have a directly measureable impact on water quality or the ecosystem (an “acute” event) the impacts of many individual actions can create long term (chronic) impacts. There is no easy answer to this problem -- however, awareness that it may be an issue and exchanging information and data can help address it.

### **Box 1. Economic Values—Social Welfare, WTP Measures, and Actual Payments**

Economists are very interested in how people value different goods and services and the importance of those values in determining welfare or wellbeing. Public projects are analyzed in a cost-benefit analysis framework whereby economic benefits and costs are compared to see if the investment produces an increase in net benefits. Since investment costs are well known, the measurement of benefits is crucial.

The confusion that often arises is that public investments, such as those supported by the IDB, have to be compared to public benefits, that is, increases in social welfare. These public benefits may be different from private financial returns. For example, a public utility that provides potable water and wastewater treatment will collect fees directly from connected consumers. In addition, the utility will produce other benefits to the public at large and to the environment. Even though it is not easy to charge for these benefits, they are still benefits of the investment. The challenge of the economic analysis is to identify the broad array of benefits of the project. Some part of these benefits can be captured via user fees, but these will normally not be enough to cover all costs. Otherwise there would be no rationale for government investment. One could just let the private sector provide the services and charge for these services.

Economists, especially environmental economists, spend a lot of effort trying to identify and measure all of these benefits. The use of the survey-based contingent valuation method (CVM) is one common way to estimate people's values for many goods and services and estimate their willingness to pay (WTP) for these services. These results are commonly used to justify public investments in water projects. However, these WTP estimates are only partial measures of the total value of a wastewater project. As seen in the total economic value approach (see Dixon 2012 for a discussion of this approach), the WTP measures are measures of direct use values (e.g. potable water supply, sewer and sanitation services). Important environmental impacts on other people and the broader ecosystem are often ignored. In addition, we know from experience that it is administratively difficult to "capture" or charge for 100 percent of society's WTP.

Note that the CBA implicitly assumes that the WTP numbers equal actual payments received. This is a strong assumption. Within a social welfare framework, the measure of individual WTP is a correct measure of changes in welfare as a result of the project and should be compared to project costs to estimate the profitability of the investment. The WTP amounts

should not be confused, however, with the amounts that can actually be collected. Based on experience, we know that even though we have great confidence in WTP numbers as a measure of the increase in social welfare, actually collecting these amounts is usually more difficult.

There are several reasons for this discrepancy between measured WTP and the amounts actually collected. First, people enjoy having some “consumer’s surplus” (a benefit received that is beyond what has been paid for) and therefore extracting all of people’s willingness to pay for anything is difficult. A related point is that the WTP number is usually either a median or a mean value. If the reported individual WTP was LARGER than the average (mean) value (the amount being charged), then people should be willing to pay that amount (and would still have some unpaid “surplus value” left over: the consumer’s surplus).

Conversely, if your individual WTP is LESS than the average value of the sample (the amount being charged), you might be quite reluctant or completely unwilling to pay the higher amount. Hence both factors—paying less than your true WTP, and the fact that some people have low, or even, zero WTP, result in actual collections that are smaller than measured total WTP. In order to fully extract total WTP amounts, one would have to implement a very complicated pricing policy that, for each household or group of households that have similar WTP values, sets the price just equal to their measured WTP. Since this is administratively (and socially) almost impossible to implement, authorities use an average value or price that is often less than mean stated WTP to charge for services.

My own personal rule of thumb is that a utility or organization is lucky if it can collect 50 percent of the expressed WTP.

Therefore, the economic analysis of projects must recognize several facts:

- The measured WTP of consumers is not equal to their actual payments; estimates of consumers’ WTP (although good measures of changes in welfare) are almost always larger than actual payments.
- Narrowly focused WTP questions value a narrow range of goods and services (usually potable water supply in the home or sanitation services). Environmental externalities are often ignored.
- There is a growing literature on valuing environmental externalities, which can then be brought into the social CBA of the project. This is the process of moving from CBA Result 1 to CBA Result 3, discussed in the Technical Note (Dixon, 2012).

If one thinks of a set of nested values then one can imagine three levels: a core set of values as seen from the point of view of the direct beneficiaries of the wastewater collection and treatment project (measured by WTP), a larger set of values that includes these core values but also includes values to others nearby and to their environment; and third, an even larger set of values that includes the previous two values but also includes society's valuation of such matters as ecosystem health, biodiversity protection, and more broadly defined environmental quality.

