Quantifying Watershed Restoration Benefits in Community Water Partnership Projects

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Prepared for:

The Coca-Cola Company

in collaboration with

The Nature Conservancy
Protecting nature. Preserving life.

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EXECUTIVE SUMMARY

The Coca-Cola Company is interested in gaining a better understanding of the watershed restoration benefits derived through its Community Water Partnership (CWP) Projects. This report describes the outcomes of an effort to quantify those benefits and advance the development of computational methodologies for this purpose. The work described in this report builds on previous “Phase I” activities described in a full report (LimnoTech and TNC, 2008) and summarized in a White Paper (DePinto, et al., 2009), and updates numbers presented in an August 5, 2009 Phase II report (LimnoTech and TNC, 2009).

For many of the CWP projects reviewed as part of this project, watershed restoration benefits are being realized through multiple activities. To date, a total of 61 activities implemented through 50 CWP projects have been quantified. The remaining projects were not quantified because implementation is still in its early stages, available information was insufficient to make an estimate, or the types of benefits are not quantifiable.

The current estimate is that the projects implemented by the end of 2009 will provide a benefit of approximately 28.8 billion liters/year, representing 21% of the product volume generated by TCCC facilities. Projects implemented by the end of 2013 are estimated to provide a beneficial gain of water of approximately 56.8 billion liters/year, representing 34% of the product volume generated by TCCC facilities (Table ES-1). An annual increase in product volume of 5.25% was assumed (per information provided by Greg Koch).

The pollution reduction benefits of these activities were also estimated as part of this exercise. The primary focus of most of the CWP projects that address water quality problems is erosion control, so the reduction in sediment yield was estimated where relevant. The preliminary estimate is that the 61 CWP activities evaluated will reduce sediment load in 2009 by 3,018,392 metric tons/year, increasing to 3,577,769 metric tons by 2013. These reductions will significantly improve the quality of receiving waters in those watersheds.

Table ES-1. Preliminary Estimate of Watershed Restoration Benefits

Year	Product Volume (billion L/yr)[1]	Estimated Quantity (billion L/yr)	Percent of Product Volume[1]
End of 2008	129.0	15.7	12%
End of 2009	135.8	28.8	21%
End of 2010	142.9	34.2	24%
End of 2011	150.4	40.7	27%
End of 2012	158.3	54.8	35%
End of 2013	166.6	56.8	34%

[1]Assumes a projected annual increase in product volume of 5.25% during 2009-2013.

Figure ES-1 shows the increase in estimated watershed restoration benefits compared to projected product volume through 2020. The ratio of benefits to product volume is also shown (black line). The graph will be refined and extended in time in the future as more information about ongoing projects becomes available, and new projects are implemented. Restoration benefits for ongoing infrastructure-dependent projects beyond 2013 will need to account for depreciation.

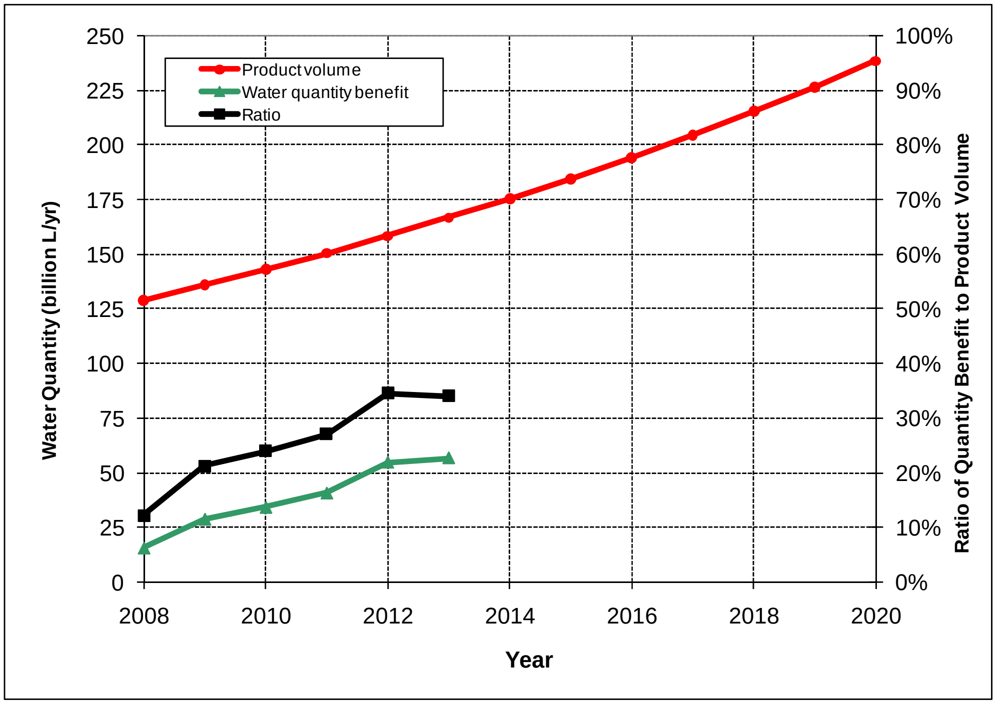

Figure ES-1. Projected Benefits Compared to Projected Product Volume

This report provides details on the quantification approach used to derived these estimates, describes the development of the computational engine, and discusses findings and associated recommendations.

1. INTRODUCTION

This document represents an essential component in the development of methods to support the advancement of water stewardship and sustainability. It builds on previous work conducted in 2008 (LimnoTech and TNC, 2008) and described in a White Paper (DePinto, et al., 2009). These previous “Phase I” activities focused on characterization of TCCC’s Community Water Partnership (CWP) projects, identification of potential activities that would enhance water resources, and development of a conceptual framework for calculating those enhancements. It also builds on previous Phase II work conducted in 2009 (LimnoTech and TNC, 2009) that began to build the computational portion of the conceptual framework, and test its utility by using it to develop an initial estimate of the total water quantity and quality benefits derived from completed and ongoing CWP projects. This Phase III work provides an update to the Phase II report and quantifies the benefits of additional projects and activities.

1.1 SUMMARY OF PHASE I PROJECT OUTCOMES

During Phase I, the project team reviewed all CWP projects and identified those that were primarily focused on water quantity and/or quality in the watershed within which they were implemented. Two other categories of projects are those directed at socio-economic benefits (i.e., water access), and those focused primarily on education or outreach.

The criteria for what “counts” as a watershed restoration activity in this context were determined to be those projects that are: 1) directed at the sustainable and equitable use of water; 2) focused on conserving or restoring water quantity and/or water quality; and 3) quantifiable in terms of their watershed restoration benefits.

Based on these criteria, nine categories of watershed restoration actions were identified through Phase I:

1. Agricultural land practice changes
2. Stormwater management
3. Land use/land cover alterations
4. Hydraulic/hydrologic waterbody alterations
5. Recaptured leakage from water systems
6. Wastewater treatment
7. Biologic management
8. Water reuse
9. Rainwater harvesting and aquifer recharge

These categories encompass a wide range of activities that can be targeted at almost any specific water quantity and/or quality problem that exists in a watershed. It is feasible, given sufficient data and information about the project, to quantify any of these actions to allow evaluation of their effect on the sustainable use of water in a watershed.

It is noteworthy that several of these watershed restoration actions have been identified as adaptation activities to reduce vulnerability to climate change. Specifically, the Intergovernmental Panel on Climate Change (IPCC) identified agricultural practice changes, hydraulic/hydrologic waterbody alterations, biologic management, water reuse, and rainwater harvesting as possible adaptation activities (IPCC, 2007; Bates, et al., 2008). Some of the restoration activities are also known to sequester carbon. For example, agricultural practices that improve water-holding capacity such as reduced tillage may also sequester carbon through both increased crop productivity and reduced soil respiration (Bates, et al., 2008). Tree plantings can also sequester significant quantities of carbon, and the slowing of forest degradation can significantly contribute to avoided emissions (Bates, et al., 2008). Furthermore, some of the restoration actions can result in an energy savings, with associated carbon-related benefits. For example, stormwater management practices that involve green infrastructure can reduce pumping and treatment needs, and reduce energy use overall. While these additional benefits are recognized, only the benefits on water quantity and quality are quantified in this report.

The project team also developed a methodology and conceptualized a framework that could be used to quantify the water quantity and quality changes associated with projects such as those implemented through the CWP, as well as other potential projects that TCCC might undertake in achieving its water stewardship goals. The conceptualized tool is referred to as the Watershed Restoration Benefits Evaluation Tool (WRBET).

1.2 PHASE II AND PHASE III OBJECTIVES

The goal of Phase II was to develop an initial estimate of the total water quantity and quality benefits derived from the CWP projects implemented to date, and to begin to build the computational engine of the WRBET. At the same time, there was interest in disseminating the conceptual framework developed in Phase I to the broader water stewardship community for review and comment, in the interest of further advancing these concepts and methods. This was accomplished during Phase II through the development of a White Paper that has been distributed to the Water Footprint Network for review and comment (DePinto, et al., 2009).

Phase III activities included continuation of the quantification work. The quantification of watershed restoration benefits from CWP projects represents an exploration of methods as well as an evaluation of the challenges involved in compiling data inputs required for those computations. A wide variety of project and activity types were evaluated, with a range of data available to support the quantification process. Recommendations for improving the quantification process are provided in Section 3.

1.3 PHASE II AND III APPROACH

Four steps were conducted as part of Phase II, as described in the following sections:

1. The list of CWP projects that have the potential to generate watershed restoration benefits was expanded to include new projects described in the 2009 Replenish Report.
2. Key data and information needed to quantify watershed restoration benefits were obtained and compiled;
3. Development of the "computational engine" of the WRBET was conducted; and
4. Watershed restoration benefits were estimated for selected activities.

The Phase III update expanded the quantification work to include additional CWP projects that have the potential to generate watershed restoration benefits. Similar to Phase II, key data and information were obtained and compiled and benefits were estimated for selected activities using the same approach taken for Phase II quantification.

1.3.1 Identification of CWP Watershed Restoration Projects

During Phase I, the approximately 140 Community Water Partnership (CWP) projects described in the 2008 Replenish report (TCCC, 2008) were categorized, and 47 projects (approximately one-third) were found to be focused primarily on water quantity and/or quality. The 2009 Replenish report (TCCC, 2009) published in February, 2009 describes more than 200 CWP projects in 60 countries. On the publication date, 57 projects had been completed, and the remaining projects were in progress or scheduled to launch within the first quarter of 2009.

The new projects in the 2009 report and others identified by TCCC staff were reviewed to identify projects that potentially involve activities that may fall into one of the nine categories of restoration activities. A total of 81 CWP projects were determined to potentially involve these types of activities based on the project descriptions in the 2009 Replenish report. A list of these projects is provided in Appendix A, along with the status of quantification work for each project.

As part of this review, the list of nine potential watershed restoration activity types developed during Phase I was revisited based on the additional information provided in the 2009 Replenish Report (TCCC, 2009) and the associated CWP database. It is recommended that the leak repair category be expanded to include water conservation measures that may be implemented as part of a CWP project (e.g., installation of water-saving fixtures in homes).

1.3.2 Compilation of Data & Supporting Information

Site-specific data and information are needed for each project before restoration activities can be quantified. To accomplish this, a survey was developed that was directed at gaining a better understanding of the project objectives, specific restoration activities being implemented, important characteristics of the watershed within which the project is taking place, and other information specific to the watershed and the project. The full survey is provided in Appendix B. The level of detail provided in the responses received varied considerably. The project team followed up via email and phone calls with numerous contacts in an effort to obtain as much of the required information as possible.

1.3.3 Development of Computational Engine

The Phase I report provided specific recommendations with respect to developing a "Watershed Restoration Benefits Estimation Tool" (WRBET) to assist in quantifying water quantity and quality benefits resulting from specific actions within a watershed (LimnoTech and TNC, 2008). The approach recommended for constructing the WRBET involved the development of two primary components: 1) a *computational engine* to provide a suite of methods to perform the calculations required to quantify benefits, and 2) an *expert system* to interact with the user to obtain the necessary information to support the benefit calculations. In terms of software development, Phase II focused on the development of the computational engine component of the overall WRBET framework.

The Phase I report recommended that a suite of process-based methods be incorporated into the WRBET computational engine to quantify changes in water quantity and quality for a variety of physical conditions and management situations. Specific recommendations were made for methods to compute changes in various pathways of the hydrologic budget, including runoff and infiltration, evapotranspiration, and groundwater storage and outflow. The watershed hydrologic budget and Runoff Curve Number methods were proposed for use in quantifying changes in runoff and infiltration quantities. For water quality, the Modified Universal Soil Loss Equation (MUSLE) method was recommended for quantifying changes in sediment runoff and yield. Several existing watershed models were identified as sources for these methods, including *Hydrologic Simulation Program – FORTRAN* (HSPF), the *Soil & Water Assessment Tool* (SWAT), and the *Watershed Analysis Risk Management Framework* (WARMF).

The development of the computational engine involved encoding key watershed algorithms, which were adapted from the HSPF and SWAT model source codes. As noted above, these algorithms use various process- and empirically-based calculations to compute water runoff and infiltration, soil water storage and movement, evapotranspiration, and groundwater storage and outflow. Several of these methods, including the Runoff Curve Number method and the MUSLE served as the basis for quantifying water quantity and quality benefits for reforestation, revegetation, riparian buffer, and conservation activities identified for the collection of CWP projects. The hydrology approach represented in the computational engine is similar to the approach described by Limbrunner et al. (2006).

All of the methodologies and models selected as the basis for the WRBET computational engine were originally developed and applied in the United States. Modeling tools for predicting watershed quantity and quality have also been developed in a number of other countries, including the United Kingdom, Canada, Australia, the Netherlands, and Denmark (see Appendix C in the Phase I report for details). The rationale for selecting the proposed suite of U.S.-based tools was three-fold:

1. The proposed U.S.-based methods have a range of capabilities that are similar to, or more advanced than, watershed modeling tools developed in other countries.

2. The proposed methods are public domain and can be freely used and modified. As a result, these methods can be efficiently extracted from their native source codes and integrated into the WRBET computational engine. Conversely, several of the more advanced watershed modeling tools available internationally (e.g., Netherlands, Denmark) require substantial investment in commercial software products.

3. The SWAT model, including the associated Runoff Curve Number and Universal Soil Loss Equation methods, has been extensively applied to watersheds in a number of countries on several continents (Gassman et al., 2005). For example, peer-reviewed publications can be found in the literature for SWAT applications in India (Tripathi et al., 2003), Finland (Grizzetti et al., 2003), China (Zhang et al., 2003), Tunisia (Bouraoui et al., 2005), United Kingdom (Shepherd et al., 1999), and Greece (Varanou et al., 2002), among other locations outside of North America.

Additional details related to the development of the WRBET computational engine and the application of specific methods to support Phase II and Phase III quantification work are provided in Appendix C.

1.3.4 Quantification of Restoration Benefits

The quantification of benefits from watershed restoration activities requires an accounting of the changes in the overall water budget of the local watershed system. As discussed in Section 1.3.3, numerous methods and modeling tools exist that can address these pathways. These quantitative tools generally fall into two categories: 1) empirically-based methods, which rely strongly on observations and data collected from study sites; and 2) process-based methods, which are derived from theoretical considerations and then calibrated and verified based on site-specific observations. In addition to these methods, a number of restoration benefits can be quantified using direct measurements based on available data. Simple and more complex empirical and process-based methods, as well as direct measurements were used to support the quantification work.

An example of a project using direct measurements is the quantification of reduced water use due to leak repair projects, such as the Big Spring Watershed Protection project. In this case, the water savings due to leak repairs was measured using meters, and the reported annual savings is the watershed restoration benefit. An example of the use of more complex empirical and process-based methods is a project involving cropland management, such as the Paw Paw River Watershed Restoration Project. In this case, The Runoff Curve Number method as implemented in the *Soil & Water Assessment Tool* (SWAT) (Neitsch et al. 2005) was used to estimate the decrease in surface water runoff for the conversion of conventionally-tilled straight row cropland to conservation tillage. The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in SWAT was used to compute the change in sediment erosion and solids washoff that would occur as a result of converting conventionally tilled cropland to conservation tillage.

The changes in water quantity were estimated in units of million liters (ML) per year. Changes in water quality were estimated in units of metric tons (MT) per year.

2. QUANTIFICATION RESULTS

A review of information in the 2009 Replenish report and associated database indicated that 81 of the more than 200 CWP projects (approximately 40%) potentially involve activities that may provide watershed restoration benefits (see Appendix A). Many of these projects were found to involve multiple restoration activities. For example, the TCCC-WWF Partnership Rio Grande/Rio Bravo project was determined to involve 11 restoration activities, including water transfers to support environmental flows, reforestation, and wastewater treatment. Eight of these activities could be quantified, and each activity was addressed separately.

For the purpose of this report, the term “project” refers to each of the approximately 200 projects described in the 2009 Replenish report and associated database. The term “activity” refers to the specific restoration actions that are being implemented under each project.

2.1 CHARACTERIZATION OF WATERSHED RESTORATION ACTIVITIES

A tally of the number of CWP projects that involve watershed restoration activities is provided by activity type in Table 2-1. The total number of projects shown in the table is larger than the 81 CWP projects determined to involve watershed restoration activities because many projects involve multiple activities. More than one-third (32) of the 81 projects involve agricultural land practice changes (e.g., irrigation improvements). Land use/land cover alterations (e.g., reforestation) are also a component of more than one-third (28) of the 81 projects.

Table 2-1. CWP Projects by Activity Type

Activity Type	Number of CWP Projects
1. Agricultural land practice changes	32
2. Stormwater management	7
3. Land use/land cover alterations	28
4. Hydraulic/hydrologic waterbody alterations	10
5. Recaptured leakage from water systems	4
6. Wastewater treatment	8
7. Biologic management	6
8. Water reuse	3
9. Rainwater harvesting for aquifer recharge	8

The information obtained through this phase of work was sufficient to quantify benefits from 61 activities being implemented through 50 of the 81 CWP projects involving watershed restoration activities. One of these projects, the Expansion of

Yelnya Bog in Belarus was quantified, but the results were not included in any benefit tallies pending review of the results by parties involved in the project. The remaining projects/activities were not quantified because insufficient information was received within the project timeframe, or the project is in its early stages, or the benefits are not quantifiable.

2.2 ESTIMATES OF WATERSHED RESTORATION BENEFITS

This section provides the results of the quantification work to date. Water quantity and water quality benefits are discussed separately below. Additional details are provided in Appendices D and E. Appendix D is a spreadsheet that includes details on each activity with sufficient information to quantify. The total estimated benefit is provided in columns K and M of the sheet named "benefits tracker" in the attached Excel workbook. This quantity is adjusted based on TCCC's percent contribution to the project (as shown in column I). For projects that TCCC did not solely fund, the total benefit was adjusted based on the estimated funding split. The total benefit is also adjusted according to the timeline for implementation, as shown in columns Q through V. For many of the projects, such as those directed by WWF, implementation follows years of study and negotiations, and those future benefits are reflected in the percentages shown in the table for the 2008-2013 period.

The supporting documentation for each project that was quantified is provided in individual fact sheets, which are included in Appendix E. Each fact sheet includes a basic description of the activity with watershed restoration benefits, contact information, the water quantity and/or water quality benefit that was estimated, the approaches used to make the estimates, and the source of data and information used to compute the quantity/quality benefits.

Several activities were investigated but not quantified as part of this phase of work because information was insufficient or the type of benefit could not be quantified. Fact sheets for these activities are included in Appendix F.

2.2.1 Water Quantity Benefits

The current estimate is that the projects implemented by the end of 2009 will provide a benefit of approximately 28.8 billion liters/year, representing 21% of the product volume by TCCC facilities. Projects implemented by the end of 2013 are estimated to provide a beneficial gain of water of approximately 56.8 billion liters/year, representing 34% of the product volume by TCCC facilities (Table 2-2). An annual increase in product volume of 5.25% was assumed (per information provided by Greg Koch).

Table 2-2. Preliminary Estimate of Water Quantity Benefits

Year	Product Volume (billion L/yr)[1]	Estimated Quantity (billion L/yr)	Percent of Product Volume[1]
End of 2008	129.0	15.7	12%
End of 2009	135.8	28.8	21%
End of 2010	142.9	34.2	24%
End of 2011	150.4	40.7	27%
End of 2012	158.3	54.8	35%
End of 2013	166.6	56.8	34%

[1]Assumes a projected annual increase in product volume of 5.25% during 2009-2013.

2.2.2 Water Quality Benefits

The pollution reduction benefits of these activities were also estimated as part of this exercise. The primary focus of almost every CWP project that addresses water quality was determined to be erosion control, so the reduction in sediment yield was estimated where relevant. The preliminary estimate is that the CWP activities evaluated will reduce sediment yield in 2009 by 3,018,392 metric tons/year, increasing to 3,577,769 metric tons by 2013 (Table 2-3). These reductions will significantly improve the quality of receiving waters in those watersheds.

Table 2-3. Preliminary Estimate of Water Quality Benefits

Year	Estimated Reduction in Sediment Yield (MT/yr)
End of 2008	2,742,396
End of 2009	3,018,392
End of 2010	3,147,073
End of 2011	3,269,547
End of 2012	3,577,769
End of 2013	3,577,769

2.2.3 Example Calculations

The six examples below illustrate how watershed restoration benefits were quantified for a selection of projects that are diverse in terms of geographic location, spatial scale, restoration activities, the types of benefits attained, and the complexity of the approaches used to quantify those benefits. The fact sheets in Appendix E provide details on these and the other CWP projects that were quantified as part of Phase II and Phase III activities.

2.2.3.a Big Spring Watershed Protection, U.S.

Big Spring is an example of a leak repair project that involved a simple quantification approach based on readily available data, and resulted in a large benefit in terms of water quantity. Big Spring is an approximately 16 million gallon per day water source serving the Borough of Bellefonte in Pennsylvania. Coca-Cola (the CCDA Waters, LLC - Milesburg plant) offered to partner with the Borough Council to fund improvements in its infrastructure in lieu of increasing water fees. The Coca-Cola plant partnered with the Borough to support improvements and provide sonic testing of the piping system to detect and repair leaks from 2006 to the present.

Water savings from the detection and repair of leaks in the water supply distribution system were obtained through the CWP survey. Since 2006, third-party leak detection technicians have identified 90 leaks with estimated water savings of 1,990,520 gallons of water/day. Based on this information, a water savings in terms of reduced pumping of 2,750 ML/yr was estimated. For the 5-year projection it was assumed that the system would continue to function as in 2008. Additional water savings over the next 5 years as a result of the ongoing leak repair program were not quantified because data on future activities were not available at the time of the survey.

2.2.3.b Rainwater Harvesting and Aquifer Recharge, India

The India rainwater harvesting/aquifer recharge projects are examples of projects that were quantified using an empirical approach, and yielded large water quantity benefits. Coca-Cola India, in conjunction with partner organizations, is installing, restoring and maintaining rainwater harvesting and aquifer recharge structures to increase access to clean water and provide water for aquifer recharge. The objective is to collect rainwater for multiple uses including aquifer recharge. Currently, there are approximately 600 rainwater harvesting structures at approximately 270 locations in communities throughout India. Structures include rooftop and surface rainwater catchments that collect water for storage and distribution and/or infiltration to recharge aquifers. Examples of these structures include storage tanks, check dams, ponds, traditional step-wells and aquifer recharge shafts. Maintenance activities are conducted at the structures to promote efficient operation and prolonged lifespan.

The India Division has estimated the rainwater harvesting potential and estimated recharge of rainwater harvesting (RWH) and artificial aquifer recharge (AAR) projects using the following equation and coefficients:

***[Estimated Recharge]* = [*Catchment Area*] x [*Annual Precipitation*] x [*Catchment Coefficient*]**

where:

- [Catchment Area] (m^2) = surface area of the catchment(s) utilized to harvest precipitation for a given project;
- [Annual Precipitation] (m^2) = best available annual rainfall data for a given location; and
- [Catchment Coefficient] = coefficient representing the estimated efficiency for each catchment type.

For projects that utilize collected precipitation for artificial aquifer recharge and/or aquifer storage and recovery (ASR), the Division assumes that this value is equal to the value calculated using the above equation. In essence, 100% of the precipitation captured is assumed to be recharged.