The challenge for the economist is to expand the analysis from the smaller core set to the third measure. This will yield an enhanced economic analysis that truly reflects social benefits as well as social costs of the proposed project. This broadest analysis will help illuminate if the project is a good investment from the perspective of the government or not. It does not say whether the project can pay for itself based solely on user fees. The goal of public investments should be to produce the largest net benefits for society. The equally important question of how you pay for these investments is an additional, but quite separate question. In some cases user fees will cover costs of water projects; in many cases governments will have to bear part of the costs of the project in order to produce larger net social benefits.

## Appendix 1. Comparative Country Statistics

	<i>Country name:</i>	<b>Trinidad and Tobago</b>	<b>Guyana</b>	<b>Paraguay</b>	<b>Uruguay</b>
<i>Country statistics:</i>					
Population (total, millions)		1.3	0.8	6.5	3.4
Urban population (%)		13.9	28.5	61.5	92.5
GNI per capita (WB Atlas method – US\$)		15,380	2,870	2,720	10,230
Adjusted Net National Income per capita (US\$)		7,838	2,486	2,493	9,746
Implicit exchange rate used in the analyses		US\$1 = TT\$6.1	US\$1=GYD 200	US\$1 = Gs 4000 (now US\$ 1 = Gs 4500)	US\$ used throughout
Freshwater resources per capita (M3)		2,874	320,048	14,822	17,639
Access to improved water system (%)		94	94	86	100
Rural (%)		93	93	66	100
Urban (%)		98	98	99	100
Access to sanitation (%)		92	84	71	100
Rural (%)		92	82	40	99
Urban (%)		92	88	90	100
Electric Power consumption (kwh/per capita)		5,662	??	1,056	2,671

Source: *Little Green Data Book 2012*. The World Bank, Washington DC

## Appendix 2. Comparative Data for Country Case Studies

	<i>IDB Project:</i>	<b>Trinidad and Tobago</b>	<b>Guyana</b>	<b>Paraguay</b>	<b>Uruguay</b>
	<i>IDB Project number:</i>	TT-L 1026	GY-L 1025	PR-L 1060	UR -L 1005
	<i>IDB loan amount (US\$ millions) and year of approval</i>	\$246.5 (2012)	\$9.5 (2010)	\$20 (2011)	\$118.6 (2006)
<i>Project analytical approach used:</i>					
Valuation technique applied		CVM	CVM	CVM	Meta-analysis and Benefit Transfer of WTP results
Proposed Number of households surveyed		1500	500	900	n/a
Environmental goods and/or services valued		Wastewater treatment	Repairs to sewage collection and removal system	Potable water; sewage collection; sewage treatment	Sewage collection and treatment; storm water collection; coastal environment
WTP values estimated/ used		From US\$3 to US\$50 per household per month	About US\$7 per household per month	Various: about US\$18.77 per household per month in intermediary cities	Various: from US\$2.4 to US\$22.5 per household per month depending on the service being valued
Environmental goods and/ or service NOT valued		Caroni Wetland; biodiversity; coastal environment	Riverine and coastal marine environment	Ecosystem services	Fisheries, public health, biodiversity in the coastal environment
Exchange rate		US\$1 = TT\$ 6.1	US\$1 = GYD 200	US\$1 = Gs 4000 (now US\$ 1 = Gs 4500)	US\$ used throughout

*Source:* Selected IDB project documents.



### **Appendix 3. Guyana**

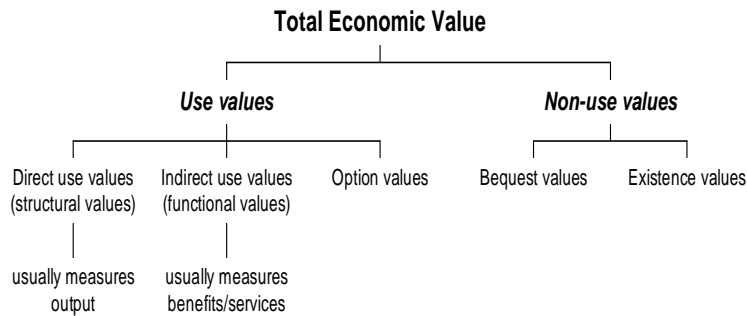
**Project:** GY-L 1025; Georgetown Sanitation Improvement Program

**Costs:** IDB \$9.5 million, local \$0.5 million. Total: \$10 million.

**Environmental services valued and valuation technique used:** A CVM survey of about 500 households was carried out to estimate the WTP for investments to provide improved sanitation services and local amenity values. The estimated values for WTP were then applied to the entire population affected by the project. By adding the WTP value to existing payments the analysis may have overestimated actual benefits.

**Comments:** The survey focused on those directly affected by the project and their immediate environment. It did not consider any indirect benefits to the river or marine environment where the sewage outfall is located. Health impacts to the affected population were not assessed separately. They were included implicitly in the estimated WTP.

**Additional valuation measures to be included in an enhanced CBA:** Since the project benefits all occur within the boundary of the project, and since no changes will be made to wastewater treatment and disposal, no additional factors need to be considered in an enhanced CBA. The one exception is if the project has a positive impact on adjacent property values.



**TEV Chart with data:**

<b>Type of value techniques</b>	<b>Goods or services (major impacts *)</b>	<b>Valuation</b>
<b>Use Values:</b>		
Direct:	<i>Local environment (consumer's surplus)</i>	** CVM
Preventive Expenditures	Sewage spills in Georgetown*	CVM;
	All direct uses	Preventive Expenditures
Indirect Use Values: (informed judgment)	Property values *	Hedonic approaches, Delphi approach
Preventive Expenditures	River and Marine environment	CVM;
	Research and Education	Expenditures
	Biological diversity conservation	CVM
Option Value:	River and Marine environment	CVM
<b>Non-use Values:</b>		
Bequest Values:	River and Marine environment	CVM
Existence Values:	River and Marine environment	CVM

#### **Appendix 4. Paraguay**

**Project:** PR-L1060; Sanitation and Potable Water Project for the Chaco, Intermediary cities, and Eastern Paraguay

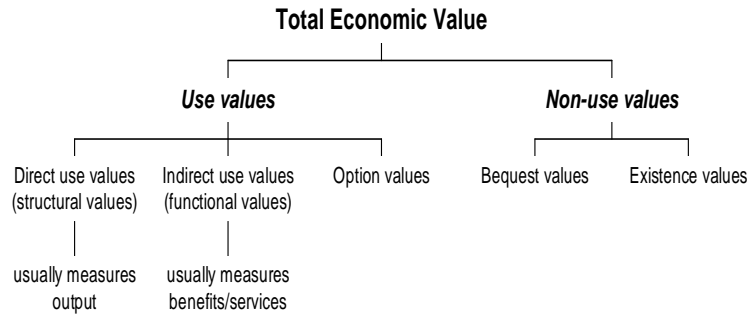
**Costs:** IDB: \$20 million, local \$2 million, plus an additional \$60 million from FECASALC.

**Environmental services valued and valuation technique used:** The project used a CVM survey of some 900 households to estimate willingness to pay (WTP) for improved potable water supplies and improved sanitation. The project also looked at the costs of alternatives to estimate values.

**Comments:** No separate questions were asked with regard to either specific health benefits or broader ecosystem benefits from the investments.

**Additional valuation measures to be included in an enhanced CBA:** Although not discussed in the IDB reports reviewed, I understand there is a lake located downstream that will receive the treated wastewater from the Itaugua component of the project. Furthermore this lake is located within a protected area and has recreational use. If the wastewater from the treatment plant has a negative impact on the lake's water quality, these impacts can be measured and valued. Depending on the nature of the impacts a variety of valuation techniques could be used: the *change in production approach* if changes in lake water affect agricultural or industrial users of the water, *travel cost* or *CVM* if the changes affect recreational users, and *property value/hedonic approaches* if the changes affect the value of nearby property. Since no data are available on these potential impacts no adjustments can be made to the CBA at the present time.

**TEV Chart with data:**



<b>Type of value techniques</b>	<b>Goods or services (major impacts *)</b>	<b>Valuation</b>
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Use Values:

Direct:	<i>Potable water supply**</i>	<i>CVM, +??</i>
	<i>Sanitation (consumer's surplus)**</i>	<i>CVM</i>

All direct uses	Preventive Expenditures
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Indirect Use Values:	<i>Ecosystem services*</i>	<i>CVM</i>
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Recreation	Travel Cost, CVM
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Property values	Hedonic
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approaches;  
informed judgment  
(Delphi Technique)

Research and Education	Expenditures
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Biological diversity conservation	CVM
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Option Value:	<i>Biological diversity</i>	<i>CVM</i>
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Non-use Values:

Bequest Values:	<i>Biological diversity</i>	<i>CVM</i>
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Existence Values:	<i>Biological diversity</i>	<i>CVM</i>
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## **Appendix 5. Trinidad and Tobago**