India Division's estimates were provided in a spreadsheet. The total benefit in terms of recharge estimated is 2,658 ML/yr in 2008 and 3,249 ML/yr in 2009. These estimates do not include projects that the India Division is in the process of verifying.

The India project data are currently undergoing further analysis using a probabilistic modeling tool developed by Delta Consultants. The model more rigorously estimates the volume of rainwater captured by a rainwater harvesting (RWH) project and artificially recharged to the aquifer, if applicable, over a period of one year using readily available and limited site-specific information. The model is currently under revision based on a Subject Matter Expert (SME) review process instituted in March-April 2009. Upon finalization, India project data will be analyzed through the model, providing for more robust estimates of water quantity benefits.

2.2.3.c Conserving the Mekong: Tram Chim National Park, Vietnam

This example involves a hydraulic/hydrologic management project that was quantified using simple calculations and yielded a large benefit in terms of a change in direct streamflow. Tram Chim National Park (TCNP) is the site of a demonstration project of the Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme. Tram Chim is a depressed wetland area within the Plain of Reeds whose protected grasslands and Melaleuca forests offer valuable habitat for many species, including the Sarus Crane (*Grus antigone*). The project objectives are to mitigate flood and drought impacts, maintain groundwater levels and reduce saline water intrusion, and demonstrate a change in the way of thinking about management practices and policy.

A comprehensive examination of water management in the park showed that prevalent fire prevention practices resulted in retention of extra water during the dry season in the largest (4700+ ha) zone of the park. At the same time, failure of control structures led to premature drying in two smaller zones (750+ ha). Optimization of water level management in the largest zone (moving towards a more natural hydroperiod) and repair of the control structures for the other two zones will contribute to dry-season replenishment. This replenishment volume will mitigate flood and drought impacts in the Plain of Reeds as well as in the downstream Mekong Delta. It will also contribute to maintenance of groundwater levels in the Tram Chim vicinity and reduce saline water intrusion at the edge of the Mekong Delta.

The replenishment volume for the largest zone (Zone A1) was calculated as the added volume of water discharged from Zone A1 when operating under the revised Tram Chim target water levels. Monthly discharge volumes under the revised levels were calculated as the difference between beginning-of-month and end-of-month volumes as estimated from park elevation zone data in conjunction with the targets. The discharge volumes under the previous management plan were calculated using reported water levels for the years 2002-2006. The discharge volumes for 2002-2006 were calculated by converting monthly water levels into volumes, then averaging across all months. Replenishment for the smaller zones (A3 and A4) was calculated as the added volume of water stored in Zones A3 and A4, which were previously dry. Target water levels of 123 cm for Zone A3 and 137 cm for Zone A4 were selected as the comparison points. The total additional volume was estimated to be 11,400 ML.

In addition to increased water availability, these actions will lead to water quality improvements. In conjunction with mimosa eradication and Melaleuca restoration, water quality will improve through reduction of acidity and through increased filtration. These water quality benefits were not quantified due to insufficient data.

2.2.3.d Rio Grande/Rio Bravo Basin – Pandeño Spring, Mexico

Pandeño Spring is an example of a hydraulic/hydrologic management project that involved simple calculations and yielded a large benefit in terms of decreased groundwater pumping. This thermal spring is about 200 square meters in size and located near the Rio Conchos in Mexico. The spring is home to an endemic fish, the Julimes pupfish (*Cyprinodon julimes*), a new species being currently described and considered to be among the three vertebrates that live at the highest temperatures on the planet. It is among several springs impacted by increasing pumping that depletes the local groundwater supply.

The objectives of this project were to reestablish a viable population of endemic pupfish in Pandeño Spring, develop a demonstration project for a legal and administrative framework authorizing environmental flows, and establish the spring as a protected area. Technical studies to support water rights acquisition were conducted to determine the needs of the fish. It was determined that 70-80 L/sec in water rights ultimately needs to be secured. The 2009 savings was based on the quantity of water that was recently secured (50 L/sec, or 1,578 ML/yr). Projected future acquisitions of 25 L/sec (resulting in a total of 75 L/sec) were assumed to take place by 2011 based on information provided by WWF. Therefore the benefit obtained by 2011 was estimated to be 75 L/sec, or 2,370 ML/yr.

2.2.3.e Flint River Watershed Restoration, U.S.

The Flint River example illustrates how benefits were quantified for a project focused on agricultural land practice improvements related to improved irrigation practices through remote soil moisture monitoring. The objective was to provide a demonstration project for decreasing irrigation water use in the region. Based on previous studies it is known that remote soil moisture monitoring can reduce irrigation application by 1-2 applications per season. However, the reduction volume is dependent on rainfall which determines irrigation rate (currently 12 inches in a dry year, 10 inches in an average year, and 8 inches in a wet year). This ongoing project will track soil conditions in real time and reduce the number of applications based on crop need.

For simplicity, it was assumed that 100% of the water not pumped from the aquifer can be claimed as a benefit. In other words, it was assumed that only a small percentage of irrigation water percolates to the aquifer after an application, and that the rest is lost to plant uptake/transpiration, evaporation from the upper soil zone, and interflow/runoff. The water quantity benefit was calculated based on the pre- and post-project irrigation application rates provided by TNC in the survey response. The annual water savings in terms of reduced groundwater usage was estimated to be 154 ML/yr.

2.2.3.f Coca-Cola Reforestation Program, Mexico

This large-scale, multi-year project is an example of a land use/land cover alteration project with large benefits that were quantified using more complex empirical and process-based methods. TCCC, the Comision Nacional Forestal (Conafor), and Pronatura Mexico are reforesting 25,000 hectares of priority ecosystems (forests, jungles, and wetlands) that supply water to different towns nationwide. The objectives are to reduce runoff and increase infiltration, reduce sediment erosion/runoff, and restore forest habitat. Approximately 30 million trees will be planted in deforested lands to mitigate climate effects, restore habitat and biodiversity, rehabilitate aquifers and watersheds, and promote economic and community growth.

The decrease in runoff for the conversion of unforested land to forested land was estimated using the Runoff Curve Number method as implemented in the *Soil & Water Assessment Tool* (SWAT) (Neitsch et al. 2005). Water quantity calculations were focused on estimating the change in runoff volume because runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield, and predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas. The benefit in terms of runoff reduction was estimated to be 9,400 ML/yr.

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the *Soil & Water Assessment Tool* (SWAT) was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method, and daily maximum hourly rainfall intensities were estimated for year 2000. The reduced annual sediment yield was estimated to be 770,472 MT/yr.

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3. DISCUSSION OF FINDINGS

The results of the quantification work highlight the wide diversity of CWP projects, in terms of geographic location, spatial scale, project objectives, and outcomes. For example, CWP activities include installation of rain gardens and rain barrels to reduce stormwater impacts, rainwater harvesting to recharge aquifers, agricultural practice changes to reduce water used in irrigation, and restoration of environmental flows through large-scale water transfers. This diversity of activities is generating a wide range of watershed restoration benefits, which were quantified through this project using a variety of simple calculations and empirical and process-based methods.

The concepts and terminology surrounding water stewardship are evolving, and the use of the term "watershed restoration benefit" is used in this report in place of the term "offset." Based on the outcomes of this quantification work, the word "restoration" was determined to be a fitting term for the benefits derived from CWP projects. As examples: rain gardens *restore* infiltration function in developed landscapes with high imperviousness; riparian buffers *restore* filtering functions that had been lost when riparian plants were removed for agriculture or other purposes; leak repairs reduce the water extracted from a river and, in doing so, help *restore* the natural flow regime; and reforestation reverses the stress on the natural hydrology that had been caused by the cutting of trees or fires and helps *restore* the natural hydrologic functions.

The primary findings of this phase of work are discussed below, with recommendations where appropriate. The findings are organized by key topic area.

3.1.1 CWP Project Objectives

The essential first step in the quantification process involved gaining an understanding of the water problem that led to the project, and the project objectives. The project objectives define the benefits to be quantified, and the methods for doing so. For some projects, the objectives were not immediately apparent from the description of the project activities, particularly when the objectives are stated very broadly (e.g., "conserve freshwater resources"). For this reason, the initial focus was to understand the specific water quality problems and goals of each project. With this information, the watershed restoration benefits to be quantified could be determined.

As an example, projects involving removal of invasive plants can serve one or more purposes. In some cases, invasive species control measures are implemented because the plants are crowding out native vegetation and reducing wetland plant diversity. In other cases the plants take up large quantities of water compared to native vegetation. In a third case, the plants are removed because they cause physical alterations to the hydrology of a river system by trapping sediment and impeding flow. In the first case, the concern is not that the plants are impacting water quantity or water quality (or this is unknown), so watershed restoration benefits were not quantified (but improvements to biodiversity were noted). In the second case where the invasive plants are "thirsty", the reduction in groundwater uptake or improvement in baseflow due to removal efforts may be quantified. In the case of physical alterations, the benefit can be quantified in terms of the change in hydrology and hydraulics (e.g., change in water level, flow, area of floodplain inundation). In this way, the project objectives drive the selection of the benefit that is quantified, and the method for doing so.

The objective of many of the CWP projects is to improve water quality by reducing erosion and associated sedimentation. Approximately one-half of the 81 CWP projects that were identified as providing watershed restoration benefits involve activities directed at erosion control. This is not surprising, given the widespread consequences of erosion due to alterations of land cover and land uses. An example is the Gulf of Mexico, where nutrient loads due to erosion in the Mississippi River watershed have caused a "dead zone" to form off the coast of Louisiana. The Great Barrier and Mesoamerican Reefs, the focus of two TCCC-WWF Partnership projects, are another example of systems impacted by sediment and nutrient loads from watersheds where land disturbances have increased erosion.

The concepts related to watershed restoration benefits were evolving as this project progressed, and many contacts were not familiar with the purpose and basis for the quantification work. The CWP guidance document in preparation will highlight the need to define specific objectives in the framework of watershed restoration benefits.

3.1.2 Availability of Required Data and Information

A great deal of time and effort was expended to obtain the data and information required to quantify benefits. The survey developed through this phase of work provided a comprehensive list of the data and information needs, but many surveys were not returned, and the responses in the surveys that were returned were often insufficient. It was challenging in many cases to get in contact with the individuals with access to the necessary information, and there was often a need for numerous iterations. In some cases, important data needed to quantify benefits were not available. As an example, local daily precipitation data, a necessary requirement to quantify runoff reduction from reforestation projects, were found to be lacking or very limited for some projects.

Additional data gathering conducted after finalization of the Phase II report has resulted in the quantification of several additional projects. These include two TCCC-WWF projects: "Protecting the Mesoamerican Reef" and "Conserving the Mekong" (Chi River Watershed project). However, the challenges associated with obtaining data and information still preclude the inclusion of some projects in the most recent quantification effort. It is recommended that the data gathering effort continue in the next phase of work, and that additional projects be quantified as feasible.

The information-gathering effort will be reduced in the future by providing project implementers with guidance that includes the monitoring data and information that should be collected as the project progresses. In addition to providing guidance on defining project objectives, the guidance document will describe the site-specific information and monitoring data needed to quantify the benefits from each type of restoration activity. A list of specific questions similar to the survey prepared for this phase of work (see Appendix B) will be included in this guidance.

3.1.3 Interpretation of Quantification Results

The watershed restoration benefits provided in this report represent the change in water quantity and/or quality due to each individual CWP project activity. Ideally, it would be desirable to quantify the benefit in terms of the change in quantity and/or quality of the “blue water” of the watershed receiving the restoration action. However, assessing the actual impact of pollutant loads in the receiving stream, lake, reservoir, estuary, or aquifer requires an additional level of modeling and/or data collection and analysis. Because of the lack of sufficient data for the watersheds associated with most of the CWP projects, the benefits were quantified in terms of the local change in quantity and/or quality due to the project activity alone, and not in terms of its impact on the larger-scale watershed hydrology. Later phases of work will include compilation of the data needed to permit evaluation of the receiving water benefit, such as the increase in base flow in the river, increase in infiltration, or decrease in evapotranspiration loss.

It is important to note that no attempt was made during this phase of work to determine if the CWP projects that were quantified as part of this effort are located in the same watersheds as TCCC’s bottling plants. For this reason, the estimates of watershed restoration benefits are not linked to particular uses in the watersheds that may be impacted by TCCC’s water use.

The quantification results presented in this report represent the project team’s best estimate of watershed restoration benefits based on data and information available at the present time. The fact sheets in Appendix E provide descriptions of the data used and assumptions made as part of the quantification work. Many of the projects are ongoing, and the estimates can be refined as additional information and monitoring data become available as the project progresses.

3.1.4 Projects Generating the Greatest Benefits

The projects that are currently generating the largest watershed restoration benefits in terms of water *quantity* involve water transfers, reforestation/revegetation, ground restoration, land conservation, leak repair, irrigation improvements, rainwater harvesting for aquifer recharge and floodplain/wetland reconnection. The projects in these categories generating the largest benefits represent a total of 23 of the 60 project activities listed in Appendix D, and these activities provide 99% of the ultimate total water quantity benefit. In terms of water *quality* (e.g., sediment reduction), the projects generating the largest benefit involve reforestation and revegetation, land conservation, and agricultural practice improvements.

Several of the CWP projects are designed to be demonstration projects, and the estimated present-day benefits are small. Examples include the TNC Flint River

Watershed Project, the USAID project in Nigeria to promote the use of small-scale irrigation methods, and the Rio Conchos pilot wastewater treatment project. The true benefits of these projects will be considerably larger if/when these projects are scaled up in the future.

3.1.5 Quantification of Reforestation Benefits

Converting barren or sparsely vegetated land to a mature native forest is generally considered to be a very beneficial action for restoring a watershed back toward its natural hydrology. However, reforestation affects many pathways in a watershed's hydrologic budget. Furthermore, those changes will gradually be manifested over time as the forest matures. Therefore, quantification of the watershed restoration benefits of CWP reforestation actions required several assumptions. The annual runoff volume was computed using the Runoff Curve Number approach developed by the Natural Resources Conservation Service (NRCS). The annual sediment load was computed based on application of the Modified Universal Soil Loss Equation (MUSLE). The two benefits are computed separately; however, the estimated sediment erosion/washoff yield depends on the magnitude of the daily runoff estimates. The results of these calculations before (i.e., "pre-project") and after (i.e., "post-project") reforestation or securing land for conservation were used to evaluate the benefits of the project.

The rationale for estimating water quantity/quality benefits based on runoff volume reduction and sediment yield reduction is that the reforestation efforts are generally restoring the watershed to a more "natural" hydrology. For example, reduction in runoff represents a shift in the local hydrologic budget back to "natural" conditions. The presence of trees or other vegetation may increase evapotranspiration relative to pre-project conditions, but, again, this represents the natural condition. For conservation projects, the assumption is that the forested/vegetation land would be converted to a more degraded land use condition (e.g., agriculture or residential) if not secured for conservation. Therefore, the benefit is the runoff "savings" that occur as the result of not allowing the land to be developed. Based on this approach, the various CWP reforestation/revegetation and conservation projects comprise a significant contribution to the total watershed restoration benefits reported in Tables 2-2 and 2-3.

It should be noted that reforestation and soil conservation measures are generally reported in the literature to reduce peak flows and stormflows associated with deforestation, but the beneficial effects on base flows are less consistent and less well-documented (LimnoTech and TNC, 2008).

Water quantity and quality benefits associated with reforestation or revegetation were assumed to take effect in the year that plantings occurred. For conservation activities, benefits were assumed to be in effect at the point in time when the land was secured for conservation. These assumptions result in benefits becoming effective at the earliest point in time possible. In reality, the benefits associated with reforestation will tend to "ramp up" over time as the plantings grow and transform into a mature forest cover. A potential alternative to making reforestation benefits effective immediately would involve developing a schedule to represent the evolution of the forest cover from plantings to mature forest. For conservation projects, it could potentially be argued that benefits should not become effective until that point in time when development of the land would have occurred if the land had not been conserved. However, this information is often not available at the time the land is set aside.

To account for these issues and to refine the estimates of the benefits of these types of actions, it will be necessary to analyze the watershed response at a finer spatial and temporal scale and to consider the long-term development of the new conditions as the system matures. This will require more site data than it has been possible to acquire to date. The necessary data for refining this calculation will be included in the guidance that is developed during the next phase of this project.

3.1.6 Volume Equivalents of Water Quality Benefits

The benefits associated with CWP projects relative to water quality were quantified in terms of the change in mass loading and were not converted to a volume equivalent. There is interest in being consistent with the Water Footprint Network as to how grey water footprints are quantified and compared with blue and green water footprints. However, there is currently no consensus on how to express water quality changes in volume equivalents. The previous analysis of this question identified four possible approaches, which were summarized in Appendix D of the Phase I report (LimnoTech and TNC, 2008). Each of these approaches is summarized briefly below:

Waste Source Purification: This method focuses on the volume and quality of the waste source. The equivalent volume for a reduction in pollution is based on the percentage that the pollution load (or concentration) is reduced. Conceptually, it can be characterized as the percentage of the waste flow that is “purified.” It is simple to apply and requires little data but includes no consideration of actual receiving water impacts or benefits.

Water Body Purification: This method is similar to the waste source purification method but focuses on changes in the receiving water rather than the waste source. Conceptually, it can be described as the percentage of the receiving water that is cleaned up by a pollution control action. The core method only considers the incremental impacts and percentage of purification from the waste source, but refinements could consider the effect of other sources, background water quality, and/or a target for purification. This method is more complex and requires more data than waste source purification, but it considers actual water body impacts and benefits.

Waste Source Dilution: This method focuses on the waste source and the reduction in concentration or load. The equivalent volume is calculated by determining the equivalent clean water flow needed to dilute the waste source in order to achieve the same level of reduction in concentration as achieved with the actual pollution control action. This method does not consider receiving water conditions. This method is simple to apply and requires limited data but can result in some large, "unreal" calculations of benefits.

Water Footprint Reduction: This method involves calculating the grey water footprint for the waste source before and after the action is taken. The footprint approach involves calculating a dilution volume relative to a water quality target or criterion. This requires specification of a water quality target against which the footprint can be computed, but it does not consider actual impacts or benefits within a water body. Unlike the waste source dilution approach, this method has an implicit cap equal to the original grey water footprint.

The problem is that depending on the specifics of a particular project, each of these approaches can result in widely varying conversions to a volume metric for a given mass loading change. Other issues include the method by which multiple pollutant reductions are credited, and whether credit for pollution load reduction should be given if that action has no significant effect on a problem that exists in the receiving water body. The benefits, issues, and implementation details associated with converting pollutant loads to a volume currency require further investigation and discussion. Until a resolution of the issues is reached, it is recommended that the water quantity and quality components of water uses or restoration actions be accounted for separately, such that quantity changes only be used to address "blue" and/or "green" components of the footprint, and quality changes (i.e., pollutant load reductions) only be used to address the "grey" component of the footprint.

3.1.7 TCCC's Cost Share

The watershed restoration benefits provided in Table 2-2 and 2-3 for each year are the product of the computed restoration benefit (in ML/yr or MT/yr) and TCCC's cost share (as a percent). The estimates of TCCC's cost contribution were generally provided by the project contacts, who often indicated that they were unsure of the actual cost split, particularly for large projects involving multiple partners. The project team's research focused primarily on the technical details of the project activities, and far less time was dedicated to this important factor. The project team generally did not have access to financial information, and therefore relied primarily on the best estimates provided by contacts. If it was determined that the project would not have occurred without TCCC funding, the TCCC share was set at 100%. Another important question related to cost share to be resolved is the best way to handle situations where TCCC funding was used indirectly to achieve benefits (e.g., funding the writing of a grant).

The complexities related to TCCC's contribution could introduce a great deal of uncertainty into the final estimates of benefits. It is recommended that the collection of cost information continue, and that the current estimates then be refined accordingly.

3.1.8 Future Projections

The watershed restoration benefits provided in Tables 2-2 and 2-3 are provided by year, for the 2008-2013 period. The annual estimates are derived from the percent complete in each year based on the information provided by the contacts on the implementation schedule. In many cases, activities are in the planning stages, and the certainty of successful implementation was based on the opinions of project managers. Where it appeared very likely that the project would proceed as planned, the predicted benefits were quantified. Where it was determined to be too early to know what specific activities will occur as a result of ongoing efforts, no attempt was made to quantify the benefits. As an example, much important progress has been made in the Yangtze River Basin related to building and operating “green dams.” Efforts have involved essential stakeholder “ice breaking”, but the ultimate outcomes are currently unknown. As another example, TCCC-WWF’s Southeast Rivers and Streams project has been primarily focused on influencing policies and regulations related to stormwater management that will ultimately reduce stormwater loads and related impacts, but it would be premature to quantify the benefits of those activities.

The benefits reported for each year are the benefits generated at the end of that calendar year. When an activity was reported to be completed during a given year, it “counted” toward the end-of-year benefit for that year.

It is important to note that the success of CWP projects in terms of attaining the full watershed restoration benefits and the length of time that a realized benefit will persist is not always known. Post-monitoring data are not often available for completed projects, and the success of ongoing or planned projects is uncertain. Furthermore, information on the long-term maintenance of existing projects is generally not available. As an example, for projects involving removal of invasive species, plans to continue removal are dependent on continued funding and other factors. For projects involving irrigation infrastructure improvements, the long-term maintenance of those systems is also dependent on continued funding. For this reason, benefits were projected out to 2013 and no longer, based on the assumption that the projects will continue to function for at least 5 years and “depreciation” of benefits is not necessary.

3.1.9 Additional Benefits Not Quantified

Through this project, water quantity and water quality benefits associated with a wide range of projects were successfully quantified. The scope of the Phase II and III effort does not, however, reflect the many other important benefits from these projects, including habitat improvement, increased biodiversity, and carbon sequestration. As an example, the removal of a small dam as part of TNC’s Etowah River Watershed Conservation Partnership project did not affect the flow regime and generate watershed restoration benefits, because it was a run-of-river dam. However, the dam removal did re-establish stream reach connectivity, thereby enabling fish passage and providing important habitat quality improvements. The best way to include these important benefits in a water certification framework warrants further discussion.

The estimates of watershed restoration benefits also do not include savings in energy use due to less water use or improvement in water quality. For example, some restoration activities such as reduced water use for irrigation result in lower energy use (and associated water use) because less water is pumped through the system.

The results presented in this report also do not consider the watershed restoration benefits from new projects without current commitments or planned expansions of current projects that extend beyond 2013. Furthermore, many of the CWP project activities are demonstration projects, and the benefits of related projects that were facilitated or created as a result of a TCCC-supported project are not included in the results. Other important benefits such as stakeholder engagement, promotion of sustainability, increased crop yields, and improved local economies are also not included in the quantification results.

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APPENDIX A

CWP Projects with Watershed Restoration Activities

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Country	Project Name	Quantified?[1]	
		Phase II (Aug. 2009)	Phase III (Dec. 2009)
Australia	Great Barrier Reef Project (Project Catalyst)	Too early	✓
Australia	Toongabbie Creek Restoration	Habitat benefits	
Australia	Watershed Protection and Regeneration Program - Landcare	Habitat benefits	
Latin America	Environmental Services for Improving Water Quality Management		Not to be quantified
Belarus	Expansion of Yelnya Bog Project		✓ Results under review
Brazil	Brazilian Rainforest Water Program	✓	
Canada	Freshwater Conservation and Sustainable Water Use in Canada		Additional information needed
China	Recycling Water Program - Hefei Plant	✓	
China	Upper Yangtze River Basin	Too early	
Ecuador	Protection of Water Resources in El Carmen		✓
Egypt	Environmental Services for Improving Water Quality Management	Too early	Too early
El Salvador	Rio San Antonio Watershed Protection Initiative		
Ghana & Ivory Coast	Transboundary Community Water Management	✓	
Guatemala	Protecting the Mesoamerican Reef • Teculutan sub-watershed • Pueblo Viejo sub-watershed (includes communities of Pueblo Viejo, Cancoy and Rio Chiquito) • The Water Fund "Sierra de las Minas"[2] • Motagua-Polochic Watersheds protection[2]		✓
Honduras	Rio Chamelecon River Watershed Protection Initiative[2]		✓
Hungary	Let's Save the Liberty (Szabadsag) Island!	Habitat benefits	
India	Checkdam for Groundwater Recharge	✓	
India	Rain Water Harvesting, Aquifer Recharge and Improved Access to Water	✓	
India	Rainwater Harvesting and Aquifer Recharge	✓	

Country	Project Name	Quantified?[1]	
		Phase II (Aug. 2009)	Phase III (Dec. 2009)
India	Rainwater Harvesting Project in 39 Villages	✓	
India	Rainwater Harvesting Project in Varanasi	✓	
India	Recharge Shafts for Sustainable Groundwater	✓	
India	Rejuvenation of a pond in Karnataka	✓	
India	Maintenance of Rainwater Harvesting Structures across India	✓	
India	Small Drip Irrigation Pilot Study		Additional information needed
Italy	Fonti del Vulture		Additional information needed
Jordan	Repair and Upgrading of an Irrigation Network in the Greigreh and Fenan Region	Too early	Additional information needed
Kenya	Community Water, Sanitation, and Sustainable Agriculture		Not to be quantified
Liberia	Paynesville Wastewater Treatment Plant		Need a contact
Malawi	Building Local Conservation Capacity - East Africa		Additional information needed
Malawi	Mulanje Mountain Community Watershed Management	✓	
Maldives	Island Sanitation in the Maldives		✓
Mali	Community Water Supply, Sanitation, and Wastewater Program	✓	
Mali	Productive Uses of Treated Wastewater	Too early	Too early
Mexico	Reforestation of Nevado de Toluca	✓	
Mexico	Mexico Restoration Forest and Reforestation Program	✓	
Mexico	Reforestation Efforts at the de Monarca Butterfly Bioreserve	✓	
Mexico	Water Management in the San Pedro Mezquital Basin in Durango-Nayarit	Too early	
Mozambique	Protecting and Preserving Lake Niassa and Lake Chiuta-Amaramba		Additional information needed
Nigeria	Improved Health and Livelihoods in Nigeria's Rural Communities	✓	
Nigeria	Water for Community Productive Use - Fish Farms		Not to be quantified
Pakistan	WWF-Pakistan Western Himalayan Ecoregion		✓

Country	Project Name	Quantified?[1]	
		Phase II (Aug. 2009)	Phase III (Dec. 2009)
Philippines	Ilagan Watershed Conservation Project in Isabela		✓
Philippines	River Councils		Additional information needed
Philippines	Go Green! Go for the Real Thing!		✓
Philippines	Laguna Lake Watershed Project • Santa Rosa River Basin Protection and Rehabilitation[4]		Too early (See fact sheet in Appendix F)
Philippines	Haribon Foundation Native Tree Nursery		Too early (See fact sheet in Appendix F)
Philippines	Green Kalinga		Too early (See fact sheet in Appendix F)
Romania	Reconnecting the Lifeline		✓
South Africa	School Plumbing Repair and Energy Savings	✓	
South Africa	Watergy Program - Fixing the Leaks	✓	
Spain/Portugal	La Guadiana Sub Basin		✓
Tanzania	Improved Community Livelihoods and Sustainable Water Management	✓	
Thailand	Conservation and Rehabilitation of the Klong Yan Watershed in Surat Thani	✓	
Thailand	Monkey Cheeks Project		Too early (See fact sheet in Appendix F)
Thailand	Sustainable Coast Living Neighborhoods		Additional information needed
Turkey	Every Drop Matters - in Saraykoy and Beypazari	✓	
United States	Big Bigby Creek Dam Removal	Habitat benefits	
United States	Big Spring Watershed Protection	✓	
United States	Chesapeake Bay Rain Barrel Donation Program	✓	
United States	ClearWater Community Watershed Partnership	✓	
United States	Adopt-A-River High Springs Watershed Partnership	Habitat benefits	
United States	Paw Paw River Watershed Restoration	✓	
United States	Tallgrass Prairie Watershed Restoration in North Texas	✓	

Country	Project Name	Quantified?[1]	
		Phase II (Aug. 2009)	Phase III (Dec. 2009)
United States	Flint River Watershed Restoration	✓	
United States	Etowah River Watershed Conservation Partnership	✓	
United States	Friends of Alum Creek	Habitat benefits	
United States	4-H_2O		Additional information needed
United States/Mexico	Protecting the Rio Grande/Rio Bravo River	✓	
United States	Rio Bosque Wetland Park Partnership [3]	✓	
United States	Southeast Rivers and Streams Freshwater Conservation Partnership	✓	
United States	Upper Chattahoochee Riverkeeper Partnership	✓	
United States	CCE - Cobb County Water Stewardship program	✓	
United States	Village of Niles Rain Garden	✓	
United States	Wildlands Conservancy within the Lehigh Valley and Lehigh River	✓	
United States	Lexington Rain Garden	✓	
Vietnam / Thailand	Conserving the Mekong • Chi River • Plain of Reeds Wetland Restoration Project [5]	✓	✓

<u>Notes</u>

[1]Check mark indicates that benefits were quantified for one or more project activities as part of this phase of work.

"Habitat benefits" indicates that project is improving habitat, and benefits to water quantity or quality cannot be quantified.

Yes in the column "Phase IV (2010 anticipated)" indicates information may become available to quantify benefits in 2010.

[2] Listed separately in 2009 Replenish Report but appears to be part of "Protecting the MesoAmerican Reef"

[3] Listed separately in 2009 Replenish Report but part of TCCC-WWF Protecting the Rio Grande/Rio Bravo

[4] Listed separately in 2009 Replenish Report, but Santa Rosa River Basin project is in the Laguna Lake watershed and is the first part of the Laguna Lake project.

[5] Listed separately in 2009 Replenish Report but part of TCCC-WWF Conserving the Mekong project

APPENDIX B
CWP Survey

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CWP Survey Overview

In an effort to quantify the "watershed restoration benefits" of TCCC's Community Water Partnership projects , additional site-specific data and information is needed. The information gathered through this survey will be used to quantify the *change in water quantity and/or water quality* when post-project conditions are compared to pre-project conditions. The projects being surveyed have been determined to *potentially* include activities that could have quantifiable effects, based primarily on a review of the information provided in the 2008 and 2009 Replenish reports. The survey questions are designed to verify that the list of "qualifying" projects is correct, and to gather specific information about each project.

In order to quantify each project's contribution, a first step is to identify all "on the ground" activities that are being planned or implemented, the progress that has been made to date, the water quantity and/or quality problems that the project was designed to address, and specific information about project activities and the location where the project is being implemented. We recognize that not all information requested is available - approximations are very useful if exact numbers are not available.

This survey is being conducted for TCCC by LimnoTech, an environmental science and engineering firm, in collaboration with The Nature Conservancy.

Thank you for talking the time to fill out this survey. If you have any questions or concerns, please contact:

Denise Knight, TCCC
deknight@na.ko.com
404-676-3638

or

Wendy Larson, LimnoTech
wlarson@limno.com
734-332-1200

Go to "Project Info" page >>

COCA-COLA COMMUNITY WATER PARTNERSHIP PROJECT INFORMATION

(please provide the following information)

	PROJECT INFORMATION			
1	Project Name:			
	PROJECT CONTACT			
2	Name:			
3	Title:			
4	Affiliation:			
5	Address:			
6	Phone:			
7	Email:			
	PROJECT LOCATION **(If multiple locations, provide only information that is common to every location)**			
8	Country:			
9	State or province:			
10	Local Municipality:			
11	Watershed name, if known:			
12	Name of natural surface water body in nearest proximity (e.g., lake, pond, river, creek):			
13	Distance to nearest water body			
14	Project location (latitude and longitude):		and	
	PROJECT STATUS AND SUPPORTING INFORMATION			
15	Percent complete as of December 31, 2008:			
16	Total cost of project:			
17	Percent funded by The Coca-Cola Company:			
18	List of Project Reports (can they be provided?):			
19	List of Project Maps/GIS Files (can they be provided?):			
20	Provide or direct us to local precipitation data:			
21	Provide or direct us to local stream flow data:			
22	Other Comments:			

Go to "Activities" page >>

Instructions

This Excel workbook contains a series of forms for you to provide the requested information. Instructions for filling out these forms are provided on each page.

You must navigate through the forms in the proper sequence by following the instructions on each page. To navigate to the Activities page, please use your mouse to click on the **'Activities'** worksheet tab below.

Please check and correct any information in blue and fill in other requested information.

COCA-COLA COMMUNITY WATER PARTNERSHIP PROJECT ACTIVITIES

(please provide information for all activities that have been or will be implemented from the list below)

ID	Activity Description	Examples/Notes	Does your project involve this activity?	Total number of locations?	Activity Still in Planning Phase? (select 'Yes' or 'No')	Start Date for Implementing Activity (month/year)	End Date for Implementing Activity (month/year)	Activity-Specific Questions
1	*Agricultural practices* : fertilizer, herbicide, or pesticide management		No					Go to 'A01'
2	*Agricultural practices* : irrigation water management	e.g., drip irrigation	No					Go to 'A02'
3	*Agricultural practices* : crop/farmland management	e.g., conservation tillage	No					Go to 'A03'
4	Vegetated filter strips/riparian buffers		No					Go to 'A04'
5	Conservation / Protection of Existing Resources	e.g., wetlands preservation, fire control	No					Go to 'A05'
6	Reforestation or revegetation	e.g., grassland restoration or tree planting	No					Go to 'A06'
7	Dam removal or change in dam operation		No					Go to 'A07'
8	Repairing leaks in water systems		No					Go to 'A08'
9	Wastewater treatment plant construction		No					Go to 'A09'
10	Wastewater treatment plant improvement	e.g., reduction in pollutant loadings	No					Go to 'A10'
11	Beneficial reuse of water	e.g., treated effluent used for agriculture	Yes					Go to 'A11'
12	Rainwater harvesting		No					Go to 'A12'
13	Invasive species control		No					Go to 'A13'
14	Transfer of water rights for environmental flows		No					Go to 'A14'
15	Other water-related activities		No					Go to 'A15'

Instructions for Activities Page

When finished providing information for each activity (row) that is applicable to your project, please proceed to the Activity-Specific Questions form designated for that row by clicking on the appropriate worksheet tab below. You can proceed to the activity-specific questions for each row if you have provided a '**Yes**' answer in the column, **Does your project involve this activity?,** and have indicated the number of locations in the column, **Total number of locations?**

After completing each Activity-Specific form, return to this form (Activities), provide the information for the next activity, navigate to the Activity-Specific Questions page for that row, and continue until all activity-specific information has been provided.

Note: Drop-down boxes with a list of answers to choose from are present in the three columns entitled, **Does your project involve this activity?, Total number of locations?** and **Activity Still in Planning Phase?**. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Agricultural Practices: Fertilizer, Herbicide, or Pesticide Management

Overview: To quantify improvements in water quality through change in management, we need to understand how the quantity and/or timing of application has been changed.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
Describe the land area where management practices have been applied (e.g., describe crop types for cropland).		
What is the surface area of cropland affected by this project?		
What is the approximate slope of the land surface?		
What are the predominant soil type(s) in the project area?		
What type of chemical application is being affected by the project? If possible, please provide a specific description, including the pre- and post-project chemical formulations, in the 'Comments' field.		
What management practices does the project involve? Provide descriptions of pre- and post-project practices in 'Comments' field.		
What reductions in fertilizer, herbicide, or pesticide application rates have been (or will be) achieved with this project?		
What are the pre- and post-project application frequencies (e.g., # days/year, months of application)		
Has the effectiveness of the change in practices been measured in any quantitative or qualitative way (e.g., improved water quality in nearby stream)? If yes, please describe and/or provide data.		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Agricultural Practices: Irrigation Water Management
Overview: To quantify the water savings through a change in irrigation management, we need to know the types of irrigation practices employed, the size of irrigated land, types of crops, and related information.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
What is the water source (e.g., aquifer, name of river/stream, etc.?		
What type of irrigation was being employed "pre-project"?		
What is the surface area of cropland affected by this project?		
Which type(s) of crops are grown in the project area?		
What is the approximate slope of the land surface?		
What are the predominant soil type(s) in the project area?		
How many days/year is the land irrigated as part of this project and previously?		
What are the approximate pre- and post-project water requirements? (e.g., in hectare-m/month or acre-ft/month)		
What are the approximate pre- and post-project irrigation efficiencies (expressed as a percentage of water uptake by crop relative to total water application)?		
Were there other changes made when the irrigation methods were modified (e.g., crop type, tillage practices)?		

Instructions for Activity-Specific Form

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Agricultural Practices: Crop/Farmland Management Practices

Overview: To quantify the water savings or water quality improvement realized through a change in crop/pasture land management, we need to understand pre- and post-project practices, and soil characteristics.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** **(where you provided a value, please indicate if it is based on measurements or an educated guess)**
What is the specific objective of improved crop/pasture land management practices?		
What is the surface area of crop/pasture land affected by this project?		
What are/were the predominant types of land covers (crop or other) for the project area (pre- and post-project)?		
What tilling practices have been used for the target area (pre- and post-project)? (e.g., fall/spring plow, turn plow, "no till")		
What contouring, contour strip, terracing, or other supporting practices have been used (pre- and post-project)?		
For cropland, is the crop productivity considered to be "high" or "moderate"?		
Has the effectiveness of the change in practices been measured in any quantitative or qualitative way (e.g., measured runoff loads before and after implementation, improved water quality in nearby stream)? If so, please provide data and explain.		
What is the approximate slope of the land surface?		
What is the predominant soil type (e.g., sand, sandy loam, silt/clay, etc.)?		
What is the approximate organic matter content in the soils, if available? (Please specify as a percentage.)		

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Vegetated Filter Strips / Riparian Buffers

Overview: To quantify the water savings or water quality improvement realized through the implementation of filter strips or riparian buffers, information on the location and size of the buffers is needed, as well as land use and soil characteristics.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
What is the specific purpose of the project?		
Has the effectiveness of the project been measured in any quantitative or qualitative way? If so, how?		
What is the approximate width of the filter strip(s) and/or riparian buffer(s)?		
What is the approximate size of the plot for which the filter strip or buffer has been designed?		
What specific types of vegetation were planted as part of the project?		
Can you provide a map or diagram showing the locations of the buffers or strips? Photographs would also be helpful.		
What is the approximate slope of the land surface?		
What are the predominant soil type(s) in the project area?		
Does the project involve riparian buffers or filter strips (not located adjacent to a stream)? Please go to appropriate set of questions below.		

Instructions for Activity-Specific Form

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Questions Related to Riparian Buffers	Response	Comments
What is the total stream length (in the longitudinal direction) where adjacent buffers were constructed?		
Were buffer improvements made to both sides/banks of the stream? If so, describe what improvements were made (e.g, type of vegetation) and where they were made.		

Questions Related to Filter Strips	Response	Comments
What is the total length of the filter strip(s)?		
Where are the filter strips located with respect to the crops (e.g., between crop rows, around field perimeter, between crops and surface water body?		
What kinds of agricultural (or other) practices are associated with the filter strip placement?		

Conservation / Protection of Existing Resources
Overview: Where land or water resources are conserved, information is needed on conservation objectives and vegetative cover.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
What specific conservation objectives are associated with the project? (select all that apply)		
What is the total surface area affected by the project?		
What is the approximate slope of the land surface?		
What are the predominant soil type(s) in the project area?		
Are wetland areas being conserved? If yes, what is the total wetland area affected?		
What kinds of specific vegetative cover are represented in the project area (e.g., specific tree or grass species)? Please be as specific as possible.		
Is the conservation effort a specific response to impending or future development of the project area? If yes, please explain the nature of the development and approximate timing.		

Does this activity involve fire control to maintain a healthy forest cover? ***If yes, please answer questions below.***		
- Has an estimate been made of the impact of past fires on local waterbodies? If yes, please provide a description of impacts and estimates of % change in water quantity/quality parameters. Please provide any supporting data, if available.		
- What is the total area of forest where fire control has occurred?		
- Has an estimate been made of the reduction in land area (e.g., in sq. kilometers) affected by forest fires due to the fire control measures? If yes, please provide the estimated percent reduction.		

Does this activity involve efforts to reduce household firewood consumption? ***If yes, please answer questions below.***		
- What is the total land area of the targeted forest?		
- Has an estimate been made of the reduction in land area cleared as a result of these efforts (e.g., area of forest left intact per household or fuel-efficient stove)? If available, please provide an estimate of the percent reduction for the land area.		

Instructions for Activity-Specific Form

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Reforestation or Re-vegetation

Overview: Quantifying changes in water quality or water quantity due to reforestation or re-vegetation requires information on pre- and post-land cover and watershed characteristics.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
What is the specific purpose of the project? Please select all that apply.		
What is the total surface area affected by the reforestation/re-vegetation project?		
What is/was the existing/previous land cover for the project area? Please be as specific as possible.		
What is the new land cover for the project area? Please be as specific as possible (e.g., indicate vegetation type and density).		
Can you provide a map or diagram showing the reforested or re-vegetated areas? Photographs would also be useful.		
What are the predominant soil type(s) in the project area?		
What is the approximate slope of the land surface?		

Instructions for Activity-Specific Form

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Dam Removal or Change in Dam Operation

<u>Overview</u>: Dam removal or a change in operations affects water quality and the flow regime, so data related to streamflow and water quality is needed.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
Does the project involve partial or full dam removal, or does it involve a change in dam operations?		
What are the specific objectives of the dam removal or change in dam operations?		
How has/will the project affected instream flow rates? Please provide pre- and post-project mean monthly flow rates, if available.		
How has/will the project affected water quality (e.g., suspended solids)?		

Location #2	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
Does the project involve partial or full dam removal, or does it involve a change in dam operations?		
What are the specific objectives of the dam removal or change in dam operations?		
How has/will the project affected instream flow rates? Please provide pre- and post-project mean monthly flow rates, if available.		
How has/will the project affected water quality (e.g., suspended solids)?		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Repairing Leaks in Water Systems
Overview: To quantify water savings due to leak repairs, information on the types of repairs made and the estimated savings are helpful.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
To which type of water-related infrastructure were repairs made? Please select all that apply.		
Specifically, where were the repairs made?		
If repairs were made to drinking water systems, what is the water supply source for the drinking water? Please select all that apply.		
What is the estimated water savings in terms of a volumetric rate (e.g., liters/year)?		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Location #2	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
To which type of water-related infrastructure were repairs made? Please select all that apply.		
Specifically, where were the repairs made?		
If repairs were made to drinking water systems, what is the water supply source for the drinking		
What is the estimated water savings in terms of a volumetric rate (e.g., liters/year)?		

Wastewater Treatment Plant Improvement

Overview: To quantify changes due to improvements, information on pre- and post-improvement conditions is needed, as well as characteristics of the receiving water.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** (where you provided a value, please indicate if it is based on measurements or an educated guess)
What is the purpose of the wastewater treatment plant improvement project (e.g., reduce effluent flow, improve water quality)?		
Please specify the pre- and post-project effluent flow for the treatment plant (e.g., in MGD).		
If treatment plant effluent loads are being reduced, please specify the targeted pollutants and the associated pre- and post-project loads.		
Has a new wetland/lagoon been constructed to facilitate improvements in wastewater treatment?		
What are the major characteristics of the water body that receives (or will receive) the effluent stream from the new treatment plant?		
- Select type of receiving water body:		
- Watershed area tributary to water body at treatment plant discharge location?		
- Approximate average daily flow of stream (e.g., m^3/s or ft^3/s)?		
Will there be any new beneficial reuse of effluent flow from the treatment facility? (please also see questions associated with Activity #11)		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Wastewater Treatment Plant Construction

Overview: To quantify the change in water quality due to improved treatment, information on pre-project conditions is needed, as well as details on the type of treatment and the receiving water.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** **(where you provided a value, please indicate if it is based on measurements or an educated guess)**
Describe problem conditions prior to the construction of the new treatment plant		
What population is (or will be) served by the new treatment facility?		
What is the type of treatment that is being implemented (e.g., primary, secondary)?		
Is the new treatment facility intended to replace septic tank systems? If so, indicate approximately how many septic systems are being replaced (or number of people affected).		
What are the major characteristics of the water body that receives (or will receive) the effluent stream from the new treatment plant?		
- Select type of receiving water body:		
- Watershed area tributary to water body at treatment plant discharge location?		
- Approximate average daily flow of stream (e.g., m^3/s or ft^3/s)?		
Will there be any beneficial reuse of effluent flow from the treatment facility? (please also see questions associated with Activity #11)		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Beneficial Reuse of Water
Overview: To quantify changes in water quality or quantity due to reuse of water, information on pre- and post-project uses as well as quantities are required.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** (where you provided a value, please indicate if it is based on measurements or an educated guess)
Describe the source of the water being reused. Please select all that apply.		
Describe the new use of the water. Please select all that apply.		
If the reused water is applied to land, what is the approximate slope of the land surface?		
If the reused water is applied to land, what are the predominant soil type(s) in the project area?		
What quantity of water is being reused in million gallons per day (MGD), cubic feet per second (CFS), or cubic meters per second (CMS)?		
Where was the water being discharged "pre-project"?		
Where was the water being discharged "post-project"?		

Instructions for Activity-Specific Form

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Location #2	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** (where you provided a value, please indicate if it is based on measurements or an educated guess)
Describe the source of the water being reused. Please select all that apply.		
Describe the new use of the water. Please select all that apply.		
If the reused water is applied to land, what is the approximate slope of the land surface?		
If the reused water is applied to land, what are the predominant soil type(s) in the project area?		
What quantity of water is being reused in million gallons per day (MGD), cubic feet per second (CFS), or cubic meters per second (CMS)?		
Where was the water being discharged "pre-project"?		
Where was the water being discharged "post-project"?		

Rainwater Harvesting

Overview: Rainwater may be collected for a variety of purposes, and quantification of changes to water quality or quantity requires information on the intended use, pre-project conditions, and site conditions.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments** (where you provided a value, please indicate if it is based on measurements or an educated guess)
What is the specific objective or purpose of the rainwater harvesting project? (Please select all that apply and answer related questions below.)		
What is the approximate area of rainwater collection?		
Is harvested rainwater replacing or supplementing a previous/existing source of water, such as water withdrawn from surface or ground water? ***If yes, please answer next 2 questions.***		
What is the previous/existing source of water (e.g., surface or ground water)?		
How much have withdrawals from this source been reduced? Please specify pre- and post-project withdrawal rates, if available (e.g., MGD or m^3/s).		

Instructions for Activity-Specific Form

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Direct use of collected water for drinking water and/or irrigation:

Question	**Response**	**Comments**
What quantity of water is being consumed (e.g., liters per year)?		
If the collected water is applied to land, what is the approximate slope of the land surface?		
If the collected water is applied to land, what are the predominant soil type(s) in the project area?		

Direct use for sanitation purposes:

Question	**Response**	**Comments**
What quantity of water is being consumed (e.g., liters per year)?		
How is the collected rainwater ultimately disposed of after being used for sanitation purposes?		

Recharge groundwater aquifer:

Question	**Response**	**Comments**
What is the rate of water recharge to the groundwater aquifer (e.g., in MGD or m^3/s)?		
Have aquifer recharge practices resulted in larger withdrawals of groundwater to supply water for drinking water supplies, irrigation, or sanitation? ***If yes, what is the approximate increase in the groundwater withdrawal rate(s)?***		
Has the recharge project affected flows in nearby surface waters (e.g., increased baseflow)? If yes, please provide measured rate of increase.		

Reduction of stormwater runoff impacts:

Question	**Response**	**Comments**
Prior to rainwater collection, where was water routed? (Please provide approximate percent)	Stormwater drainage system: Infiltration:	
Is the collected rainwater treated in any way prior to discharge?		
Where is the collected rainwater ultimately discharged?		
What is the total quantity (volumetric rate) of rainwater collected?		
Is the rainwater harvesting achieved through use of rain barrels? ***If yes, please answer questions below.***		
- What is the primary purpose of the rain barrel program?		
- How many rain barrels have been distributed?		
- Approximately how many households are using rain barrels?		
- How large are the rain barrels (approximate volume, e.g., in gallons)?		
- How is the collected rainwater generally used (e.g., gardening)?		
- Can you provide an estimate of the total volume of water collected by the rain barrels in an average year?		