**Project:** TT-L1026; Wastewater Rehabilitation Program – Phase 1 (6-2012)

**Costs:** IDB \$246.5 million

**Environmental services valued and valuation technique used:** The project used a CVM (contingent valuation method) survey of some 1500 beneficiaries to determine the WTP (willingness to pay) for improved handling of wastewater—both collection and treatment. Three surveys of about 500 respondents each were used to elicit WTP for three scenarios: first, for those households already connected to sewers and treatment systems the CVM survey determined their WTP for improved measures to ensure that the receiving bodies for wastewater are not polluted. Second, for those households connected to a sewer system but without functioning treatment plants, the CVM survey was used to estimate their WTP for wastewater treatment and protection of receiving bodies. The third set of questionnaires was for households with no improved sanitary services at present, and was used to estimate the WTP for collection and treatment of wastewater.

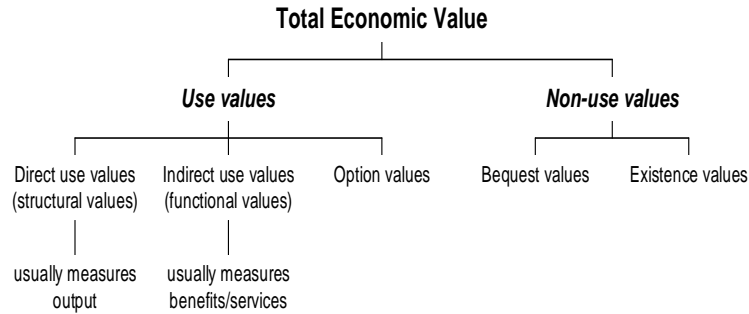
Not surprisingly, the WTP response for Group 1 (\$TT19.2/hh/month) was less than for Group 2 (\$TT 31.5/hh/month) and both were considerable less than the WTP response for Group 3 (ca. \$TT 100/hh/month). Group 1 already had wastewater collection and treatment, Group 2 had collection but no treatment, and Group 3 had neither collection nor treatment. The exchange rate is about US\$1 equals \$TT 6.1.

**Comments:** No questions were asked about the WTP for reducing impacts of wastewater disposal on either the Caroni Wetlands (near Malabar) or the coastal environment (near San Fernando). No questions about the health impacts of improved wastewater handling were asked. Although health benefits would normally be considered to be included in the WTP response for the project beneficiaries, these estimates would not normally include any benefits received by those located outside of the project.

**Additional valuation measures to be included in an enhanced CBA:** Two changes are suggested: First, reduce the amount presently shown as a benefit from sale or use of the treated

wastewater and “costs avoided.” Although the TT\$12 per M3 seems much too high a value to assign to all the wastewater produced, I cannot say what the correct amount should be. Revisit the benefit listed as “costs avoided” to see which ones should really be considered as project benefits. Second, add in a per person or per household value for the overall benefits to the Caroni Swamp and the coastal areas in both locations (if it can be shown that the project would have a measurable impact on downstream water quality – or is part of a broader series of investments that will have an impact). This would require the use of a CVM study to estimate people’s willingness-to-pay for this ecosystem benefit. Although probably small per person, many people would be aware of and affected by improved conservation of this important wetland—Caroni—and secondarily to improvements to the coastal areas.

**TEV Chart with data:**



<b>Type of value techniques</b>	<b>Goods or services (major impacts *)</b>	<b>Valuation</b>
<b>Use Values:</b>		
Direct:	<i>WTP for wastewater collection and treatment**</i>	CVM
	All direct uses	Preventive
<b>Expenditures</b>		
Indirect Use Values:	Tourism (producer's surplus)	Lost economic rents
	Research and education	Expenditures
	Health benefits preventive expenditures, others	CVM,
	Wetland conservation (Caroni)**	Travel Cost; CVM
	Coastal conservation**	CVM
	Research and Education	Expenditures
	Biological diversity conservation*	CVM
Option Value:	Biological diversity (Caroni)	CVM
<b>Non-use Values:</b>		
Bequest Values:	Biological diversity (Caroni)	CVM
Existence Values:	Biological diversity (Caroni)	CVM

## **Appendix 6. Uruguay**

**Project:** UR-L1005; Montevideo Sanitation Project

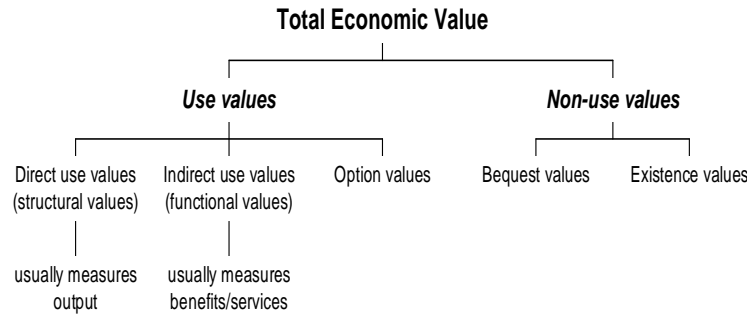
**Costs:** IDB: \$118.6 million.