Invasive Species Control

Overview: To quantity the change in water quantity due to invasive species control, information on the types of plants, area of control, and area or mass removed is needed.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	**Response**	**Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)**
Please name the types/species of plants that are targeted for removal or control.		
Describe what is known about the impact of these plants on water quantity or quality in the target watershed. Please indicate whether the invasive plants impact surface water, ground water, or both.		
Are specific areas (e.g., subwatersheds) targeted for control? If yes, can you provide maps or schematics of the affected areas?		
Has an estimate been made of the quantity of water taken up by the invasive plants (e.g., liters per hectare per year), or the change in water quality?		
Are estimates available for the quantity (area or mass) of plants that have been removed to date? Please provide size of land area where plants have been removed (if available).		
If project is ongoing, what quantity (area or mass) of plants is expected to be removed in the future?		
Have estimates been made (or projected) for the post-project water quantity or quality improvements due to invasive plant controls? (e.g., liters per day increase in baseflow per square meter of plants removed)		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Transfer of Water Rights for Environmental Flows
Overview: To quantify the impact on instream flow due to transfer of water rights, information on withdrawal rates, and water uses is needed.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	0
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Question	Response	Comments (where you provided a value, please indicate if it is based on measurements or an educated guess)
Please list all water bodies where water rights transfers have been or will be accomplished. If available, maps or schematics would be very helpful.		
Are USGS gage data or other flow data available for stream locations affected by the project?		
Have water rights transfers already occurred as part of this project? ***If yes, please answer questions below.***		
- How was the water used "pre-project" (e.g., irrigation)?		
- What quantity of water is no longer withdrawn (e.g., MGD)?		
- Have measurements been made of instream changes due to these transfers?		
- If the water was previously used for irrigation, how is the land area used now?		
Will additional water rights transfers occur in the future as part of this project? ***If yes, please answer questions below.***		
- Please provide a timetable for project implementation, if available.		
- How is the water currently being used (e.g., irrigation)?		
- What quantity of water will no longer be withdrawn (e.g., MGD or m^3/s)?		
- Have predictions been made of the expected instream changes due to these future transfers? If yes, please provide estimates of pre- and post-project flow rates.		

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

Other Water-Related Activities

Overview: Please provide a comprehensive description of your water-related activity in the space provided below.

(please provide and/or correct the following information in blue)

Location #1	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Description of Activity (please provide any relevant data)

Location #2	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Description of Activity (please provide any relevant data)

Location #3	
Project Name:	*0*
Country:	0
State or province:	0
Local Municipality:	0
Watershed name, if known:	0
Type of surface water body in nearest proximity:	0
Distance to nearest water body	0
Project location (latitude, longitude):	,

Description of Activity (please provide any relevant data)

Instructions for Activity-Specific Form

You may provide activity-specific information for multiple locations, if applicable, as this form is replicated 10 times below. When finished providing information for each Question on this form, return to the Activities Page and continue providing information for the next activity.

Note: Drop-down boxes with a list of answers to choose from are present in the **yellow** highlighted cells in the '**Response**' column, where present. Access the drop-down box list by using your mouse to select a cell in these columns, click on the arrow that appears at the bottom right of the cell, and click on your answer.

APPENDIX C
Description of Computational Engine

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Overview

The Phase I report provided specific recommendations with respect to developing a "Watershed Restoration Benefits Estimation Tool" (WRBET) to assist in quantifying water quantity and quality benefits resulting from specific actions within a watershed. The recommended approach involved the development of two main components of the WRBET: 1) a *computational engine* to provide a suite of methods to perform the calculations required to quantify benefits, and 2) an *expert system* to interact with the user to obtain the necessary information to support the benefit calculations. In terms of software development, Phase II focused on the development of the computational engine component of the overall WRBET.

The Phase I report recommended that a suite of process- and empirically-based methods be incorporated into the WRBET computational engine (CE) to provide a means for quantifying changes in water quantity and quality for a variety of physical conditions and management situations. The collection of proposed water quantity methods provide a means for calculating the movement of water through the various pathways represented in the watershed hydrologic budget, as depicted in Figure C-1. The water quality methods build on the water quantity results by calculating the transport of sediment and other pollutants of interest (e.g., nutrients) along these pathways. Sediment erosion and runoff, along with associated nutrients, is of particular interest in many circumstances, although leaching of dissolved-phase pollutants to soil water and groundwater may also be of concern depending on site-specific conditions.

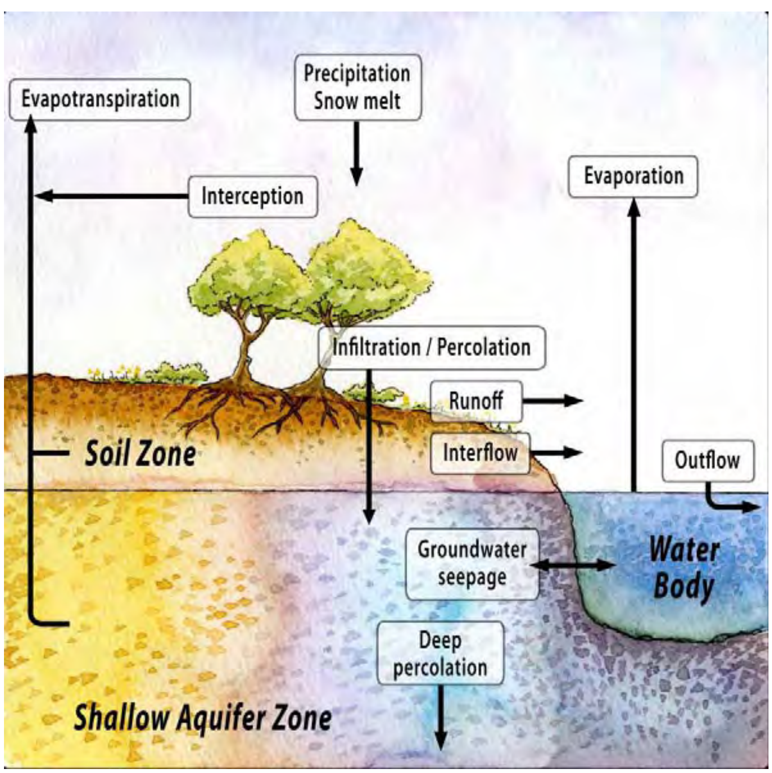

Figure C-1. Watershed Hydrologic Transport Pathways

Computational Engine Development

Several existing watershed models were identified in the Phase I report as sources for the quantity and quality-related methods described above, including *Hydrologic Simulation Program – FORTRAN* (HSPF), *Soil & Water Assessment Tool* (SWAT), and *Watershed Analysis Risk Management Framework* (WARMF). These modeling tools provide a collection of process- and empirically-based methods to compute water runoff and infiltration, soil water storage and movement, evapotranspiration, and groundwater storage and outflow. The methods incorporated into the WRBET CE were consistent with those recommended in the Phase I report and are summarized below:

- Runoff/Infiltration:

  Runoff and infiltration can be estimated using a combination of two methodologies included in the CE: 1) the watershed hydrologic budget approach adapted from the HSPF model (Bicknell et al, 2003), and 2) the Runoff Curve Number approach originally developed by the Natural Resources Conservation Service (USDA-NRCS, 1986) and adapted from the SWAT model (Neitsch et al., 2005). If detailed site-specific data are available to parameterize the watershed land surface and soil characteristics, then the hydrologic budget approach provides a robust method for estimating runoff and infiltration rates. However, many sites, particularly those located in countries other than the United States (U.S.), have only limited data available. In these cases, the Runoff Curve Number method is better suited for estimating runoff quantities.

- Snow Accumulation / Melt:

  For watersheds that routinely experience sub-freezing conditions during the winter months, it is critical to account for the impact of snowfall and snow melt. Snow accumulation and melt can have a significant impact on the overall watershed hydrologic budget, particularly the estimation of the magnitude and timing of runoff quantities. The approach implemented in the SWAT model for simulating snow accumulation and melt was incorporated into the CE in order to provide this important capability for watershed locations where significant snowfall occurs (e.g., Paw Paw River watershed in southwestern lower Michigan).

- Evapotranspiration:

  Potential evapotranspiration (PET) is required for supporting the runoff volume estimates and the estimation of actual evapotranspiration from the watershed surface, canopy, and soil zones. The Hamon method (Lu et al., 2005; Hamon, 1963) was incorporated into the CE for the purpose of estimating PET. This method is more attractive than alternatives methods for estimating PET because it only requires latitude and daily air temperature as inputs.

- Soil Water Budget:

  Meaningful predictions of water storage and vertical flow rates in the unsaturated (i.e., vadose) soil zone require detailed information concerning watershed soil layer properties, including density, permeability, and water storage capacities. The CE includes soil water algorithms adapted from the HSPF model that can be applied for watershed areas where these properties can be reasonably estimated. “Upper” and “lower” soil zones are represented by site-specific storage capacities, which in turn effect the percolation of water through the soil to the underlying shallow aquifer zone.

- Groundwater / Baseflow:

  Shallow groundwater storage and baseflow can be simulated using the groundwater accounting and baseflow recession methods adapted from the HSPF and SWAT models. Applying these groundwater methods requires estimates of aquifer storage capacity and recession characteristics, as well as predictions of rates of water percolation from the unsaturated soil zone to the saturated zone.

- Soil Erosion / Washoff:

  Soil erosion and washoff associated with runoff are calculated using the Modified Universal Soil Loss Equation (MUSLE) (Williams, 1975) adapted from the SWAT model. While the original USLE is limited to calculating average soil erosion over long periods of time (e.g., multiple years), the MUSLE can be used to estimate event-specific sediment yields that can be aggregated to the time period(s) of interest (e.g., monthly basis).

  The SWAT model also provides an equation (6:1.11.2) to estimate the reduction in sediment load for runoff passing through a filter strip or riparian buffer (Neitsch et al., 2005). This equation was incorporated into the CE to complement the MUSLE, as described in the application section below.

Additional methods for quantifying changes in water quantity and quality can be incorporated as needed into the CE as development of the WRBET progresses. The current version of the computational engine was constructed using an object-oriented approach based on the Visual Basic .NET language. This modular approach provides considerable flexibility in terms of 1) adding and modifying methods as development of the WRBET progresses, and 2) efficiently integrating the CE with the “expert system” component described in the Phase I report.

Computational Engine Application

In its current state of development, the CE consists of a collection of methods that cannot be directly applied without connecting the CE to a user interface or expert system. However, a number of project activities identified as part of the CWP project quantification effort required application of detailed methods contained in the CE. This included any activities requiring estimates of the change in water runoff quantity and/or sediment erosion/washoff yields, such as reforestation, revegetation, conservation actions, and construction of riparian buffers.

In order to accommodate the quantification of changes in runoff quantity and sediment yields, a subset of methods available in the CE were adapted for use in a spreadsheet-based estimation tool. The methods incorporated in the spreadsheet tool included:

- Runoff Curve Number method (as implemented in the SWAT model);
- Hamon method for estimating PET (for cases when estimates of daily PET are not available), and
- MUSLE for estimating sediment erosion and washoff; and the
- SWAT empirical equation for estimating reductions in sediment loads for riparian buffers or filter strips (Neitsch et al., 2005).

The Runoff Curve Number method was selected for use in supporting the CWP quantification work because a majority of the reforestation/revegetation and conservation activities were conducted in areas where detailed soil data are not readily available, and, therefore, application of the detailed hydrologic budget method is precluded.

The key input datasets required to support the application of these methods for the CWP project activities outlined above include: 1) meteorological time series, 2) land cover/use and soil conditions, 3) land slope conditions, and 4) cover/crop management and other practice (e.g., contouring of cropland) factors, when applicable. The overall approach and input datasets involved in implementing the CE-based water quantity and quality benefit calculations are described below.

<u>Step #1: Obtain/process local meteorological datasets</u>

Observed time series for daily precipitation and minimum/maximum air temperature are required to apply the Runoff Curve Number and MUSLE methods. These meteorological datasets were obtained for as many years as possible from available data sources. For watershed sites located within the U.S., precipitation and air temperature datasets were readily obtained from the internet using USEPA's BASINS 4 watershed modeling software tool. Typically, daily PET datasets were also available from the BASINS database, which eliminated the need to use the Hamon method to develop estimates for U.S. locations.

The availability of meteorological datasets for locations in other countries besides the U.S. are often limited, and the overall quality of these datasets is relatively poorer. The "TuTiempo.net" website (http://www.tutiempo.net/en/) was found to provide the most comprehensive source of recent/historical weather data for other countries. Considerable effort was required to obtain and quality check data for countries such as Ghana, Tanzania, Mexico, and Brazil. Fortunately, it was possible to obtain one or multiple years of reasonably complete daily precipitation and minimum/maximum air temperature datasets to support water quantity/quality calculations for most locations.

Step #2: Develop estimates of watershed characteristics/parameters

Estimates were required for key physical characteristics and associated parameters for watersheds where CE-based methods were applied. Key physical input parameters included:

- Land use/cover characteristics (e.g., agricultural land, forest land);
- Soil characteristics, including hydrologic soil group (HSG – types A/B/C/D) and/or available water capacity (AWC);
- Average land slope conditions; and
- Cover management and crop practice factors to support the MUSLE.

The approaches used to develop the required parameter estimates are described below. Detailed documentation of the assumptions and final parameter estimates developed for each reforestation, revegetation, and conservation activity are provided in the individual fact sheets for those activities (see Appendix E).

Land use/cover characteristics and hydrologic soil group (HSG) classification were used to obtain Curve Number estimates to support the runoff estimates based on tables provided by USDA-NRCS (1986). For locations within the U.S., site-specific HSG classifications were estimated based on STATSGO datasets (http://soils.usda.gov/survey/geography/statsgo/) obtained via the BASINS 4 program. For other countries, regional estimates of soil available water content (AWC) were obtained from Baatjes (1996) and used to infer a HSG classification. Professional judgment was required to assign appropriate pre- and post-project land use/cover characteristics for watershed reforestation/revegetation and conservation activities. For example, the following Curve Number assignments were made for the "Brazilian Rainforest Water Program" reforestation activity:

- Pre-project Conditions:
    - Pasture/grassland in "fair" condition: 50-75% vegetative cover (CN = 69)
    - Hydrologic soil group (HSG) "B"
- Post-project:
    - Woodland in "good" condition (CN = 55)
    - Hydrologic soil group (HSG) "B"

Similar to the soil estimation approaches discussed above, the approach used to estimate local land slope (on a percentage basis) varied depending on whether the watershed of interest was located inside or outside the U.S. For watersheds within the U.S., local fine-resolution (e.g., 50-meter) digital elevation models (DEMs) were obtained via BASINS 4 and used to estimate average slope for the area(s) of interest. For watersheds outside the U.S., a global slope dataset obtained from the U.S. Geological Survey and the American Geological Institute (AGI) (http://www.agiweb.org/pubs/globalgis/) was used to estimate slopes. This dataset is derived from global DEM data available at a resolution of ½ degree (~900 meters).

Therefore, the global slope dataset may not provide accurate estimates of local slope in mountainous areas or other areas where topography varies significantly within a one-kilometer distance.

Estimates of the cover management (C) and crop practice (P) factors were required for activities where soil erosion and washoff were quantified. These two factors serve as inputs to the MUSLE, along with derived factors for land slope/distance, runoff volume, and peak rainfall intensity. The C and P factors, which are identical to the factors used in the original USLE, were assigned based on tabulated values compiled from a variety of USLE-related sources (Haith et al., 1992).

Step #3: Calculate runoff quantities for pre- and post-project conditions

Using the meteorological time series data and the approaches described above for estimating watershed physical parameters, the Runoff Curve Number approach was used in conjunction with the SWAT-based snow accumulation and melt algorithm to compute daily runoff of surface water for the available time period (i.e., spanning one or more years, depending on the availability of weather data). Daily runoff quantities were summed across each year to develop annual estimates of runoff volume, and annual volumes were then averaged across all years. This approach was used to develop estimates of annual average runoff volume for both pre-project and post-project conditions. For example, Table C-1 shows the pre- and post-project runoff volumes estimated for the "Brazilian Rainforest Water Program" reforestation activity.

Table C-1. Estimated Runoff Volumes for the "Brazilian Rainforest Water Program" Reforestation Activity

Year	Pre-Project Runoff Volume (ML/yr)	Post-Project Runoff Volume (ML/yr)
2006	8,752	4,257
2007	10,633	9,696
2008	24,690	24,037
Average:	***14,692***	***12,663***

Once annual average runoff volume estimates were developed, the post-project volume (e.g., 12,663 ML/yr) was subtracted from the pre-project volume (e.g., 14,692 ML/yr) to obtain the water quantity benefit in terms of the reduction in annual average runoff volume (e.g., 2,029 ML/yr).

Step #4: Calculate soil erosion/washoff for pre- and post-project conditions

As discussed above, the MUSLE was applied to estimate sediment yield reductions for projects where changes in land cover/use would be expected to affect erosion and washoff of sediment from the watershed surface. The approach used to estimate water quality benefits in terms of sediment yield reduction was analogous to the approach described above for estimating benefits resulting from runoff volume reductions. Pre- and post-project conditions were used to generate annual estimates of sediment yield, which were then averaged to obtain annual average sediment yields. As an example, Table C-2 provides sediment yield estimates (in metric tons per year, MT/yr) developed for the "Brazilian Rainforest Water Program" reforestation activity.

Table C-2. Estimated Sediment Yields for the "Brazilian Rainforest Water Program" Reforestation Activity

Year	Pre-Project Sediment Yield (MT/yr)	Post-Project Sediment Yield (MT/yr)
2006	104,124	2,468
2007	130,556	5,935
2008	336,200	16,399
Average:	***190,293***	***8,268***

Similar to the approach used for runoff volume, the annual average sediment yield obtained for the pre-project condition (~190,300 MT/yr) was subtracted from the post-project sediment yield (~8,300 MT/yr) to obtain the average reduction in sediment yield (~182,000 MT/yr). In general, estimated reductions in sediment yield tend to be greater than reductions in runoff volume because the degree of sediment erosion/washoff is highly dependent on the degree and quality of vegetative cover present on the watershed land surface. For the "Brazilian Rainforest Water Program" example presented above, a 14% reduction in runoff volume is estimated, as compared to a 95% reduction in sediment yield.

Watershed restoration activities involving the construction or rehabilitation of riparian buffers or filter strips require additional considerations. The purpose of riparian buffers (and filter strips) is generally to reduce the delivery of sediment and other pollutants (e.g., nutrients) associated with runoff from the watershed land surface to a water body (typically a stream reach). A two-step approach was required to estimate the reductions in sediment loading to a water body based on the presence of a buffer:

1. The Runoff Curve Number and MUSLE approaches discussed above are used to estimate the runoff volume and sediment yield (in MT/yr) generated from the watershed area that drains directly through the buffer.
2. Equation 6:1.11.2 in the SWAT model technical documentation (Neitsch et al., 2005) is used to estimate the sediment trapping efficiency of the buffer (*trap_eff*) based on the width of the buffer (w_{buffer}, meters):

$$trap\_eff = \frac{(2.1661 * w_{buffer} - 5.1302)}{100} \tag{C-1}$$

The water quality benefit provided by the buffer was then calculated as the reduction in sediment yield (MT/yr) based on the trapping efficiency: [WQ_Benefit (MT/yr)] = [trap_eff]*[Sed_Yield (MT/yr)].

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APPENDIX D
Quantification of Watershed Restoration Benefits

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Appendix D: Quantification of Watershed Restoration Benefits

	End 2008	End 2009	End 2010	End 2011	End 2012	End 2013
TCCC Consumption Usage (billion L/yr):	129.0	135.8	142.9	150.4	158.3	166.6
TCCC Watershed Quantity Benefits (billion L/yr):	15.7	28.8	34.2	40.7	54.8	56.8
% of Benefits Relative to Usage:	12%	21%	24%	27%	35%	34%

Project ID	Country	Partner / Lead	Project Description	App E Page #	Description of Activity	Activity Timeline	% TCCC Contribution	Water Quantity Benefits: Type of Benefit Quantified	Water Quantity Benefits: Quantity Change (million L/yr)	Water Quality Benefits: Target Pollutant	Water Quality Benefits: Loading Change (MT/yr)	TCCC Water Quantity Benefit (million L/yr)	TCCC Water Quality Benefit (MT/yr)	% Complete (end 2008)	% Complete (end 2009)	% Complete (end 2010)	% Complete (end 2011)	% Complete (end 2012)	% Complete (end 2013)	Goals / Problems Addressed
1	U.S. MI	TNC	Paw Paw River Watershed Restoration	1	Cropland management (conservation tillage - 809 ha)	2009 - 2011	100%	Runoff (decrease)	168.00	Sediment	2,238	168.00	2,238.00	0%	33%	66%	100%	100%	100%	Reduce runoff and sediment from agricultural lands; increase recharge / baseflow
				5	Removal of glossy buckthorn	2009 - 2011	1%	Direct streamflow	68.90	None		0.69	0.00	0%	39%	66%	100%	100%	100%	Reduce evapotranspiration losses from wetland areas
2	U.S. TX	TNC	Tallgrass Prairie Watershed Restoration in North Texas	7	Conservation of prairie lands and wetlands (526 ha)	Sept 2008 - May 2009	50%	Runoff (decrease)	424.00	Sediment	1,637	212.00	818.50	100%	100%	100%	100%	100%	100%	Maintain hydrologic condition of prairie lands
				11	Invasive species control (134 ha)	Sept 2008 - May 2009	50%	Runoff (decrease)	41.00	Sediment	164	20.50	82.00	40%	100%	100%	100%	100%	100%	Increase infiltration, reduce sediment erosion/runoff
				15	Revegetation of prairie lands (113 ha)	Sept 2008 - May 2009	100%	Runoff (decrease)	34.00	Sediment	307	34.00	307.00	0%	100%	100%	100%	100%	100%	Increase infiltration, reduce sediment erosion/runoff
				19	Riparian buffer construction (2.8 ha)	Sept 2008 - May 2009	100%	Runoff (decrease)	2.80	Sediment	5.1	2.80	5.10	0%	100%	100%	100%	100%	100%	Increase infiltration; reduce sediment erosion/runoff
3	U.S. GA	TNC	Flint River Watershed Restoration	23	Remote soil moisture monitoring for irrigation management	April-Sept 2009	100%	GW usage (decrease)	154.00	None		154.00	0.00	0%	100%	100%	100%	100%	100%	Provide demonstration projects for decreasing irrigation water usage
4	U.S. GA	TNC	Etowah River Watershed Conservation Partnership	26	Riparian buffer (Raccoon Creek)	Apr 2009 - May 2012	100%	None	0.00	Sediment	100	0.00	100.00	0%	25%	50%	75%	100%	100%	Stabilize stream bank (reduce instream erosion)
				29	Stormwater management (tributary ditch improvements)	Apr 2009 - May 2012	100%	None	0.00	Sediment	33	0.00	32.60	0%	25%	50%	75%	100%	100%	Stabilize stream bank (reduce instream sediment erosion); increase infiltration
5	Ghana, Ivory Coast	GETF	Transboundary Community Water Management	32	Conservation/reforestation of tropical rain forest (~13.5 ha)	Aug 2007 - Feb 2009	100%	Runoff (decrease)	6.00	Sediment	27	6.00	26.50	100%	100%	100%	100%	100%	100%	Protect biodiversity, reduce sediment & other pollutant loads
6	Mali	GETF	Community Water Supply, Sanitation, and Wastewater Program	37	Irrigation system improvements (drip irrigation)	Nov 2005 - Aug 2008	100%	GW usage (decrease)	0.18	None		0.18	0.00	100%	100%	100%	100%	100%	100%	Reduce irrigation water usage
7	Tanzania	GETF	Improved Community Livelihoods and Sustainable Water Management	39	Reforestation (23 ha)	Jan-Aug 2009	100%	Runoff (decrease)	17.00	Sediment	30	17.00	30.20	0%	100%	100%	100%	100%	100%	Reduce land degradation & sediment erosion
8	South Africa	GETF	<u>Two Projects:</u> 1.) Watergy Program - Fixing the Leaks and 2.) School Plumbing Repair and Energy Savings	44	Leak repair in schools & private households	1997 - 2009	100%	SW/GW usage (decrease)	407.52	None		407.52	0.00	96%	100%	100%	100%	100%	100%	Increase water use efficiency
9	Malawi	GETF	Mulanje Mountain Community Watershed Management	47	Irrigation system improvements (drip irrigation)	2008	100%	SW usage (decrease)	0.18	None		0.18	0.00	100%	100%	100%	100%	100%	100%	Promote & demonstrate use of drip irrigation kits
10	Nigeria	GETF	Improved Health and Livelihoods in Nigeria's Rural Communities	49	Irrigation system improvements (drip irrigation)	2007 - 2008	100%	SW/GW usage (decrease)	1.26	None		1.26	0.00	100%	100%	100%	100%	100%	100%	Promote improved small-scale irrigation methods
14	U.S. PA	Delta	Big Spring Watershed Protection	52	Repairing leaks in drinking water systems	2006 - ongoing	100%	SW/GW usage (decrease)	2,750.00	None		2,750.00	0.00	100%	100%	100%	100%	100%	100%	Increase water use efficiency
15	U.S. PA	Delta	Wildlands Conservancy within the Lehigh Valley and Lehigh River	54	Abandoned mine drainage treatment (Lausanne Tunnel)	2004 - 2009	50%	None	0.00	Iron	20	0.00	9.96	100%	100%	100%	100%	100%	100%	Reduce sediment runoff to streams; stabilize stream bank
							50%	None	0.00	Aluminum	7.5	0.00	3.74	100%	100%	100%	100%	100%	100%	
							50%	None	0.00	Sulfates	1,327	0.00	664.64	100%	100%	100%	100%	100%	100%	
				59	Jordan Creek stream stabilization project	2009	50%	None	0.00	Sediment	7.9	0.00	3.95	0%	100%	100%	100%	100%	100%	Stabilize stream bank (reduce erosion)
				62	Little Lehigh stream bank stabilization project	2008	50%	None	0.00	Sediment	3.5	0.00	1.75	100%	100%	100%	100%	100%	100%	Stabilize stream bank (reduce erosion)
				65	Monocacy Creek stream restoration projects (Edgewood Valley Farm, Just Enuff Angus Farm)	2008	50%	None	0.00	Sediment	7.6	0.00	3.80	100%	100%	100%	100%	100%	100%	Reduce sediment runoff to streams; stabilize stream bank
16	U.S. PA	Delta	Clearwater Community Watershed Partnership: the Scotia Barrens Conservation Project's Halfmoon Wildlife Corridor	69	Conservation/protection of existing resources (106 ha)	2009 - 2010	1%	Runoff (decrease)	11.90	Sediment	223	0.08	1.54	0%	0%	100%	100%	100%	100%	Conservation/protection of a corridor for wildlife passage
18	U.S. IL	Delta	Village of Niles Rain Garden	75	Community rain garden (1.5 acre)	2008	100%	Runoff (decrease)	5.50	None		5.50	0.00	25%	100%	100%	100%	100%	100%	Reduce stormwater runoff