**Environmental services valued and Valuation technique used:** The project used the Benefit Transfer approach based on a meta-analysis of past studies to estimate willingness to pay per household per month (WTP) for improved sanitation and improved storm water drainage. WTP estimates for improvements and protection of the coastal environment are also included.

**Comments:** The approach was quite comprehensive and included values for protection of the marine environment. No specific questions were asked with regard to the level of treatment of wastewater and resulting impacts on fisheries, aquatic biodiversity, or public health.

**Additional valuation measures to be included in an enhanced CBA:** In order to really expand the analysis from CBA Result 1 and 2 (largely available in the existing analysis), it will be necessary to get considerable information on alternative treatment options and their costs, and the impacts of these different treatment options on ambient water quality in the receiving waters, both from this investment and cumulative impacts over time. This information, in turn, can be used to estimate economic impacts on recreational uses and productive uses such as fisheries. With this information a CBA Result 3 analysis could be attempted.





**TEV Chart with data:**

<b>Type of value techniques</b>	<b>Goods or services (major values *)</b>	<b>Valuation</b>	
<b>Use Values:</b>			
Direct:	<i>Sanitation (consumer's surplus)**</i>	<i>CVM</i>	
	<i>Storm water drainage (consumers surplus)**</i>	<i>CVM</i>	
	Research and education	Expenditures	
	All direct uses	Preventive Expenditures	
	Indirect Use Values:	<i>Coastal protection*</i>	<i>CVM</i>
		Tourism (in Montevideo)	Travel Cost; CVM
Fisheries*		Change in Production; CVM	
Research and Education		Expenditures	
Aquatic biological diversity conservation*		CVM	
Option Value:	Biological diversity	CVM	
<b>Non-use Values:</b>			
Bequest Values:	Biological diversity	CVM	
Existence Values:	Biological diversity	CVM	

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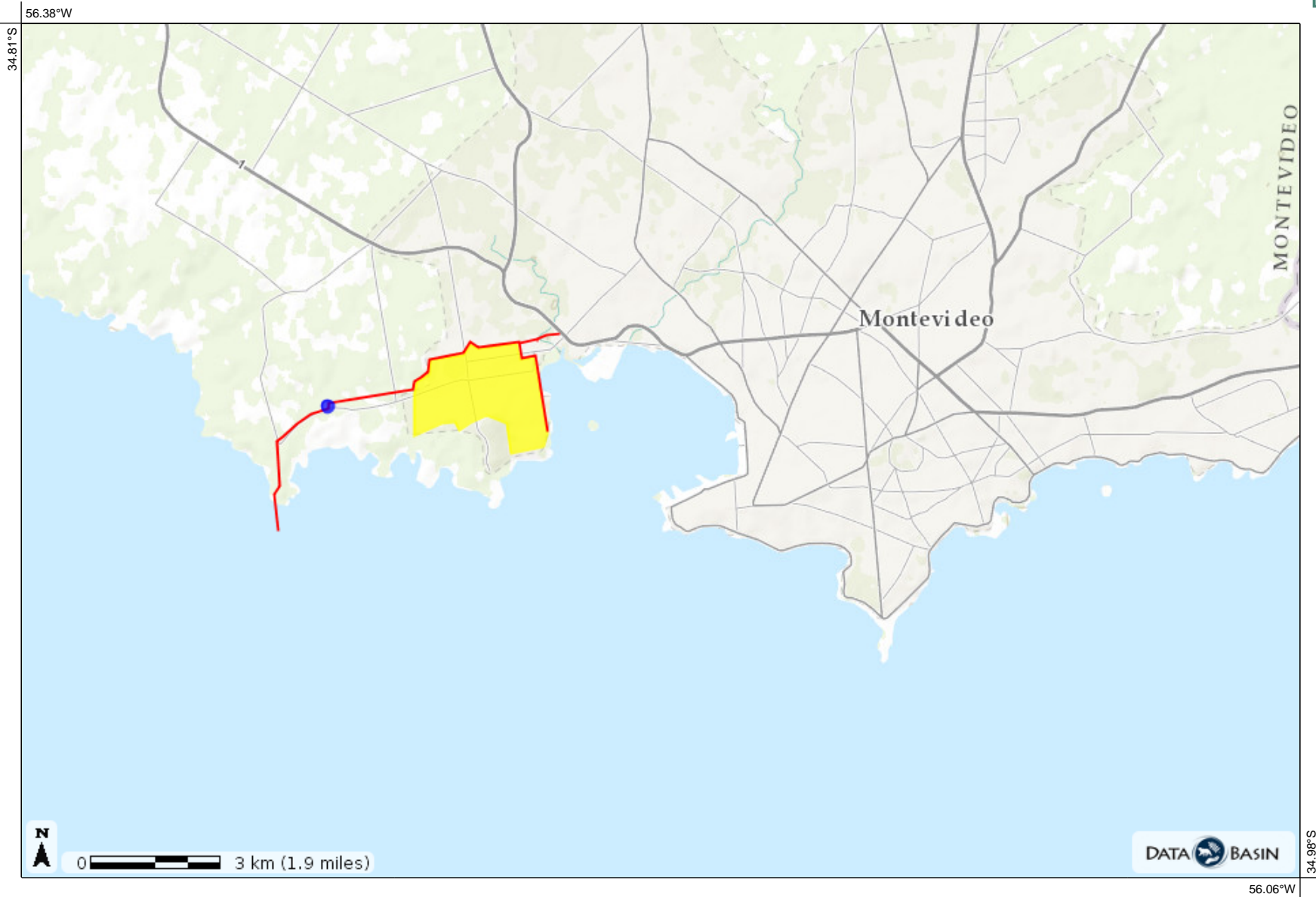
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# Montevideo, Uruguay