	End 2008	End 2009	End 2010	End 2011	End 2012	End 2013
TCCC Consumption Usage (billion L/yr):	129.0	135.8	142.9	150.4	158.3	166.6
TCCC Watershed Quantity Benefits (billion L/yr):	15.7	28.8	34.2	40.7	54.8	56.8
% of Benefits Relative to Usage:	12%	21%	24%	27%	35%	34%

Project ID	Country	Partner / Lead	Project Description	App E Page #	Description of Activity	Activity Timeline	% TCCC Contribution	Water Quantity Benefits		Water Quality Benefits		TCCC Water Quantity Benefit (million L/yr)	TCCC Water Quality Benefit (MT/yr)	% Complete (end 2008)	% Complete (end 2009)	% Complete (end 2010)	% Complete (end 2011)	% Complete (end 2012)	% Complete (end 2013)	Goals / Problems Addressed
								Type of Benefit Quantified	Quantity Change (million L/yr)	Target Pollutant	Loading Change (MT/yr)									
20	U.S. MD	Delta	Chesapeake Bay Rain Barrel Donation Program	78	Rainwater harvesting (Baltimore, MD; Charlottesville, VA)	2008	100%	Runoff (decrease)	8.73	None		8.73	0.00	100%	100%	100%	100%	100%	100%	Reduce stormwater runoff
21	U.S. / Mexico	WWF	Protecting the Rio Grande / Rio Bravo River	87	*Rio Conchos* - Delicias Irrigation District modernization	2002 - ongoing	0.03%	SW usage (decrease)	396,000.00	None		118.80	0.00	100%	100%	100%	100%	100%	100%	Reduce irrigation water usage
				89	*Rio Conchos* - Pandeno Springs (water efficiency improvements)	2007 - ongoing	51%	GW pumping (decrease)	2,370.00	None		1,208.70	0.00	0%	67%	73%	100%	100%	100%	Secure flows to re-establish population of endemic fish
				98	*Rio Conchos* - reforestation in headwaters (122.5 ha)	2007 - ongoing	35%	Runoff (decrease)	14.60	Sediment	220	5.11	77.00	100%	100%	100%	100%	100%	100%	Reduce sediment erosion/runoff and sedimentation
				92	*Rio Conchos* - Pilot wastewater treatment plant (50 people)	2009	60%	None		Sediment	61.4	0.00	36.86	0%	1%	1%	100%	100%	100%	Demonstration project for wastewater treatment
							60%	None		BOD	27.6	0.00	16.58	0%	1%	1%	100%	100%	100%	
							60%	None		Total Coliform	3.0	0.00	1.78	0%	1%	1%	100%	100%	100%	
							60%	None		Fecal Coliform	0.030	0.00	0.02	0%	1%	1%	100%	100%	100%	
				96	*Rio Conchos* - Rainwater harvesting for drip irrigation	2007 - ongoing	35%	SW usage (decrease)	0.01	None		0.00	0.00	100%	100%	100%	100%	100%	100%	Augment domestic & irrigation water supplies
				81	*Pecos River* - wetland restoration	2007 - 2011	1%	Floodplain inundation (increase)	123	None		1.23	0.00	0%	33%	66%	100%	100%	100%	Re-establish channel morphology
				102	*Rio Grande (Caballo Dam to American Dam, New Mexico)* - Reestablishment of channel morphology and floodplain connectivity	2007 - ongoing	30%	Direct streamflow	3,765	None		1,129.38	0.00	0%	0%	16%	33%	50%	66%	Re-establish channel morphology and floodplain connectivity
				83	*Rio Grande (Big Bend, Texas)* - Reestablishment of channel morphology and floodplain connectivity	2007 - ongoing	30%	Infiltration (increase)	3,040	None		911.97	0.00	0%	20%	28%	35%	42%	49%	Re-establish channel morphology and floodplain connectivity
				105	*Rio Grande (Rio Bosque Wetland Park)* - Acquisition of water rights to support environmental flows	2007 - ongoing	50%	Direct streamflow	6,661	None		3,330.40	0.00	0%	25%	50%	75%	100%	100%	Secure water supply to sustain habitat
22	U.S. Southeast	WWF	Southeast Rivers and Streams Freshwater Conservation Partnership	108	Cumberland River Compact / Coke Consolidated Nashville plant (rainwater harvesting)	2008	100%	Runoff (decrease)	18.44	None		18.44	0.00	100%	100%	100%	100%	100%	100%	Reduce stormwater runoff
25	Honduras	WWF	Rio Chamelecon River Watershed Protection Initiative	111	Conversion of degraded open land to managed cropland	2008 - 2009	31%	Runoff (decrease)	18.00	Sediment	14,571	5.49	4,444.16	0%	100%	100%	100%	100%	100%	Reduce sediment erosion/washoff
28	Vietnam / Thailand	WWF	Conserving the Mekong	115	*Chi River subcatchment:* Reforestation	2008 - ongoing	50%	Runoff (decrease)	128.00	Sediment	171	64.00	85.35	100%	100%	100%	100%	100%	100%	Reduce sediment erosion/runoff; improve biodiversity
				122	*Chi River subcatchment:* Agricultural practices	2008 - ongoing	50%	None		Sediment	2,856	0.00	1,428.00	25%	100%	100%	100%	100%	100%	Demonstration project for improved agricultural practices to reduce sediment, nutrient, and chemical runoff.
				119	*Plain of Reeds (Tram Chim N.P.):* Conservation/ protection of existing resources	2008 - 2011	50%	Direct streamflow	11,400.00	None		5,700.00	0.00	80%	90%	100%	100%	100%	100%	Mitigate flood and drought impacts
31	Romania	WWF	Reconnecting the Lifeline	126	Re-establishment of floodplain wetland connectivity to Danube River	2011 - 2013	38%	Floodplain inundation (increase)	13,750.00	None		5,156.25	0.00	0%	0%	0%	33%	66%	100%	
33	Pakistan	WWF	WWF-Pakistan Western Himalayan Ecoregion	131	Revegetation of bare slope (10 ha)	2008 - 2010	100%	Runoff (decrease)	8.50	Sediment	4,475	8.50	4,475.00	33%	66%	100%	100%	100%	100%	
35	Brazil	TCCC	Brazilian Rainforest Water Program	136	Reforestation (3,000 ha)	2006 - 2010	50%	Runoff (decrease)	2,029.00	Sediment	182,025	1,014.50	91,012.50	7%	13%	51%	100%	100%	100%	Reduce sediment erosion/runoff
36	China	TCCC	Recycling Water Program - Hefei Plant	141	Beneficial water reuse	2007	100%	SW pumping (decrease)	1.00	None		1.00	0.00	100%	0%	0%	0%	0%	0%	Reuse of wastewater
37	Mexico	TCCC	Reforestation of Nevado de Toluca Park	143	Reforestation (1,000 ha)	2005 - 2010	20%	Infiltration (increase)	540.00	Sediment		108.00	0.00	60%	80%	100%	100%	100%	100%	Increase recharge of local aquifer

	End 2008	End 2009	End 2010	End 2011	End 2012	End 2013
TCCC Consumption Usage (billion L/yr):	129.0	135.8	142.9	150.4	158.3	166.6
TCCC Watershed Quantity Benefits (billion L/yr):	15.7	28.8	34.2	40.7	54.8	56.8
% of Benefits Relative to Usage:	12%	21%	24%	27%	35%	34%

Project ID	Country	Partner / Lead	Project Description	App E Page #	Description of Activity	Activity Timeline	% TCCC Contribution	Water Quantity Benefits		Water Quality Benefits		TCCC Water Quantity Benefit (million L/yr)	TCCC Water Quality Benefit (MT/yr)	% Complete (end 2008)	% Complete (end 2009)	% Complete (end 2010)	% Complete (end 2011)	% Complete (end 2012)	% Complete (end 2013)	Goals / Problems Addressed
								Type of Benefit Quantified	Quantity Change (million L/yr)	Target Pollutant	Loading Change (MT/yr)									
38	Mexico	TCCC	Mexico Restoration & Reforestation Program	148	Reforestation (25,000 ha)	2008 - 2012	100%	Runoff (decrease)	9,400.00	Sediment	770,472	9,400.00	770,472.00	7%	39%	50%	60%	100%	100%	Reduce runoff / increase infiltration; reduce sediment erosion/runoff
				145	Ground restoration (infiltration trenches)	2008 - 2012	100%	Infiltration (increase)	18,780.00	Sediment		18,780.00	0.00	7%	39%	50%	60%	100%	100%	Reduce runoff / increase infiltration; reduce sediment erosion/runoff
39	Mexico	TCCC	Reforestation Efforts at the de Monarca Butterfly Bioreserve	154	Reforestation (2,000 ha)	2007 - 2009	100%	Infiltration (increase)	1,080.00	Sediment		1,080.00	0.00	66%	100%	100%	100%	100%	100%	Rehabilitate degraded forest areas
40	Philippines	WWF	Ilagan Watershed Conservation Project in Isabela	156	Conversion of degraded grassland to agro-forestry (220 ha)	2009 - 2010	72%	Runoff (decrease)	136.00	Sediment	11,200	98.33	8,097.60	0%	50%	100%	100%	100%	100%	Reduce sediment erosion/runoff from degraded grassland areas
41	Turkey	TCCC	Every Drop Matters - in Saraykoy and Beypazari	162	Leak repair: replacing water mains to reduce water loss	2007 - 2008	89%	GW pumping (decrease)	45.38	None		40.39	0.00	100%	100%	100%	100%	100%	100%	Increase water use efficiency
42	Maldives	UNDP	Island Sanitation in the Maldives	164	Construction of wastewater treatment facilities	2007 - 2008	39%	None		Sediment	9.4	0.00	3.67	100%	100%	100%	100%	100%	100%	
							39%	None		BOD	7.8	0.00	3.06	100%	100%	100%	100%	100%	100%	
							39%	None		Total Coliform	0.272	0.00	0.11	100%	100%	100%	100%	100%	100%	
							39%	None		Fecal Coliform	0.00272	0.00	0.00	100%	100%	100%	100%	100%	100%	
43	Thailand	TCCC	Conservation and Rehabilitation of the Klong Yan Watershed in Surat Thani	169	Conservation of forest land	2008	100%	Runoff (decrease)	2,078.00	Sediment	2,679,600	2,078.00	2,679,600.00	100%	100%	100%	100%	100%	100%	Conservation of existing forest land; decrease runoff
51	India	TCCC	India Rainwater Harvesting and Aquifer Recharge Projects (8 projects)	173	Rainwater harvesting and artificial aquifer recharge	Ongoing	100%	Recharge (increase)	3,249.00	None		3,249.00	0.00	82%	100%	100%	100%	100%	100%	Recharge aquifer and enhance water supply
70	Spain	WWF	La Guadiana Sub Basin	177	Reforestation (15 ha)	2008	50%	Runoff (decrease)	3.60	Sediment	254	1.80	127.00	100%	100%	100%	100%	100%	100%	Reduce runoff / increase infiltration; reduce sediment erosion/runoff
71	U.S. GA	TCCC	CCE - Cobb County Water Stewardship program	182	Rainwater harvesting	2008 - 2011	100%	Runoff (decrease)	4.07	None		4.07	0.00	100%	100%	100%	100%	100%	100%	Reduce stormwater runoff
72	U.S. GA	TCCC	CCNA - Upper Chattahoochee Riverkeeper Partnership	185	Rainwater harvesting	2008 - 2009	100%	Runoff (decrease)	8.13	None		8.13	0.00	30%	100%	100%	100%	100%	100%	Reduce stormwater runoff
73	Australia	WWF	Great Barrier Reef Project (Project Catalyst)	188	Improved agricultural practices	2009 - 2013	50%	None		Phosphorus	9.9	0.00	4.95	0%	100%	100%	100%	100%	100%	Reduction of runoff and nutrient, sediment and pesticide loadings to the Great Barrier Reef
								None		Nitrogen	32	0.00	16.00	0%	100%	100%	100%	100%	100%	
								None		Pesticides	0.134	0.00	0.07	0%	100%	100%	100%	100%	100%	
75	Ecuador	TCCC	Protection of Water Resources in El Carmen	194	Reforestation (120 ha)	2008 - 2010	53%	Runoff (decrease)	423.00	Sediment	15,860	222.79	8,353.46	0%	42%	100%	100%	100%	100%	Reduce runoff / increase infiltration; reduce sediment erosion/runoff
76	Guatemala	WWF	Protecting the Mesoamerican Reef	198	*Communities of Pueblo Viejo, Cancoy:* Improved agricultural practices (201 ha)	2007 - 2009	30%	None		Sediment	1,954	0.00	586.20	50%	100%	100%	100%	100%	100%	Reduction of sediment loadings to the Polochic and Motagua Rivers and the Mesoamerican Reef (Carribean Sea).
				202	*Communities of Pueblo Viejo, Cancoy:* Forest conservation (1,021 ha)	2007 - 2009	30%	Runoff (decrease)	151.00	Sediment	17,160	45.30	5,148.00	50%	100%	100%	100%	100%	100%	
				207	*Teculutan subwatershed:* Drip irrigation (9 ha)	2008 - 2009	30%	SW usage (decrease)	98.00	None		29.40	0.00	10%	100%	100%	100%	100%	100%	
77	Philippines	TCCC	Go Green! Go For the Real Thing!	210	Reforestation / revegetation (13 ha)	2009	44%	Runoff (decrease)	14.50	Sediment	389	6.38	171.16	0%	100%	100%	100%	100%	100%	
78	U.S. KY	Delta	Lexington Rain Garden	216	Rain garden at Coke bottling plant	2008	100%	Runoff (decrease)	3.40	None		3.40	0.00	100%	100%	100%	100%	100%	100%	Reduce stormwater runoff

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APPENDIX E
Fact Sheets for Activities Quantified

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PROJECT NAME: Paw Paw River Watershed Restoration
PROJECT ID #: 01

DESCRIPTION OF ACTIVITY: Implement conservation tillage practices for 2,000 acres of cropland in the Paw Paw River watershed

LOCATION: Paw Paw River watershed (located near the city of Paw Paw in southwest lower Michigan)

PRIMARY CONTACT:

John Legge	Dan Fields	Rena Stricker	Jon Radtke
West Michigan Conservation Director		Ecologist for Coca-Cola North America	Water Resources Manager
The Nature Conservancy	Coca-Cola Company	Delta Consultants	Coca-Cola Company
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OBJECTIVES:
- Reduce runoff and increase infiltration/baseflow
- Reduce sediment erosion / runoff

BACKGROUND & ACTIVITY DESCRIPTION: Implementing conservation tillage (e.g., no till) practices for agricultural fields that are currently subject to conventional tillage is expected to: 1) reduce runoff quantities and enhance groundwater baseflow, and 2) reduce sediment erosion and runoff from agricultural fields.

ACTIVITY TIMELINE:
- Project will be implemented during a 2-year period extending from September 2009 through August 2011.

COCA-COLA CONTRIBUTION: 100%
- Project would not have occurred without TCCC funding. There are other sources of funding related to implementation.

WATERSHED RESTORATION BENEFITS CALCULATED:
1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of conventionally-tilled straight row cropland to conservation tillage. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project: Conventional tillage (CN=81)
    - straight row crop
    - "poor" condition (< 20% residue coverage)
    - Hydrologic soil group "B"
- Post-project: Conservation tillage (CN=75)
    - straight row crop + crop residue
    - "good" condition (>20% residue coverage)
    - Hydrologic soil group "B"

Hourly meteorological data for local weather stations were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 29-year period (1970-1998), including the effects of seasonal snow accumulation and melt. Total annual average runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project: 2,624 ML/yr (324 mm/yr)
- Post-project: 2,456 ML/yr (303 mm/yr)
- **Benefit (runoff reduction): 168 ML/yr (21 mm/yr)**

Data Sources:

- Size of area targeted for conservation tillage: 2,000 acres (809 Ha)
- Slope: 1% (estimated based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "B"
    - Characterized by moderate to high infiltration rates
    - Based on STATSGO soils database available through BASINS
- Meteorological data:
    - All meteorological data obtained via USEPA's BASINS version 4 software
    - Hourly precipitation data were obtained for Coloma, MI for the 1970-1998 period.
    - Hourly air temperature and evapotranspiration rates were obtained for Berrien Springs, MI for the 1970-2006 period.

Assumptions:

- Land slope was assumed to be 1% on average for the agricultural areas of interest (based on local topographic data)
- SWAT model parameter "CNCOEF" was set to 1.0 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- It was assumed that TCCC will provide funding for BMP implementation.

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting conventionally tilled cropland to conservation tillage. The meteorological and physical datasets described above for the runoff calculation were used. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1970-1998 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as 0.20 and 0.062 for pre-project and post-project conditions, respectively, based on information provided in Haith (1992). Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 3,137 MT/yr (3.9 MT/ha/yr)
- Post-project: 899 MT/yr (1.1 MT/ha/yr)
- **Benefit (reduced sediment yield): 2,238 MT/yr (2.8 MT/ha/yr)**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.17 for use in MUSLE equation.

Assumptions:

- Land slope was assumed to be 1% on average for the agricultural areas of interest.
- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).
- The USLE "Practice Factor" (P) was assumed to be 1.0, corresponding to no contouring or terracing of the land surface.

OTHER BENEFITS NOT QUANTIFIED

- None

NOTES

- This is a preliminary estimate. Monitoring and modeling are being conducted as part of the project.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. “Generalized Watershed Loading Functions – Version 2.0 User’s Manual.” December. Cornell University. Ithaca, NY.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. “Soil and Water Assessment Tool Theoretical Documentation: Version 2005.” January.

USDA-NRCS. 1986. “Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55).” 2nd Edition.

Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Paw Paw River Watershed Restoration
PROJECT ID #: 01

DESCRIPTION OF ACTIVITY: Removal of glossy buckthorn (invasive species) from prairie fens

LOCATION: Paw Paw River watershed (located near the city of Mattawan in southwest lower Michigan)

PRIMARY CONTACT:

John Legge	Dan Fields	Rena Stricker	Jon Radtke
West Michigan Conservation Director		Ecologist for Coca-Cola North America	Water Resources Manager
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OBJECTIVES:

- Reduce evapotranspiration losses of water from wetland areas by clearing the invasive species glossy buckthorn from heavily infested areas.

BACKGROUND & ACTIVITY DESCRIPTION: Glossy buckthorn is an invasive species that has infested large areas within prairie fens located in the Paw Paw watershed. A previous groundwater level study conducted by TNC in Lenawee, Michigan indicated that one acre of dense glossy buckthorn removed 0.325 million gallons of water per year. Therefore, removal of glossy buckthorn is expected to enhance groundwater baseflow derived from these wetland areas.

ACTIVITY TIMELINE:

- Project will be implemented during a 3-year period extending from January 2009 through December 2011.
- A total of 22 acres of a planned 56 acres (39%) have been cleared to date.

COCA-COLA CONTRIBUTION: 1%

- Project is only receiving minor funding from Coca-Cola, but some volunteer assistance by Coca-Cola employees contributes to this goal.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in groundwater storage / baseflow

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1. INCREASE IN GROUNDWATER STORAGE / BASEFLOW

Approach & Results:

The Nature Conservancy previously conducted a groundwater level study in Lenawee, Michigan to investigate the impacts of glossy buckthorn on local water quantity. The results of this study suggest that dense areas of glossy buckthorn will remove approximately 0.325 million gallons of water per acre per year (MG/ac/yr) via uptake of surface and ground water and subsequent transpiration losses.

The approach taken assumes that the water lost via glossy buckthorn uptake and transpiration would have otherwise been maintained as groundwater storage and would have eventually been available for baseflow to the stream network. Based on this assumption, the water quantity benefit can be expressed in terms of the groundwater storage/baseflow that would be available due to the removal of glossy buckthorn. The application of the unit water loss associated with glossy buckthorn (0.325 MG/ac/yr = 1.23 ML/ac/yr) to the total planned area of removal (56 acres) gives a **total quantity benefit of 68.9 ML/yr**.

Data Sources:

- Size of area targeted for glossy buckthorn removal: 56 acres (22.7 ha)
- Water usage data for glossy buckthorn obtained from the groundwater levels study in Lenawee, Michigan.

Assumptions:

- Glossy buckthorn water uptake rates measured in the Lenawee study are representative of uptake rates in the Paw Paw River watershed.
- Water uptake rates for glossy buckthorn are much greater than uptake rates for native wetland plant species that will succeed them.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved wetland plant species diversity (i.e., promotion of native species via removal of invasive species).

NOTES:

REFERENCES:

PROJECT NAME: Tallgrass Prairie Watershed Restoration in North Texas
PROJECT ID #: 02

DESCRIPTION OF ACTIVITY: Conservation of native prairie land (1,300 acres)

LOCATION: The Clymer Meadow Preserve located within East Fork Trinity River watershed (approximately 20 miles northeast of Dallas, Texas).

PRIMARY CONTACT:

David Bezanson	Brad Cozart	Rena Stricker	Jon Radtke
The Nature Conservancy	Coca-Cola Company – Dallas Syrup Plant, Grand Prairie Plant	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
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OBJECTIVES:
- Open space conservation
- Protection of water resources (including reduction in runoff and increase in infiltration)

BACKGROUND & ACTIVITY DESCRIPTION: The Nature Conservancy is pursuing several activities at its Clymer Meadow Preserve, including the conservation of 1,300 acres (526 ha) of native prairie grassland, with 24 acres of wetlands. The conservation effort is in direct response to the ongoing conversion of large, native grassland tracts to rural residential development. This activity involves purchasing land or obtaining conservation easements to prevent land conversion.

Clymer Meadow Preserve (photo by TNC)

ACTIVITY TIMELINE:

- Project will be implemented between September 2008 and May 2009.