## Legend

- Area of Improvement
- UR-L1005 pipes
- UR-L1005 treatment plant

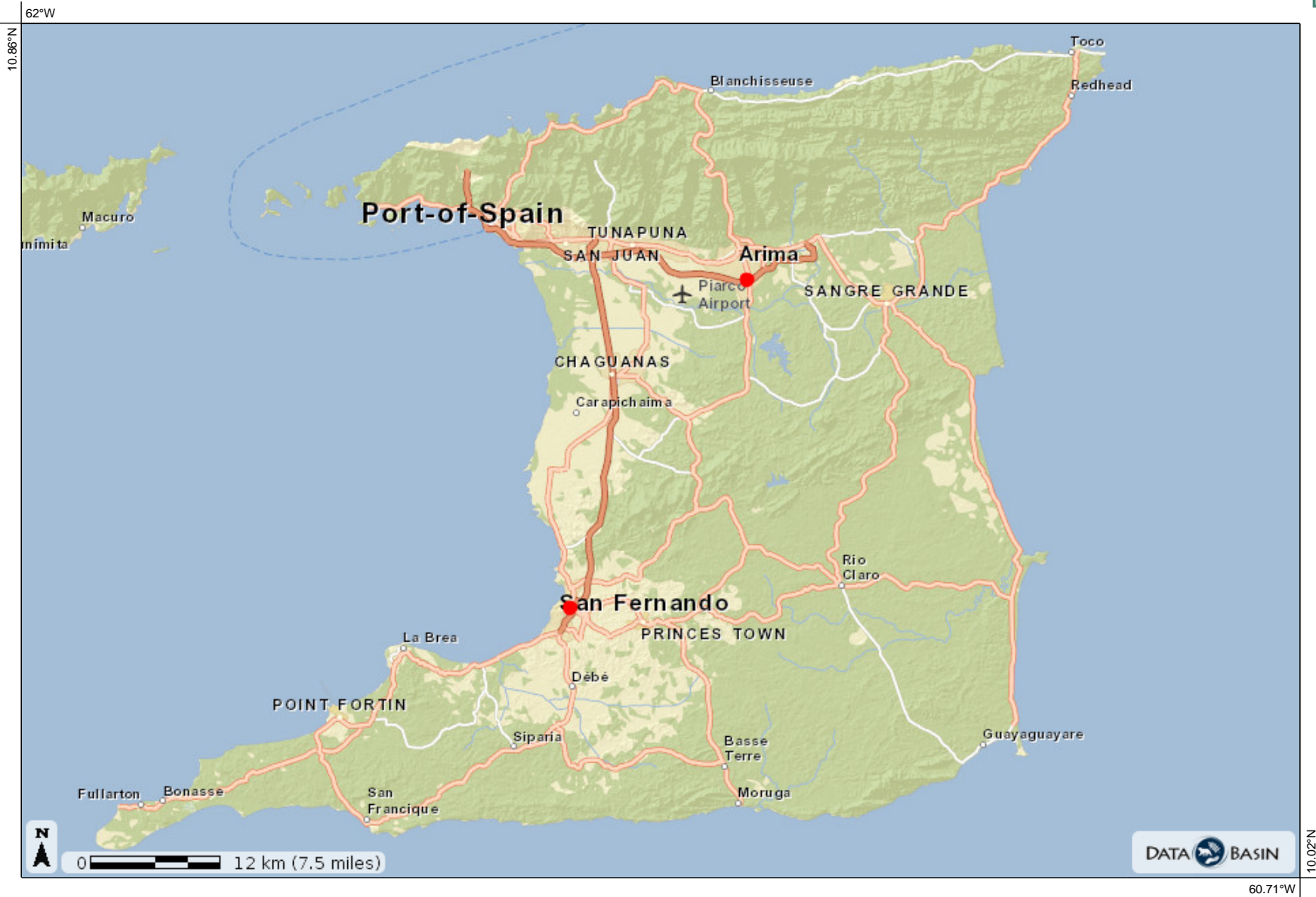
UR-L1005