COCA-COLA CONTRIBUTION: TBD

- Assumed 50% for current esitmates

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff that would occur by preventing the conversion of grasslands to rural residential land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project": rural residential development
  - Herbaceous cover (grass/weed mixture) in "fair" condition, 30-75% cover (CN = 89)
  - Hydrologic soil group "D"
- "Post-project": native grassland
  - Grassland/range in "good" condition, >75% cover (CN = 80)
  - Hydrologic soil group "D"

Hourly meteorological data for Dallas, TX (Love Field) were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 12-year period (1995-2006). Total annual average runoff volumes and the resulting water quantity benefit for preserving the 1,300-acre (526 ha) native grassland area were estimated as follows:

- "Pre-project" (rural residential development): 1,213 ML/yr (231 mm/yr)
- "Post-project" (grassland/range - "good" condition): 789 ML/yr (150 mm/yr)
- **Benefit (runoff reduction): 424 ML/yr**

Data Sources:

- Size of revegetated prairie area: 1,300 acres (526 ha)
- Slope: 2% (estimated average based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "D"
  - Characterized by low infiltration rates
  - Based on STATSGO soils database available through BASINS
- Meteorological data:
  - All meteorological data obtained via USEPA's BASINS version 4 software
  - Hourly precipitation, air temperature, and evapotranspiration data were obtained for the Dallas Love Field weather station (ID: TX412244) for the 1995-2006 period.

Assumptions:

- "Pre-project" (i.e., post-development) conditions were assumed to be 30-75% herbaceous cover ("fair" condition), and "post-project" (conserved land) was assumed to have greater than 75% native grass cover ("good" condition).
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting rural residential area to native grassland area. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1995-2006 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as follows based on information available in Haith (1992):

- "Pre-project": prairie with ~60% cover as weeds/grass mixture (C = 0.06)
- "Post-project": prairie with ~80% cover as grass (C = 0.01)

Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 1,837 MT/yr (3.5 MT/ha/yr)
- Post-project: 200 MT/yr (0.4 MT/ha/yr)
- **Benefit (reduced sediment yield): 1,637 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.32 for use in MUSLE equation.

Assumptions:

- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Increase in infiltration and baseflow
- Improvements in terrestrial habitat and biodiversity

NOTES

- Estimations are preliminary. Monitoring is being conducted as part of the project.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Tallgrass Prairie Watershed Restoration in North Texas
PROJECT ID #: 02

DESCRIPTION OF ACTIVITY: Removal of invasive prairie plant species

LOCATION: The Clymer Meadow Preserve located within East Fork Trinity River watershed (approximately 20 miles northeast of Dallas, Texas).

PRIMARY CONTACT:

David Bezanson	Brad Cozart	Rena Stricker	Jon Radtke
The Nature Conservancy	Coca-Cola Company – Dallas Syrup Plant, Grand Prairie Plant	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
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dbezanson@tnc.org	bcozart@na.ko.com	rstricker@na.ko.com	jradtke@na.ko.com

OBJECTIVES:

- Increase infiltration and reduce sediment erosion
- Eliminate monocultural stands of invasive plant species
- Promote expansion of native prairie grass species and overall biodiversity

BACKGROUND & ACTIVITY DESCRIPTION: The Nature Conservancy is pursuing several activities at its Clymer Meadow Preserve, including the removal of 330 acres (134 ha) of invasive grass species, including tall fescue, Johnsongrass, and King Ranch bluestem. Tall fescue and Johnsongrass develop into monocultural stands, lowering species diversity and decreasing overall function. King Ranch bluestem is a non-native bunchgrass characterized by interstitial bare ground between clumps, which promotes soil loss, soil crusting, and enhanced runoff / decreased infiltration. In 2008, approximately 130 acres of land were treated, including removal of 100 acres of tall fescue, 30 acres of King Ranch bluestem, and <1 acre of Johnsongrass.

Clymer Meadow Preserve (photo by TNC)

ACTIVITY TIMELINE:

- Invasive plant removal is ongoing.

COCA-COLA CONTRIBUTION: TBD

- Assumed 50% for current estimates

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff that would occur by removal of invasive prairie species and succession by native grassland species. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project": grassland area dominated by invasive species
    - Grassland in "fair" condition, 50-75% cover (CN = 84)
    - Hydrologic soil group "D"
- "Post-project": native grassland
    - Grassland/range in "good" condition, >75% cover (CN = 80)
    - Hydrologic soil group "D"

Hourly meteorological data for Dallas, TX (Love Field) were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 12-year period (1995-2006). Total annual average runoff volumes and the resulting water quantity benefit for preserving the 1,300-acre (526 ha) native grassland area were estimated as follows:

- "Pre-project" (invasive species): 242 ML/yr (180 mm/yr)
- "Post-project" (native grassland): 201 ML/yr (150 mm/yr)
- **Benefit (runoff reduction): 41 ML/yr**

Data Sources:

- Size of invasive species treatment/removal area: 330 acres (134 ha)
- Slope: 2% (estimated average based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "D"
  - Vertisols (Pellusterts) and Mollisols (Haploquolls)
  - Characterized by low infiltration rates
  - Based on STATSGO soils database available through BASINS
- Meteorological data:
  - All meteorological data obtained via USEPA's BASINS version 4 software
  - Hourly precipitation, air temperature, and evapotranspiration data were obtained for the Dallas Love Field weather station (ID: TX412244) for the 1995-2006 period.

Assumptions:

- "Pre-project" (i.e., area dominated by invasive species) conditions were assumed to be grassland in "fair" condition (50-75% cover), and "post-project" (native grassland) was assumed to be in "good" condition (> 75% vegetative cover).
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting rural residential area to native grassland area. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1995-2006 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as follows based on information available in Haith (1992):

- "Pre-project": prairie with ~80% cover as weeds (C = 0.04)
- "Post-project": prairie with ~80% cover as grass (C = 0.01)

Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 207 MT/yr (1.5 MT/ha/yr)
- Post-project: 43 MT/yr (0.3 MT/ha/yr)
- **Benefit (reduced sediment yield): 164 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.32 for use in MUSLE equation.

Assumptions:

- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Increase in infiltration and baseflow
- Improvements in terrestrial habitat and biodiversity

NOTES

- These are preliminary estimates. Monitoring is being conducted as part of the project.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Tallgrass Prairie Watershed Restoration in North Texas
PROJECT ID #: 02

DESCRIPTION OF ACTIVITY: Revegetation of prairie land with native grassland species

LOCATION: The Clymer Meadow Preserve located within East Fork Trinity River watershed (approximately 20 miles northeast of Dallas, Texas).

PRIMARY CONTACT:

David Bezanson	Brad Cozart	Rena Stricker	Jon Radtke
The Nature Conservancy	Coca-Cola Company – Dallas Syrup Plant, Grand Prairie Plant	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
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OBJECTIVES:
- Reduce runoff quantity and increase infiltration
- Improve biodiversity

BACKGROUND & ACTIVITY DESCRIPTION: The Nature Conservancy is pursuing several activities at its Clymer Meadow Preserve, including the revegetation of 280 acres (113 ha) of degraded riparian woodland with native grass and tree species. Cover goals for grassland communities are 70% total cover by native perennial grasses and forbs, and the goal for tree planting is a minimum of 6 trees per acre surviving to maturity. Revegetation with native plant species is expected to improve the infiltration characteristics of the grassland and promote floral and faunal habitat and biodiversity.

Clymer Meadow Preserve (photo by TNC)

ACTIVITY TIMELINE:

- Project will be implemented between September 2008 and May 2009.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff resulting from the construction of a riparian buffer. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project":
    - Grassland/range in "fair" condition, 50-75% cover (CN = 84)
    - Hydrologic soil group "D"
- "Post-project":
    - Grassland/range in "good" condition, >75% cover (CN = 80)
    - Hydrologic soil group "D"

Hourly meteorological data for Dallas, TX (Love Field) were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 12-year period (1995-2006). Total annual average runoff volumes and the resulting water quantity benefit for revegetating the 280-acre (113 ha) prairie area were estimated as follows:

- Pre-project (grassland/range - "fair" condition): 204 ML/yr (180 mm/yr)
- Post-project (grassland/range - "good" condition): 170 ML/yr (150 mm/yr)
- **Benefit (runoff reduction): 34 ML/yr**

Data Sources:

- Size of revegetated prairie area: 280 acres (113 ha)
- Slope: 2% (estimated average based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "D"
    - Characterized by low infiltration rates
    - Based on STATSGO soils database available through BASINS
- Meteorological data:
    - All meteorological data obtained via USEPA's BASINS version 4 software
    - Hourly precipitation, air temperature, and evapotranspiration data were obtained for the Dallas Love Field weather station (ID: TX412244) for the 1995-2006 period.

Assumptions:

- Vegetative cover was assumed to be 50-75% ("fair" condition) prior to this activity and greater than 75% ("good" condition) following the revegetation efforts.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting grassland from "fair" to "good" cover conditions (see definitions in previous section). The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1995-2006 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as follows based on Haith (1992):

- "Pre-project": prairie with ~60% cover as weeds/grass (C = 0.08)
- "Post-project": prairie with ~80% cover as grass (C = 0.01)

Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 343 MT/yr (3 MT/ha/yr)
- Post-project: 36 MT/yr (0.3 MT/ha/yr)
- **Benefit (reduced sediment yield): 307 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.32 for use in MUSLE equation.

Assumptions:

- Land slope was assumed to be 1% on average for the agricultural areas of interest.
- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Increase in infiltration and baseflow
- Improvements in terrestrial floral and faunal habitat

NOTES

- Estimates are preliminary. Monitoring is being conducted as part of the project.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. “Generalized Watershed Loading Functions – Version 2.0 User’s Manual.” December. Cornell University. Ithaca, NY.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. “Soil and Water Assessment Tool Theoretical Documentation: Version 2005.” January.

USDA-NRCS. 1986. “Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55).” 2nd Edition.

Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Tallgrass Prairie Watershed Restoration in North Texas
PROJECT ID #: 02

DESCRIPTION OF ACTIVITY: Construction of a riparian buffer

LOCATION: The Clymer Meadow Preserve located within East Fork Trinity River watershed (approximately 20 miles northeast of Dallas, Texas).

PRIMARY CONTACT:

David Bezanson	Brad Cozart	Rena Stricker	Jon Radtke
The Nature Conservancy	Coca-Cola Company – Dallas Syrup Plant, Grand Prairie Plant	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
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OBJECTIVES:

- Reduce runoff quantity, increase infiltration

BACKGROUND & ACTIVITY DESCRIPTION: The Nature Conservancy is pursuing several activities at its Clymer Meadow Preserve, including the planting of a 7-acre riparian buffer area along a 1,400 foot reach of Clymer Creek, a tributary of Arnold Creek and the East Fork Trinity River. The buffer consists of native woody and grass species and will have a width of approximately 200 feet along both banks of the creek.

Clymer Meadow Preserve (photo by TNC)

ACTIVITY TIMELINE:

- Project will be implemented between September 2008 and May 2009.

COCA-COLA CONTRIBUTION: 100%

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff that would occur by constructing the riparian buffer. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

In general, buffers probably do not substantially reduce the quantity of runoff and shallow subsurface (interflow) water delivered to a stream due their close proximity to the stream network. However, reductions in runoff are being considered in this particular case because the planned buffer width (200 feet) is much greater than a typical riparian buffer width.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project":
  - Herbaceous cover (grass/weed mixture) in "fair" condition, 30-75% cover (CN = 89)
  - Hydrologic soil group "D"
- "Post-project": native grassland
  - Woodlands in "good" condition (CN = 77)
  - Hydrologic soil group "D"

Hourly meteorological data for Dallas, TX (Love Field) were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 12-year period (1995-2006). Total annual average runoff volumes and the resulting water quantity benefit for preserving the 1,300-acre (526 ha) native grassland area were estimated as follows:

- "Pre-project" (rural residential development): 6.5 ML/yr (231 mm/yr)
- "Post-project" (grassland/range - "good" condition): 3.7 ML/yr (131 mm/yr)

- **Benefit (runoff reduction): 2.8 ML/yr**

Data Sources:

- Size of revegetated prairie area: 7 acres (2.8 ha)
- Slope: 2% (estimated average based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "D"
    - Characterized by low infiltration rates
    - Based on STATSGO soils database available through BASINS
- Meteorological data:
    - All meteorological data obtained via USEPA's BASINS version 4 software
    - Hourly precipitation, air temperature, and evapotranspiration data were obtained for the Dallas Love Field weather station (ID: TX412244) for the 1995-2006 period.

Assumptions:

- "Pre-project" (i.e., post-development) conditions were assumed to be 30-75% herbaceous cover ("fair" condition), and "post-project" (conserved land) was assumed to have greater than 75% native grass cover ("good" condition).
- Calculations assume that the riparian buffer is sufficiently mature to affect runoff/infiltration characteristics.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and runoff that would occur as a result of converting rural residential area to native grassland area. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1995-2006 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as follows based on information available in Haith (1992):

- "Pre-project": prairie with ~60% cover as weeds/grass mixture (C = 0.06)
- "Post-project": woodland with 40-75% tree canopy (C = 0.002)

Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 5.2 MT/yr (1.9 MT/ha/yr)
- Post-project: 0.1 MT/yr (0.04 MT/ha/yr)
- **Benefit (reduced sediment yield): 5.1 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.32 for use in MUSLE equation.

Assumptions:

- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Increase in infiltration and baseflow
- Improvements in terrestrial habitat and biodiversity
- Improvements in fish habitat (due to increase in stream shading)

NOTES

- Monitoring is being conducted as part of the project, so estimates are preliminary.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Flint River Watershed Restoration
PROJECT ID #: 03

DESCRIPTION OF ACTIVITY: Remote soil moisture monitoring for irrigation management

LOCATION: Flint River Watershed, Georgia

PRIMARY CONTACT:

David Reckford	Rena Stricker	Jon Radtke
The Nature Conservancy	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
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OBJECTIVES

- Provide demonstration project for decreasing irrigation water use

BACKGROUND & DESCRIPTION OF ACTIVITY:

This is a demonstration project focused on improved irrigation practices through remote soil moisture monitoring. Based on estimates by UGA and USDA, remote soil moisture monitoring can reduce irrigation application by 1-2 applications/season; however, the reduction volume is dependent on rainfall which determines irrigation rate (currently: 12 inches in a dry year; 10 in an average year; 8 in a wet year). This project will track soil conditions in real time, and reduce the number of applications based on crop need.

ACTIVITY TIMELINE:

- Project initiation: 2008
- Anticipated project completion: 2009

COKE CONTRIBUTION: 100%

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in groundwater pumping

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1. INCREASE IN RECHARGE

Approach and Results

For simplicity, it was assumed that 100% of the water not pumped from the aquifer can be claimed as a benefit (i.e., assume that only a small percentage of irrigation water percolates to the aquifer after an application, and that the rest is lost to plant uptake/transpiration, evaporation from the upper soil zone, and interflow/runoff.

- 1 acre inch = 27,154 gallons or 102,790 liters of water;

Center pivot irrigation is used on ~1,000 acres of land with a slope of 1-2%. The crop season is 6 months.

The water quantity benefit was calculated based on the pre- and post-project irrigation application rates provided by David Reckford in the survey response.

- Pre-project: 2 ac-in/month * 6 months * 1000 acres = 1.23 billion L/yr
- Post-project: 1.75 ac-in/month * 6 months = 1.08 billion L/yr
- Represents a 12.5% reduction in irrigation water applied
- 1 acre inch = 102,790.15461 liter

Water savings = 0.25 ac-in/month *6 months * 1000 acres = 154 million L/yr

Data sources

- All information used in the estimate was provided by D. Reckford.

Assumptions

- It is assumed that the acreage in the program is 1,000 acres. This is an approximation at the present time.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

REFERENCES

Evans, Robert O, et al. 1998. Irrigation Conservation Practices Appropriate for the Southeastern United States. Edited by: Daniel L. Thomas. Project Report 32.

PROJECT NAME: Etowah River Watershed Conservation Partnership
PROJECT ID #: 04

DESCRIPTION OF ACTIVITY: Riparian buffer planting for Raccoon Creek

LOCATION: Raccoon Creek within the Etowah River watershed

PRIMARY CONTACT:

Katie Owens	Rena Stricker	Jon Radtke
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OBJECTIVES:
- Streambank stabilization to reduce instream erosion
- Improved riparian shading for fish habitat

BACKGROUND & ACTIVITY DESCRIPTION: Raccoon Creek, a tributary to the Etowah River, is located adjacent to a 300-foot Georgia Power right of way. An approximately 6,700 foot reach of Raccoon Creek is currently void of riparian vegetation due to overlap with the right of way. The project will involve planting a 25-foot wide riparian buffer along the west and east banks of this reach. The riparian buffer is primarily intended to improve stream stabilization and improve the quality of fish habitat via improved shading.

ACTIVITY TIMELINE:
- Project will be implemented during a 3-year period from April 2009 through May 2012.

COCA-COLA CONTRIBUTION: 100%
- Project is fully funded by Coca-Cola (see note below)

WATERSHED RESTORATION BENEFITS CALCULATED:
1. Decrease in sediment runoff

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1. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the current sediment erosion and washoff for the land areas adjacent to Raccoon Creek that drain directly to Raccoon Creek for the reach where the buffer is planned. The direct drainage areas were delineated manually in GIS and overlain with lands use, soils, and topography data. The characteristics of this area can be summarized as follows:

- Total drainage area: 226 acres (91 ha)
- Land use: 58% forest, 24% pasture, 8% open space, 9% herbaceous cover
- Average slope: 1.5%
- Hydrologic soil group "B" (moderate infiltration)

For simplicity, 33% of the total area was assumed to be pasture and 67% was assumed to be forested. The cover and management factors (C_{usle}) for pasture and forest were estimated as 0.090 and 0.003, respectively.

Hourly precipitation, air temperature, and potential evapotranspiration (PET) data were obtained for Dallas, GA (station ID: GA092485) for the 1970-2006 period. These datasets were used to calculate daily total precipitation and PET and average/maximum air temperature.

The Curve Number (USDA-NRCS, 1986) and MUSLE methods were used to estimate total annual sediment yield for the direct drainage area based on the physical characteristics and meteorological datasets described above. The total land-based sediment load to Raccoon Creek was estimated to be 150 MT/yr. The SWAT model also provides an equation to estimate the reduction in sediment load due to the presence of a riparian buffer (Equation 6:1.11.2; Neitsch et al. 2005). Using this equation, a trapping efficiency of 67% is calculated for a buffer width of 25 feet (7.6 m). Therefore, the **reduction in sediment load is estimated as 100 MT/yr**.

Data Sources:

- Size of direct drainage area: 226 acres (91 ha) (estimated from GIS)
- Slope: 1.5% (estimated based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "B"
  - Characterized by moderate to high infiltration rates
  - Based on STATSGO soils database available through BASINS
- Meteorological data:
  - All meteorological data were obtained via USEPA's BASINS (version 4) software.
  - Hourly precipitation, air temperature, and PET data were obtained for Dallas, GA for the 1970-2006 period.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.28 for use in MUSLE equation.

Assumptions:

- Riparian buffer was assumed to have optimal filtering efficiency.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction of instream bank sediment erosion
- Improvements in fish habitat quality due to riparian shading

NOTES: *[per Katie Owens email, 5/18/09]* TNC submitted a $100,000 grant proposal to USFWS to assist in the restoration of Raccoon Creek. A number of sites need actual streambank stabilization using Geomatting, which would be paid for through these additional funds. The TCCC funds are being used for plantings.]

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PROJECT NAME: Etowah River Watershed Conservation Partnership
PROJECT ID #: 04

DESCRIPTION OF ACTIVITY: Stormwater Infiltration Project

LOCATION: Etowah River watershed

PRIMARY CONTACT:

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OBJECTIVES:

- Improved infiltration characteristics, dissipation of energy in the ditch.
- Reduction of sediment bank erosion and gullying within the stormwater ditch.
- Reduction of sediment bank erosion within the Etowah River downstream of the ditch outlet.

BACKGROUND & ACTIVITY DESCRIPTION: The stormwater infiltration project involved stabilizing and improving stormwater infiltration surrounding the Upper Etowah River Alliance's office, which is located just outside of downtown Canton on the mainstem Etowah.

The stormwater infiltration project focused primarily on a large drainage ditch and the development of an environmentally friendly parking pad. In its' current state the drainage ditch was rapidly eroding and causing downstream streambank instability.

The goal of the stormwater infiltration project was to slow water in the ditch down to allow for infiltration, especially after high rain flow events. This was accomplished by reshaping the channel of the ditch, removing invasives in and along the ditch, replanting native vegetation along the ditch, and placing Channel Soxx within the ditch bed in order to slow water and allow for infiltration. This particular ditch is downstream of McLure Street and multiple homes so this project should reduce non point source pollution entering the Etowah River. In addition to work on the ditch, a porous parking lot was also established, rather than using the typical concrete pad. This project involved using environmentally friendly porous material that allows water to infiltrate rather than increasing stormwater flows to the adjacent ditch and Etowah River.

This project is also considered Phase 1 in the stabilization of a major streambank erosion site, located just downstream of the UERA office and drainage ditch. Increasing infiltration of stormwater immediately upstream of the streambank erosion site will reduce downstream streambank erosion, thus reducing sediment loads entering the river.

ACTIVITY TIMELINE:

- Project will be implemented during a 3-year period from April 2009 through May 2012.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in instream sediment erosion

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1. DECREASE IN INSTREAM SEDIMENT EROSION

Approach & Results:

Instream erosion rates are highly site-specific and require monitoring data to accurately quantify. Examples of monitoring data that could be used to support a sediment erosion calculation include 1) suspended sediment concentrations at the ditch outlet for storm events, and/or 2) estimates of bank retreat rates. These data are not available at this time; however, the typical dimensions of the ditch and the dimensions of the eroded section of the ditch were provided by TNC staff:

- Typical dimensions:
  - Depth: ~4 ft
  - Width: ~3-5 ft
- Eroded reach:
  - Length: ~30 ft
  - Maximum depth: 12 ft
  - Width: 18 ft

The timeline for the erosion and gullying of the lower 30 feet of the ditch is unknown. If it is assumed that the erosion has occurred over a period of approximately 10 years, then the annual rate of erosion from the banks and the bottom of the ditch is roughly 1 foot/year. Based on this estimate and the average dimensions of the eroded section of the ditch, the annual volume of sediment erosion within the ditch can be approximated as: (16 ft^2) x (30 ft) = 480 ft^3 = 13.6 m^3. Assuming a sediment bulk density of 2,400 kg/m3, the total sediment mass eroded is 32,600 kg/yr (32.6 MT/yr). It is anticipated that the ditch improvements will essentially eliminate erosion; therefore, the **total benefit in terms of reduction of sediment delivery to the Etowah is 32.6 MT/yr.**

Data Sources:

- TNC staff provided the physical dimensions of the stormwater ditch (including "typical" dimensions and the dimensions of the eroded section – see above).

Assumptions:

- Erosion of the banks and downcutting into the ditch has been occurring at a rate of approximately 1 foot per year.
- Ditch improvements will essentially eliminate sediment erosion due to downcutting and bank erosion.

OTHER BENEFITS NOT QUANTIFIED

- Enhanced infiltration within the stormwater ditch.
- Reduced instream bank erosion in the Etowah River downstream of the ditch outlet.

NOTES

- Increases in infiltration of stormwater delivered to the ditch were not quantified because these rates will be site-specific and require direct or indirect measurement.
- Decreases in bank erosion within the Etowah River downstream of the ditch outlet were not quantified because data on bank retreat rates or a detailed model would be required to support this estimate.

REFERENCES:

PROJECT NAME: Transboundary Community Water Management
PROJECT ID #: 05

DESCRIPTION OF ACTIVITY: Reforestation of riparian zones

LOCATION: Ghana and Ivory Coast - Tano River Basin Watershed (Western Region of Ghana and Aboisso Prefecture of Ivory Coast)

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OBJECTIVES:
- Reduce erosion
- Reduce sedimentation in river
- Restore riparian forest habitat.

BACKGROUND & ACTIVITY DESCRIPTION:

Deforestation can contribute to increased soil erosion, reduced soil fertility, reduced receiving water quality, and decreased biodiversity (both terrestrial and aquatic). The Water Research Institute of Ghana has noted that in the Transboundary project area, annual rainfall and discharge rates have been decreasing during the past few decades. Although there is no scientific evidence to support that deforestation has been a factor, these trends are generally attributed to widespread deforestation and land use changes. Deforestation may also contribute to flooding problems. A program to reverse degradation of the Tano River watershed area includes:

- Creation of 100 meter buffer strips along the banks of Tano River and 30 meter buffer strips along all tributaries;
- Initiation of agro-forestry activities in the buffer strips;
- Prohibition of farming close to the river and its tributaries;
- Prevention of wild fires;
- Public awareness campaigns.

There are approximately 20 tributaries that feed the Tano River at its headwaters. Some are severely threatened from land clearing and associated erosion. The effects of environmental degradation in the headwaters is felt downstream. This part of the Tano River watershed is also proximate to the (Newmont Gold Ghana) NGG operations.

This program addresses a need to restore riparian zones. Technical studies were conducted, and the estimated area of riparian zone identified for rehabilitation was 1,000 hectares (according to final contractor workplan). Combating wildfires was another key activity.

In Ghana, the project focused on two regions: Brong Ahafo Region and Western Region (Brong Ahafo is located directly north of Western Region). In the Ivory Coast, the project focused on the Aboisso Prefecture and the Sous-Prefectures.

ACTIVITY TIMELINE: 100% Complete

- April 2008: Five community nurseries in place with a total of about 8,000 seedlings of 4 indigenous species (Edinam, Emire, Ofram and Mahogany). Tree planting (2,300 seedlings of Mahogany, Cedrela, Ofram, Emire, Edinam and Kola) in five communities along the Tano River began mid May 2008 in Ghana and July 2008 in Ivory Coast. (*from April 2008 Quarterly Report)*
- September 2008: 10,000 trees (Mahogany, Cedrela, Ofram, Emire, Edinam and Kola) planted along the Tano River. *(from September 2008 Quarterly Report)*
- March 2009: 13,544 indigenous timber trees (Mahogany, Cedrela, Ofram, Emire, Edinam and Kola) planted along the Tano River in Ghana as of February 2009. *(from survey responses)*

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff water quantity
2. Decrease in sediment runoff

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1. DECREASE IN RUNOFF WATER QUANTITY

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested (e.g., pasture/range) land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:

    - Hydrologic soil group (HSG) “C”
    - Pasture/grassland in “fair” to “good” condition: > 50-75% vegetative cover (CN = 76.5)
- Post-project:
    - Hydrologic soil group (HSG) “C”
    - Woodland in “good” condition (CN = 70)

Daily precipitation and air temperature data were obtained for Adiake, Cote D'Ivoire from TuTiempo.net for the 2003-08 period. Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for years 2003-08. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space): 49.4 ML/yr (366 mm/yr)
- Post-project (reforested land): 43.4 ML/yr (322 mm/yr)
- **Benefit (runoff reduction): 6.0 ML/yr (44 mm/yr)**

Data Sources:

- Size of reforested land area: 13.5 ha (estimated based on 13,500 trees planted, assuming 1,000 trees per hectare)
- Slope: assumed to be 5% (conservative estimate)
- Soil type: “Available water content” of 3 mm per meter of soil depth (Batjes, 1996) – consistent with hydrologic soil group “C” characteristics.
- Daily precipitation data for years 2003-08 were obtained for Adiake, Cote D'Ivoire (station ID: 655850) from TuTiempo.net (http://www.tutiempo.net/en/Climate/Adiake/655850.htm).

Assumptions:

- Reforested land area is approximately 13.5 ha (based on an assumed tree density of ~1,000 trees per hectare).
- Precipitation data obtained for Adiake, Cote D'Ivoire for years 2003-08 are generally representative of average annual precipitation conditions for the areas where reforestation is occurring. (Average precipitation for Adaike for 2003-08 is 1,301 mm/yr.)
- The pre-project land cover can be appropriately characterized as open pasture/rangeland with approximately 50-75% or more vegetative cover. (Note that this provides a conservative estimate of Curve Number for areas that have been utilized as crop land.)
- The average slope conditions for the reforested area are approximately 5% (conservative estimate).

- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass, 80% cover (C_{usle} = 0.01)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (pasture/rangeland): 29.1 MT/yr (2.2 MT/ha/yr)
- Post-project (forested): 2.6 MT/yr (0.2 MT/ha/yr)
- **Benefit (reduced sediment yield): 26.5 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife
- Shading of streams lowers water temperatures and improves fishery

NOTES

- Survey response states the area restored is unknown – but workplan states 1,000 hectares.

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PROJECT NAME: Community Water Supply, Sanitation, and Wastewater Program
PROJECT ID #: 06

DESCRIPTION OF ACTIVITY: Irrigation improvements

LOCATION: Mali

PRIMARY CONTACT:
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OBJECTIVES
- Reduce irrigation water usage
- Improve crop yields

BACKGROUND & DESCRIPTION OF ACTIVITY:
A new technology for small-scale irrigation was introduced, involving 78 drip kits. These were used to irrigate 7.6 hectares of cropland. The outcome was an increase in irrigation water use efficiency from 60% to 90%. The irrigation water source is the local groundwater aquifer.

ACTIVITY TIMELINE: (from Close-Out Report)
- Project duration: November 9, 2005 to July 30, 2008

COCA-COLA CONTRIBUTION: 100%
- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:
1. Decrease in ground water pumping

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1. DECREASE IN GROUND WATER PUMPING

Approach & Results
Irrigation water usage rates were reported in the survey response. Estimates of pre-project water usage are 1,200,000 m3/ha/month, and post-project water usage was estimated at 800,000 m3/ha/month. This results in a water savings of **400,000 m3/ha/month** (more than 18 billion liters per year assuming a 6 month irrigation season). The contact confirmed this water savings, but it is highly elevated and unrealistic for the project's small 7.6 ha plot of cropland.

As a result, the benefit from irrigation water savings was estimated based on data reported for a similar drip irrigation project with a similar land area in Nigeria ("Improved Health and Livelihoods in Nigeria's Rural Communities"). The water savings in Nigeria was computed as the difference between pre-project water usage and post-project water usage, resulting in savings for a 7.6 hectare irrigated plot as follows:

- Pre-project water usage: 20,000 L/day
- Post-project water usage: 18,000 L/day
- Water savings: 2,000 L/day
- Number of days of irrigation per year: 90
- **Benefit (water savings) of 180,000 liters/year = 0.18 ML/yr**

Data sources

- Water savings used were reported for the drip irrigation project conducted in Nigeria

Assumptions

- Assumed conditions in Mali and Nigeria are similar.
- Assumed Water savings of 2,000 L/day
- Assumed number of days irrigation/year = 90
- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER BENEFITS NOT QUANTIFIED: None

NOTES: The approach is conservative because the irrigated area in Nigeria is 4 Ha, and the Mali project involves 7.6 Ha.

REFERENCES

GETF. 2009. Community Water Supply, Sanitation, and Small-Scale Agriculture, WADA Mali Close-Out Report.

PROJECT NAME: Improved Community Livelihoods and Sustainable Water Management
PROJECT ID #: 07

DESCRIPTION OF ACTIVITY: Reforestation

LOCATION: Wami/Ruvu and Pangani River Basins, Tanzania.

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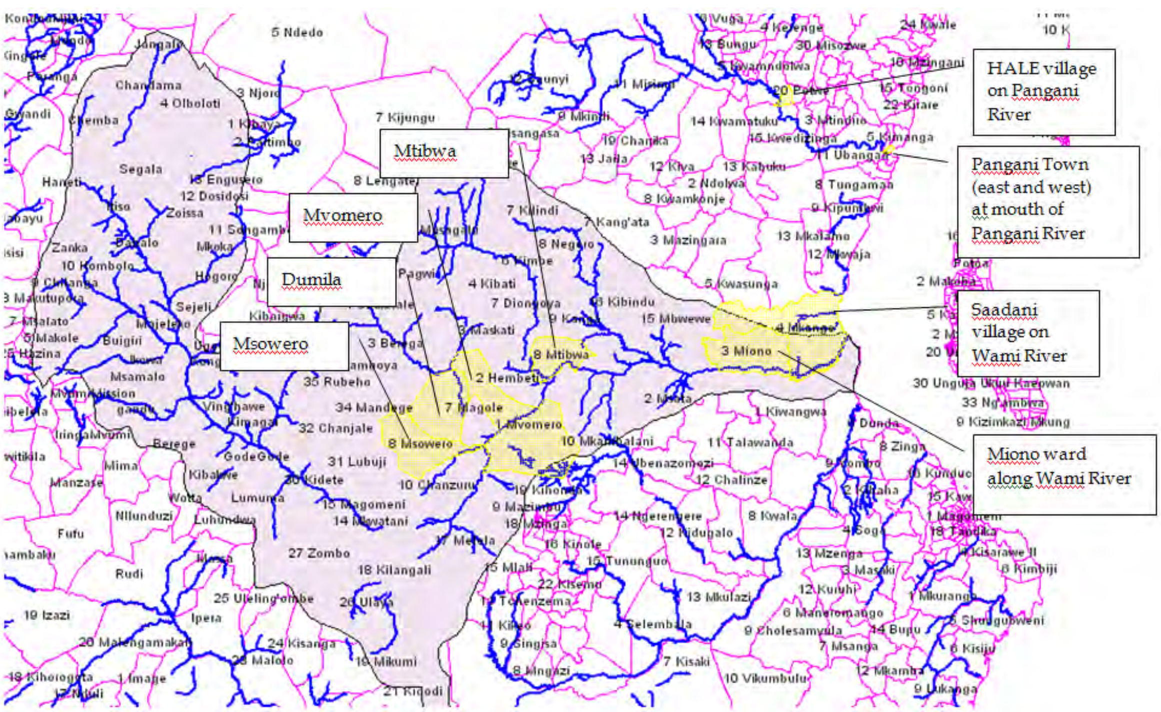
OBJECTIVES:

- Reduce land degradation and erosion

BACKGROUND & ACTIVITY DESCRIPTION: A reforestation effort to reduce land degradation was introduced in April 2007 at two project sites (Msowero Village in Kilosa District and Miono Ward in Bagamoyo District) where, initially, more than 13,000 tree seedlings were planted and three tree nurseries established to sustain the tree planting initiatives. At the project completion in August 2008, 38,861 trees (including cedar trees, among others) were planted on 23 hectares at eight locations in the Wami River Basin. Other project activities included development of water supply and sanitation



Map of Wami watershed (gray shape) showing wards (yellow highlight) included in the WADA project. Three additional wards in the Pangani basin are located in the upper right corner. Labels refer to wards or villages included in the project. (From Close-Out Report)

ACTIVITY TIMELINE:

- ***April-June, 2007*** *(from June 2007 Quarterly Report):* 13,000 trees were planted at two project sites and three tree nurseries were established.
- ***August, 2008*** *(from survey response and February 2009 Close-Out Report):* Activity completion with a total of 38,861 trees planted on 23 hectares at eight locations.

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff water quantity
2. Decrease in sediment runoff

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1. DECREASE IN RUNOFF WATER QUANTITY

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested (e.g., pasture/range) land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "B"
  - Pasture/grassland in "fair" condition: 50-75% vegetative cover (CN = 69)
- Post-project:
  - Hydrologic soil group (HSG) "B"
  - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained for Dar Es Salaam Airport from TuTiempo.net for the 2003-08 period. Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for years 2003-08. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space): 48.9 ML/yr (213 mm/yr)
- Post-project (reforested land): 31.9 ML/yr (139 mm/yr)

- **Benefit (runoff reduction): 17.0 ML/yr (74 mm/yr)**

Data Sources:

- Size of reforested land area: 23 ha (provided by contact)
- Slope: assumed to be 5% (based on 0-10% estimate provided by contact)
- Soil type: "Available water content" of 7 mm per meter of soil depth (Batjes, 1996) – consistent with hydrologic soil group "B" characteristics.
- Daily precipitation data for years 2003-08 were obtained for Dar Es Salaam Airport (station ID: 655850) from TuTiempo.net (http://www.tutiempo.net/en/Climate/Adiake/655850.htm).

Assumptions:

- Precipitation data obtained for Dar Es Salaam Airport for years 2003-08 are generally representative of average annual precipitation conditions for the areas where reforestation is occurring. (Average precipitation for 2003-08 dataset is 1,065 mm/yr.)
- The pre-project land cover can be appropriately characterized as open pasture/rangeland with approximately 50-75% vegetative cover. (Note that this provides a conservative estimate of Curve Number for areas that have been utilized as crop land.)
- The average slope conditions for the reforested area are approximately 5%.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass, 80% cover (C_{usle} = 0.01)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (pasture/rangeland): 32.3 MT/yr (1.4 MT/ha/yr)

- Post-project (forested): 2.1 MT/yr (0.1 MT/ha/yr)
- **Benefit (reduced sediment yield): 30.2 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife

NOTES

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Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Supply with Watergy Intervention and Education (2 projects: 1.) Watergy Program - Fixing the Leaks, 2.) School Plumbing Repair and Energy Savings)
PROJECT ID #: 08

DESCRIPTION OF ACTIVITY: Leak repair in drinking water and sanitary plumbing systems

LOCATION: South Africa

PRIMARY CONTACT:
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james.dyett@getf.org & nicole.terrillion@getf.org

OBJECTIVES

- Increase water use efficiency

BACKGROUND & DESCRIPTION OF ACTIVITY: Watergy projects promote water conservation in South African communities by repairing leaks and promoting water savings in schools and private households.

ACTIVITY TIMELINE: (from CWP survey information received from GETF and project closeout reports – see References)

- May to October 2009: Leak repairs at schools in Ekhuruleni, Gauteng, SA; Cape Town, Western Cape, SA; Mandela Bay, Eastern Cape, SA
- August 2006 to April 2007: Leak repairs at 3650 households in Sharpeville, Gauteng, South Africa
- May through November 2006: Leak repairs at seven primary schools (Fred Habedi, Masimini, Theo Twala, Duduza, James Nkosi, Emzimkulu, Elusindisweni) in municipalities of Groblersdal, Middelburg, Witbank, Duduza, Standerton, Katorus in provinces of Gauteng & Mpumalanga, South Africa
- December 2005 through July 2006: Leak repairs at 1,371 households in Munsieville (Proper and Ext1), Gauteng, South Africa
- Approximately 1997 to 2004: Leak repairs at three primary schools (Ntuthuko, Vumbeni, Abram Hlope) in Ekhuruleni, Gauteng, SA

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface/ground water usage

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1. DECREASE IN SURFACE/GROUND WATER USAGE

Approach & Results
Water savings were reported for five projects (a-e, below) in either the project survey returned by GETF or in the project-associated Close-Out reports. Water savings were not reported for three schools

because of water meter or water supply failures, so savings for these schools were estimated as the average of water savings for all other reporting schools.

a. Water savings at schools in three municipalities (Ekhuruleni, Cape Town, Western Cape, Mandela Bay) - May to October 2009

Water Savings: Estimate 660 L/hour savings per municipality = 5,781,600 L/year savings per municipality = 17,344,800 L/year total savings

Data sources:

- Water savings were reported in CWP Survey.

Assumptions:

- Assumed no depreciation in savings over 5 years (systems continue to function as when repairs completed).

b. Water savings at 3650 households in Sharpeville - August 2006 to April 2007:

Water Savings: 513 KL per day from municipal meter readings = 187,245,000 L/year

Data sources:

- Water savings were reported in Sharpeville Close-Out Report and Power Point presentation (Alliance to Save Energy, 2006).

Assumptions:

- Assumed no depreciation in savings over 5 years (systems continue to function as when repairs completed).

c. Leak repairs at seven primary schools in provinces of Gauteng & Mpumalanga - May through November 2006:

Water Savings: 20,809,243 L/year from meter readings

Data sources:

- Water savings were reported in Close-Out Report

Assumptions:

- Water savings were not reported for one school (Emzimkulu Primary School) because of frequent interruptions of water supply during logging exercise, so savings for this school was estimated as the average of water savings for all other reporting schools for all projects.
- Assumed no depreciation in savings over 5 years (systems continue to function as when repairs completed).

d. Leak repairs at 1,371 households in Munsieville - December 2005 through July 2006

Water Savings: 432.733 KL per day from municipal meter readings = 157,947,545 L/year

Data sources:

- Water savings were reported in Close-Out Report & Power Point presentation (Alliance to Save Energy, 2006).

Assumptions:

- Assumed no depreciation in savings over 5 years (systems continue to function as when repairs completed).

e. Leak repairs at three primary schools in Ekhuruleni

Water Savings: 24,173,186 L/year from meter readings

Data sources:

- Water savings were reported in Close-Out Report.

Assumptions:

- Water savings were not reported for two schools (Ntuthuko Primary School, Abram Hlope Primary School) because of water supply and/or meter failure problems, so savings for these schools were estimated as the average of water savings for all other reporting schools for all projects.
- Assumed no depreciation in savings over 5 years (systems continue to function as when repairs completed).

Total Water Savings at Schools and Households

- **Total savings from the 5 Watergy/USAID projects listed above = 407,519,774 liters/year = 407.52 ML/yr**

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Environmental benefits from water conservation behaviors as a result of community education

NOTES

- This project included job training for more than 80 beginner plumbers, improved the plumbing infrastructure for more than 37,800 people, and promoted water conservation education for community members.

REFERENCES

Alliance to Save Energy. 2008. The Implementation of a Watergy Intervention and Education Project at Selected Schools Within the Coca-Cola/Shanduka Beverages Area of Supply, Closure Report, December.

Alliance to Save Energy. 2006. Presentation on the Repair of Leaks on Private Properties in Munsieville & Sharpeville.

Alliance to Save Energy. 2006. Munsieville Private Property Leak Repair Project, Close-Out Report, September.

Alliance to Save Energy. 2007. Sharpeville Private Property Leak Repair Project, Close-Out Report, April.

Alliance to Save Energy. 2008. The Implementation of a Watergy Intervention and Education Project at Selected Schools within the Ekurhuleni Metropolitan Area, Closure Report, April.

PROJECT NAME: Mulanje Mountain Community Watershed Management
PROJECT ID #: 09

DESCRIPTION OF ACTIVITY: Small scale irrigation improvements

LOCATION: Malawi

PRIMARY CONTACT:
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OBJECTIVES

- Promote and demonstrate use of drip irrigation kits
- Boost production of irrigated vegetables which are in high demand

BACKGROUND & DESCRIPTION OF ACTIVITY: A new technology for small-scale irrigation (drip kits) was introduced. Previous irrigation techniques were gravity, treadle pump and bucket/watering cans. The introduction and demonstration of small, affordable and locally-manufactured drip irrigation kits created significant interest amongst farmers and a local food canning and processing company that provides a ready market for local produce. Drip irrigation is expected to boost production of irrigated vegetables. Fifty drip irrigation kits were distributed for demonstrations to farmers in vegetable irrigation clubs and nine kits were distributed to schools under a school feeding and nutrition program, based on organic farming. The kits are each capable of irrigating up to 200 square meters of cropland. Without demonstrations to highlight their advantages, such as water conservation and labor savings, farmers will be unwilling to accept the kits on credit.

ACTIVITY TIMELINE:

- Project duration: January 2008 to June 2008 (from Close-Out Report)
- Project is 100% complete

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface water use

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1. DECREASE IN SURFACE WATER USE

Approach

Water usage and other essential information were not reported, so water savings were estimated based upon data reported for a drip kit irrigation project conducted in Nigeria ("Improved Health and Livelihoods in Nigeria's Rural Communities"). Water savings in Nigeria were computed as the difference between pre-project water usage and post-project water usage, resulting in savings for a 4 hectare irrigated plot as follows:

- Pre-project water usage: 20,000 L/day
- Post-project water usage: 18,000 L/day
- Water savings: 2,000 L/day
- Number of days of irrigation per year: 90
- **Benefit (water savings) of 180,000 liters/year = 0.18 ML/yr**

Data sources

- Data deficiencies for this project are:
  - Soil type, pre- & post-project water requirements, pre- & post-project irrigation efficiencies, other changes implemented in association with drip irrigation - survey responses for this information is "unknown."
  - Size of irrigated area: Conflicting information provided. Survey response states 6 hectares, but the supporting information is 60 kits @ 100m2 which equals 0.6 hectares (60 kits @ 100m2 * 1 ha/10,000m2 = 0.6 ha). Close out report states that area is 1.18 ha (59 kits @ 200m2).

Assumptions

- Approach assumes similar conditions to Nigeria project
- Assumed Water savings of 2,000 L/day
- Assumed number of days irrigation/year at 90
- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED: None

NOTES: Site-specific estimate of water savings can be computed if data deficiencies listed above are addressed.

REFERENCES

Development Alternatives, Inc. 2009. Malawi Close-Out Report: Mount Mulanje Community Watershed Partnership Program, WADA Malawi Close-Out Report.

CWP survey response from GETF for "Improved Health and Livelihoods in Nigeria's Rural Communities."

PROJECT NAME: Improved Health and Livelihoods in Nigeria's Rural Communities
PROJECT ID #: 10

DESCRIPTION OF ACTIVITY: Implementation of small-scale irrigation improvements

LOCATION: Nigeria (4 locations)

PRIMARY CONTACT:
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OBJECTIVES

- Reduce irrigation water usage
- Increase crop yields
- Promote improved small-scale irrigation methods

BACKGROUND & DESCRIPTION OF ACTIVITY: Methods for small-scale drip irrigation were introduced. An income generation project was implemented as a pilot project to enable farming of improved varieties of various crops and vegetables through sustainable practices.

ACTIVITY TIMELINE:

- Project duration: 2007- 2008 (from Close-Out Report and survey response)
- Project is 100% complete

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface/ground water usage

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1. DECREASE IN SURFACE/GROUND WATER USAGE

Approach & Results

Water usage was provided in survey response. The water savings were computed as the difference between pre-project water usage and post-project usage at each of the 4 cropland locations. The water benefit in liters per year is calculated as the water savings in liters per day times 90 days of irrigation per year, as follows:

Location 1

- Land area: 4 hectares
- Water source: groundwater well

- Water usage rates on days of irrigation:
    - Pre-Project: 20,000 L/day
    - Post-project: 18,000 L/day
    - Water savings: 2,000 L/day
    - Water benefit: 180,000 L/year

Location 2

- Land area: 2 hectares
- Water source: Challawa dam (surface water)
- Water usage rates on days of irrigation:
    - Pre-Project: 10,000 L/day
    - Post-project: 8,000 L/day
    - Water savings: 2,000 L/day
    - Water benefit: 180,000 L/year

Location 3

- Land area: 4 hectares
- Water source: Watari dam (surface water)
- Water usage rates on days of irrigation:
    - Pre-Project: 20,000 L/day
    - Post-project: 15,000 L/day
    - Water savings: 5,000 L/day
    - Water benefit: 450,000 L/year

Location 4

- Land area: 4 hectares
- Water source: Watari dam (surface water)
- Water usage rates on days of irrigation:
    - Pre-Project: 20,000 L/day
    - Post-project: 15,000 L/day
    - Water savings: 5,000 L/day
    - Water benefit: 450,000 L/year

Total Water Savings Benefit (Locations1- 4)

- **Benefit (water savings) of 1,260,000 liters/year = 1.26 ML/yr**

Data sources

- Water usage data were provided in survey responses.
- Reported number of days irrigation/year = 90 days

Assumptions

- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES:

REFERENCES

Woman Farmers Advancement Network. 2009. Improved Health and Livelihoods in Nigeria's Rural Communities, WADA Malawi Close-Out Report, January 30.

PROJECT NAME: Big Spring Watershed Protection
PROJECT ID #: 14

DESCRIPTION OF ACTIVITY: Leak detection and repair of municipal water distribution and piping system

LOCATION: Borough of Bellefonte, Pennsylvania

PRIMARY CONTACT:

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Delta Consultants	CCDA Waters, LLC, Howard, PA
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OBJECTIVES

- Increase water use efficiency

BACKGROUND & DESRIPTION OF ACTIVITY: Big Spring is an approximately 16 million gallon per day spring water source serving the Borough of Bellefonte, a number of neighboring communities (including the Borough of Milesburg) and commercial customers. The Borough of Bellefonte uses over six million gallons of water per day to service its community. The city has had problems with aging piping and distribution infrastructure that was causing leaks and water loss. The Borough Council considered increasing water fees to fund infrastructure improvements, but Coca-Cola (the CCDA Waters, LLC - Milesburg plant) offered to partner with the Borough Council to fund improvements in its infrastructure in lieu of increasing water fees. The Coca-Cola plant partnered with the Borough to support the construction of a catchment around and a cover over the Big Spring from 1998 to 1999, to support improvements in the Big Spring pump house from 2006 to 2007, and to provide sonic testing of the piping system to detect leaks from 2006 to the present.