# Trinidad

## Legend

● TT-L1026



TT-L1026

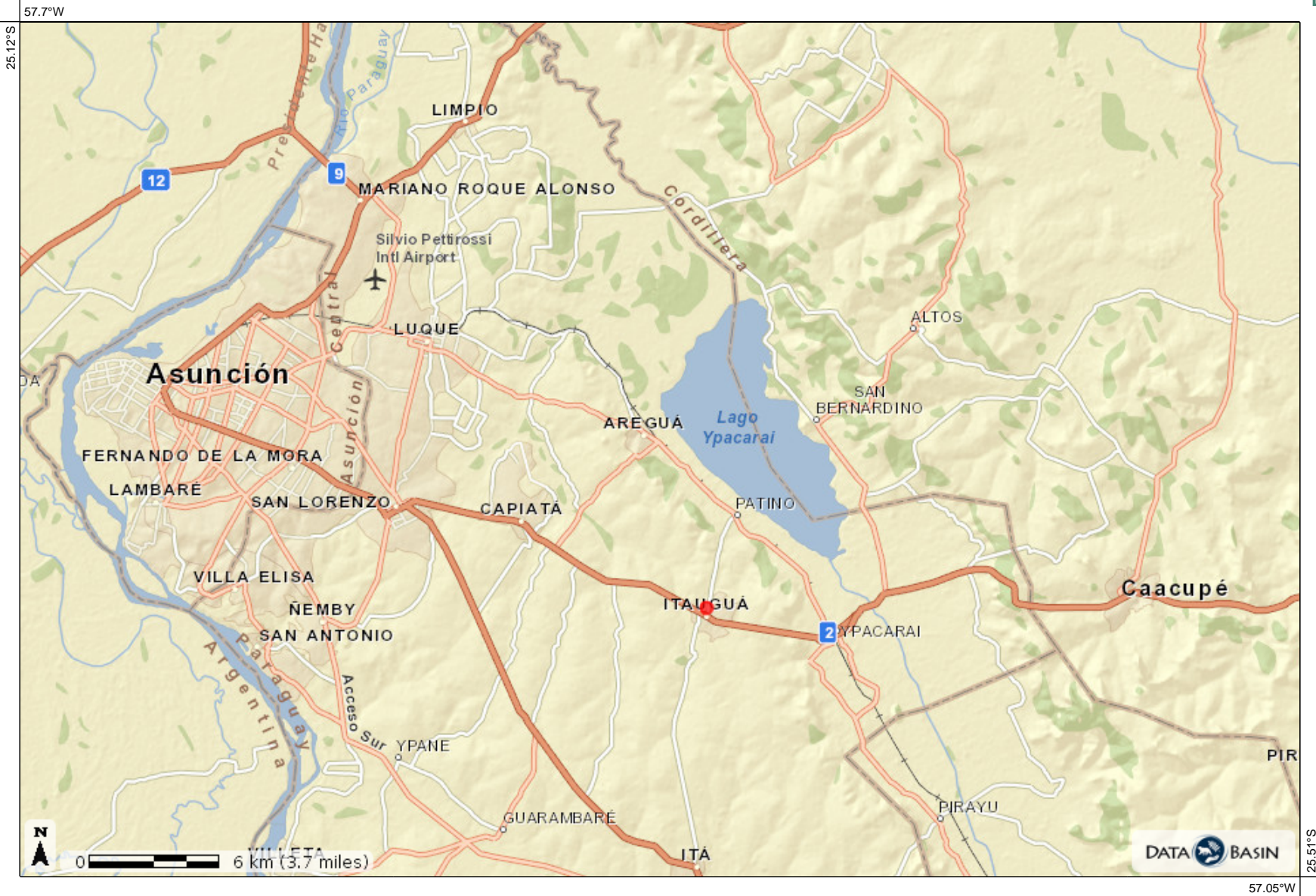




# Paraguay- central region and Lago Ypacarai

## Legend

● PR-L1060




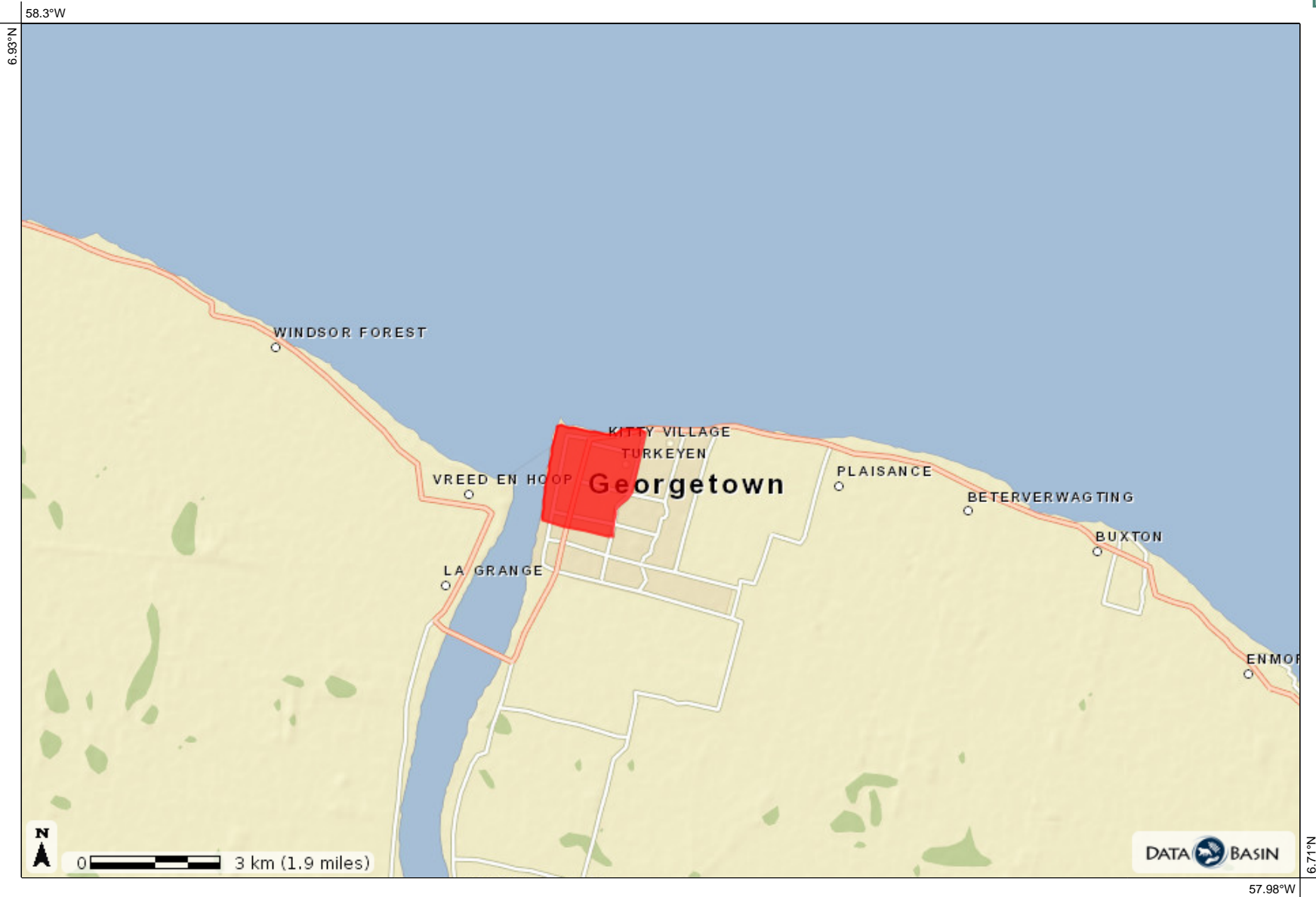
PR-L1060



# Georgetown, Guyana

## Legend

 GY-L1025



GY-L1025