ACTIVITY TIMELINE:

- Construction of a catchment around and a cover over the Big Spring from 1998 to 1999
- Improvements in the Big Spring pump house from 2006 to 2007
- Sonic testing of the piping system to detect leaks and repair of detected leaks from 2006 to the present

COCA-COLA CONTRIBUTION: 100%

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in ground water pumping

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1. DECREASE IN GROUND WATER PUMPING

Approach

Water savings from the detection and repair of leaks in the water supply distribution system are reported in the project survey returned by Delta Consultants. Since 2006, third-party leak detection technicians have identified 90 leaks with estimated water savings of 1,990,520 gallons of water/day.

2008 and onward water savings

- 1,990,520 gal/day = 726,539,800 gal/yr = 2,750,252,320 liters/year
- **Benefit (water savings): 2,750,252,320 liters/year = 2,750 ML/yr**

Data sources

- Water savings were reported in survey response.

Assumptions

- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER BENEFITS NOT QUANTIFIED

- 2006-2008 water savings would have increased yearly as more leaks were repaired – no data provided to determine actual savings during this time period.

NOTES

- Industries and homeowners benefited because water fees were not increased.

REFERENCES

PROJECT NAME: Wildlands Conservancy within the Lehigh Valley and Lehigh_River – Abandoned Mine Drainage Treatment at Lausanne Tunnel and Big Buck Mountain #2 Tunnel (US PA)
PROJECT ID #: 15

DESCRIPTION OF ACTIVITY:

1. Lausanne Tunnel – operation, maintenance and monitoring activities necessary to ensure the operation of a 1.5 acre acid mine drainage (AMD) passive wetland treatment system installed to treat the Lausanne Tunnel's discharge to the Nesquehoning Creek, a tributary of the Lehigh River
2. Big Buck Mountain #2 Tunnel - construction of a passive treatment system consisting of a flushable oxic limestone drain followed by an aerobic wetland basin to neutralize acidity and reduce AMD metals loadings from the Buck Mountain #2 Tunnel discharge into Buck Mountain Creek and the Lehigh River.

LOCATION:

1. Lausanne Tunnel - Lehigh Gorge State Park, Borough of Jim Thorpe, Carbon County, PA
2. Big Buck Mountain #2 - Buck Mountain Creek, Lausanne Township, Lehigh River watershed, PA

PRIMARY CONTACT:
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OBJECTIVES:

1. Lausanne Tunnel - reduce loads of acid mine drainage constituents into Nesquehoning Creek
2. Big Buck Mountain #2 - reduce loads of acid mine drainage constituents into Buck Mountain Creek

BACKGROUND & ACTIVITY DESCRIPTION: Abandoned mine drainage (AMD) is undoubtedly the largest negative impact to water quality in the Lehigh River watershed. Each day the Lehigh River receives approximately 75,000 lbs of AMD-related heavy metals. The Lehigh River watershed contains numerous strip mines, pits, and underground workings being drained by eight discharges that enter four major Lehigh tributaries. Two AMD structures (the Lausanne Tunnel and Big Buck Mountain #2) are the focus of this project and are described below.

1. Lausanne Tunnel –
   The Lausanne Tunnel Abandoned Mine Drainage Restoration Project involves a 1.5 acre constructed passive wetland treatment system to treat AMD from the Lausanne Tunnel discharge into Nesquehoning Creek, a tributary of the Lehigh River. The design and construction activities were completed in June 2004. Beginning in 2004, Wildlands Conservancy, along with PA DEP Bureau of Abandoned Mine Reclamation, has conducted visual site inspections, water flow and water quality sampling and analysis, and vegetation inspections to determine the effectiveness of the passive wetland treatment system and to address any issues or areas of concern. Invasive/exotic plant species are identified and removed before they spread to an extent that could impair the functionality of the system.

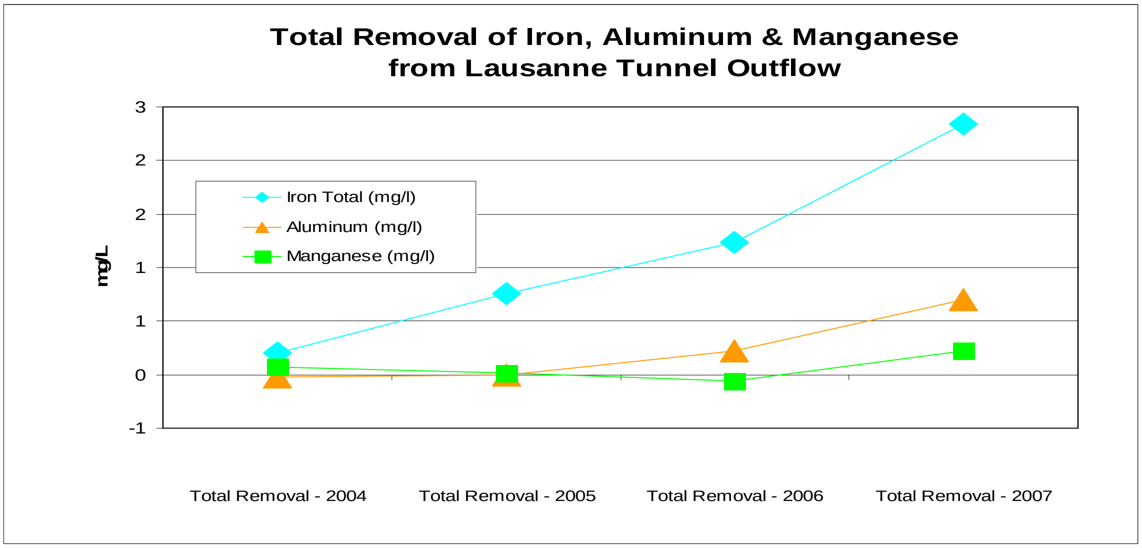
Lausanne Tunnel Discharge (Photo: Wildlands Conservancy)

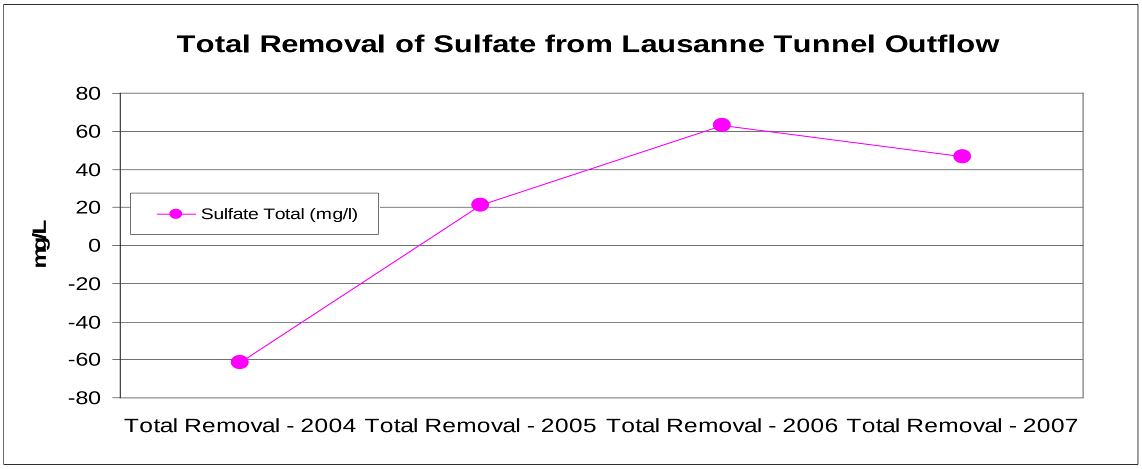
The ability to increase retention time is critical because the longer water is allowed to remain in the system the more opportunity there is for the heavy metals to be removed and absorbed by aquatic plants of the wetland. In 2006 a dye tracer was used to study water flow through the system resulting in the installation of hay bales between the wetland segments to retard water flow. More recent water quality sampling results have led engineers from the Bureau of Abandoned Mine Reclamation to suggest the installation of two weirs at the site. The weirs will further increase water retention time in the wetland system and allow collection of more accurate water quality and flow data.

Passive Wetland Treatment System: Lausanne Tunnel water flows through pipes (forefront) into Wetland A (Photo: Wildlands Conservancy)

Wetland A water flowing over hay bales into Wetland B (Photo: Wildlands Conservancy)

Flow and water quality sampling has been conducted at the Lausanne Tunnel, within the wetlands, and at the Nesquehoning Creek, below the Lausanne Tunnel discharge. Water quality data has been gathered at Lausanne Tunnel since 1998. The Lausanne Tunnel passive wetland treatment system removes significant quantities of heavy metals from the discharge. Upon analysis of annual data gathered from 2004 to 2007, the removal of iron from the water continues to increase significantly. In 2007, more than 48% of the total iron concentration was removed compared to 2006 when 26% was removed from the Lausanne Tunnel discharge. In 2007, 56% of the aluminum concentration was removed compared to 29% in 2006. Sulfate, aluminum and iron removal rates have all improved since the treatment system was completed in 2004.





2. Big Buck Mountain #2 Tunnel-
   This remediation project involves the construction of a passive treatment system consisting of a flushable oxic limestone drain followed by an aerobic wetland basin to neutralize acidity and reduce metals loadings from the discharge. Completion of this project will greatly reduce AMD loadings from the Buck Mountain #2 Tunnel to Buck Mountain Creek and the Lehigh River. Construction was scheduled to begin in December 2008. By May 2009, the project was complete but no monitoring data has been reported.

ACTIVITY TIMELINE:

1. Lausanne Tunnel -
   - June 2004 – completion of treatment system design and construction activities
   - 2004-Present – water quality and flow monitoring (most recent reported data is from 2007)
   - 2006 – water flow dye study and installation of hay bales between wetland segments to increase water retention time in wetlands
   - 2008-9 – future installation of weirs to increase water retention time in wetlands and provide for more accurate flow measurements
   - May 2009 - project 30% complete (per May 26, 2009 email from Rena Sticker)

2. Big Buck Mountain #2 Tunnel-
   - December 2008 – scheduled start of AMD treatment system construction
   - May 2009 – project 100% complete (per May 26, 2009 email from Rena Sticker)

COCA-COLA CONTRIBUTION:

1. Lausanne Tunnel - 50% of the $20,000 total cost (reported in LTI CWP survey)
2. Big Buck Mountain #2 Tunnel - 5% of the $300,000 total cost (reported in LTI CWP survey)

WATERSHED RESTORATION BENEFITS CALCULATED: Lausanne Tunnel only

1. Water Quality - Decreased pollutant loading

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1. DECREASE IN POLLUTANT LOADING – LAUSANNE TUNNEL

Approach & Results

- Daily load reductions were reported in the LTI CWP survey for iron, aluminum and sulfates.
- The system is preventing approximately 120 lbs of iron, 45 lbs of aluminum, and 8,000 lbs of sulfates from entering Nesquehoning Creek and Lehigh River each day.
- Additional monitoring data for alkalinity, pH, total suspended solids, manganese and hot acidity was reported in units of concentration, but flow data and/or loads associated with these parameters was not; therefore reduced loads for these additional parameters could not be quantified.

- **Water Quality Benefits (reduced loads):**
  20 MT/yr total iron
  7.5 MT/yr aluminum
  1,327 MT/yr sulfates

Data sources

- See References

Assumptions

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OTHER BENEFITS NOT QUANTIFIED

- Concentration changes associated with the passive wetlands treatment system were reported also for alkalinity, pH, total suspended solids, manganese, and hot acidity. Associated flow data were not reported and water quality loading benefits were not calculated for these parameters.

NOTES: Big Buck Mountain – unable to quantify, no monitoring data has been reported to date.

REFERENCES

Wildlands Conservancy, 2008. Community Water Partnerships Project of Coca-Cola Foundation & Wildlands Conservancy within the Lehigh Valley and Lehigh River Watershed of Eastern Pennsylvania. Project Update Report, November 10.

Wildlands Conservancy, 2007. Lausanne Tunnel Abandoned Mine Drainage Restoration Project, Project Completed 2004. Wildlands Conservancy, 2007 Update Report, July.

PROJECT NAME: Wildlands Conservancy within the Lehigh Valley and Lehigh River
PROJECT ID #: 15

DESCRIPTION OF ACTIVITY: Jordan Creek stream stabilization project

LOCATION: Jordan Creek located within Lowhill Township, Lehigh County (long: -75.6331, lat: 40.6522)

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OBJECTIVES:

- Streambank stabilization to reduce instream erosion

BACKGROUND & ACTIVITY DESCRIPTION: The *Jordan Creek Stream Bank Stabilization Project* will include completing the design, permitting and construction of stream bank stabilization improvements, and the installation of native riparian plantings along approximately 1,000 linear feet of the Jordan Creek, at the Trexler Nature Preserve in Lowhill Township, Lehigh County.

This project is the first phase of a multi-phase restoration strategy throughout a one mile stretch of stream characterized by severely eroded, bare soil stream banks (4-6 feet in height) and an almost complete lack of in-stream structural habitat. Because of the degraded bank riparian zone, each storm event further entrenches the stream and erodes the banks. The project will involve installation of multiple stream bank stabilization and aquatic habitat improvement structures, and management of invasive species. The buffer will help to create a functioning floodplain, filter runoff and decrease sedimentation of the Jordan Creek watershed. This project will improve stream bank stability along the Jordan Creek, reduce non-point source pollution in the form of sediment and excess nutrients, improve water quality within the Little Lehigh watershed, and provide a model for best management practices.

Jordan Creek (photo provided by Rena Sticker/Delta Consultants)

ACTIVITY TIMELINE:

- Planning is ongoing and the riparian planting project will be completed in fall 2009.

COCA-COLA CONTRIBUTION: 50%

- Cost split provided by Rena Stricker in 5/22/09 email. The other 50% makes up additional partner funding sources and in-kind services.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in sediment runoff

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1. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the current sediment erosion and washoff for the land areas adjacent to Jordan Creek that drain directly to the creek for the reach where the revegetation is planned. The direct drainage areas were delineated manually in GIS and overlain with land use, soils, and topography data. The characteristics of this area, including land uses and associated Curve Numbers (CN) and Cover/Management Factors (C_{usle}) can be summarized as follows:

- Total drainage area: 70.3 acres (28.5 ha)
- Average slope: 11%
- Hydrologic soil group "C" (low infiltration rates)
- Land use:
  - 42% forest (CN = 70, C_{usle} = 0.001)
  - 51% pasture / open space, "fair" condition (CN = 79, C_{usle} = 0.06)
  - 7% straight row crop, "good" condition (CN = 85, C_{usle} = 0.20)

Hourly precipitation, air temperature, and potential evapotranspiration (PET) data were obtained for the Allentown, PA weather station (station ID: PA360106) for the 1970-2006 period. These datasets were used to calculate daily total precipitation and PET and average/maximum air temperature.

The Curve Number (USDA-NRCS, 1986) and MUSLE methods were used to estimate total annual sediment yield for the direct drainage area based on the physical characteristics and meteorological datasets described above. To simplify the calculations, area-weighted average CN (75.6) and C_{usle} (0.045) values were computed based on the land use distribution presented above. The total direct drainage sediment load to Jordan Creek for the reach of interest was estimated to be 567 MT/yr.

The SWAT model provides an equation to estimate the reduction in sediment load due to the presence of a riparian buffer (Equation 6:1.11.2; Neitsch et al. 2005). Using this equation, a trapping efficiency of 1.4% is calculated for an assumed buffer width of 10 feet (3.0 m). Therefore, the **total reduction in sediment load is estimated as 7.9 MT/yr**.

Data Sources:

- Size of direct drainage area: 70.3 acres (28.5 ha) (estimated from GIS)
- Slope: 11% (estimated via GIS based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) “C”
    - Characterized by low infiltration rates
    - Based on STATSGO soils database available through BASINS
- Meteorological data:
    - All meteorological data were obtained via USEPA’s BASINS (version 4) software.
    - Hourly precipitation, air temperature, and PET data were obtained for Allentown, PA for the 1970-2006 period.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate an average soil erodibility factor (K) of 0.24 for use in the MUSLE equation.

Assumptions:

- Buffer width was assumed to be approximately 10 feet (3.0 m) on either side of the creek.
- Riparian buffer was assumed to be sufficiently mature in order to optimally filter sediment.
- The SWAT-based “CNCOEF” parameter was assumed to be 0.0 (parameter used to calculate change in soil moisture capacity based on daily PET).

OTHER BENEFITS NOT QUANTIFIED

- Reduction of instream bank sediment erosion and accompanying loading of sediments and nutrients into stream
- Improvements in quality of fish habitat

NOTES

REFERENCES

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. “Soil and Water Assessment Tool Theoretical Documentation: Version 2005.” January.

USDA-NRCS. 1986. “Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55).” 2nd Edition.

Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Wildlands Conservancy within the Lehigh Valley and Lehigh River
PROJECT ID #: 15

DESCRIPTION OF ACTIVITY: Little Lehigh Stream Bank Stabilization Project at Poole Wildlife Sanctuary

LOCATION: Jordan Wildlands Conservancy/Poole Wildlife Sanctuary in Emmaus, PA (long: -75.6331, lat: 40.6522)

PRIMARY CONTACT:
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OBJECTIVES:

- Reduction of sediment runoff to the stream
- Streambank stabilization to reduce instream erosion

BACKGROUND & ACTIVITY DESCRIPTION: The *Little Lehigh Stream Bank Stabilization Project at Poole Wildlife Sanctuary* project will involve the installation and maintenance of a brush revetment structure along approximately 250 linear feet of stream bank, and maintenance of previously constructed stream bank stabilization and fish habitat enhancement structures. Implementation of this project has improved stream bank stability along approximately 250 linear feet of stream bank of the Little Lehigh Creek, reduced non-point source pollution (in the form of sediment) and improved water quality within the Little Lehigh Creek; improved protection of Wildlands Conservancy's floodplain boardwalk structure, public safety and future access to Wildlands Conservancy/Pool Wildlife Sanctuary's floodplain trails which are utilized for public recreation and educational programming activities, and a "Best Management Practices" demonstration site for local municipalities, private landowners and the general public.

Eroded bank in Little Lehigh River

ACTIVITY TIMELINE:

- Project was implemented by the end of 2008.

COCA-COLA CONTRIBUTION: 50%

- Cost split provided by Rena Stricker in 5/22/09 email. The other 50% makes up additional partner funding sources and in-kind services.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in sediment runoff

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1. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the current sediment erosion and runoff for the land areas adjacent to Jordan Creek that drain directly to the creek for the reach where the revegetation is planned. The direct drainage areas were delineated manually in GIS and overlain with lands use, soils, and topography data. The characteristics of this area, including land uses and associated Curve Numbers (CN) and Cover/Management Factors (C_{usle}) can be summarized as follows:

- Total drainage area: 32.7 acres (13.2 ha)
- Average slope: 4%
- Hydrologic soil group "B" (moderate infiltration rates)
- Land use:
  - 47% low-density residential
    - 80% open space, fair condition (CN = 69, C_{usle} = 0.06)
    - 20% impervious (CN = 98, C_{usle} = 0)
  - 32% forest (CN = 55, C_{usle} = 0.001)
  - 21% pasture / open space, "fair" condition (CN = 69, C_{usle} = 0.06)

Hourly precipitation, air temperature, and potential evapotranspiration (PET) data were obtained for the Allentown, PA weather station (station ID: PA360106) for the 1970-2006 period. These datasets were used to calculate daily total precipitation and PET and average/maximum air temperature.

The Curve Number (USDA-NRCS, 1986) and MUSLE methods were used to estimate total annual sediment yield for the direct drainage area based on the physical characteristics and meteorological datasets described above. To simplify the calculations, area-weighted average CN (67.2) and C_{usle} (0.035) values were computed based on the land use distribution presented above. The total direct drainage sediment load to Jordan Creek for the reach of interest was estimated to be 248 MT/yr.

The SWAT model provides an equation to estimate the reduction in sediment load due to the presence of a riparian buffer (Equation 6:1.11.2; Neitsch et al. 2005). Using this equation, a trapping efficiency of 1.4% is calculated for an assumed buffer width of 10 feet (3.0 m). Therefore, the **total reduction in sediment load is estimated as 3.5 MT/yr**.

Data Sources:

- Size of direct drainage area: 32.7 acres (13.2 ha) (estimated from GIS)
- Slope: 4% (estimated via GIS based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "B"
  - Characterized by moderate infiltration rates
  - Based on STATSGO soils database available through BASINS
- Meteorological data:
  - All meteorological data were obtained via USEPA's BASINS (version 4) software.
  - Hourly precipitation, air temperature, and PET data were obtained for Allentown, PA for the 1970-2006 period.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate an average soil erodibility factor (K) of 0.32 for use in the MUSLE equation.

Assumptions:

- Buffer width was assumed to be approximately 10 feet (3.0 m) on either side of the creek.
- Riparian buffer was assumed to be sufficiently mature in order to optimally filter sediment.
- The SWAT-based "CNCOEF" parameter was assumed to be 0.0 (parameter used to calculate change in soil moisture capacity based on daily PET).

OTHER BENEFITS NOT QUANTIFIED

- Reduction of instream bank sediment erosion
- Improvements in quality of fish habitat

NOTES

REFERENCES

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

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PROJECT NAME: Wildlands Conservancy within the Lehigh Valley and Lehigh River
PROJECT ID #: 15

DESCRIPTION OF ACTIVITY: Monocacy Creek Stream Restoration Projects

LOCATIONS: Two project sites within the Monocacy Creek watershed:

1. Just Enuff Angus Farm, East Allen Township, Northampton County
2. Edgewood Valley Farms, Bushkill Township, Northampton County

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OBJECTIVES:

- Reduction of sediment runoff to the stream
- Streambank stabilization to reduce instream erosion

BACKGROUND & ACTIVITY DESCRIPTION: The *Monocacy Creek Stream Restoration Projects* were implemented to improve water quality and aquatic habitat conditions in two tributaries of the Monocacy Creek. These projects also serve as education/demonstration projects for similar stream and riparian buffer enhancement projects on agricultural lands. The projects collectively included establishment of riparian buffer areas with native plants, enhancement of existing riparian buffer areas, construction of stream fencing for livestock exclusion, and construction of stabilized agricultural crossings. The projects resulted in improved stream and riparian corridor habitat conditions along approximately 3,000 linear feet of stream and establishment and enhancement of approximately two acres of riparian buffer habitats. In addition 250 linear feet of upland stream bank was repaired at Edgewood Valley Farms through storm water best management practices.

Edgewood Valley Farms: Pre-project (left) & Post-Project (right) Conditions

ACTIVITY TIMELINE:

- Project was implemented prior to the end of 2008.

COCA-COLA CONTRIBUTION: 50%

- Cost split provided by Rena Stricker in 5/22/09 email. The other 50% makes up additional partner funding sources and in-kind services.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in sediment runoff

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1. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the current sediment erosion and runoff for the land areas adjacent to Jordan Creek that drain directly to the creek for the reach where the revegetation is planned. The direct drainage areas were delineated manually in GIS and overlain with lands use, soils, and topography data. The characteristics of this area, including land uses and associated Curve Numbers (CN) and Cover/Management Factors (C_{usle}) are summarized below.

Hourly precipitation, air temperature, and potential evapotranspiration (PET) data were obtained for the Allentown, PA weather station (station ID: PA360106) for the 1970-2006 period. These datasets were used to calculate daily total precipitation and PET and average/maximum air temperature.

The Curve Number (USDA-NRCS, 1986) and MUSLE methods were used to estimate total annual sediment yield for the direct drainage area based on the physical characteristics and meteorological datasets described above. To simplify the calculations, area-weighted average CN (Edgewood: 83.6, Just Enuff: 85.9) and C_{usle} (Edgewood: 0.15, Just Enuff: 0.16) values were computed based on the land use distribution presented above. The total direct drainage sediment load to Monocracy Creek tributaries for the reaches of interest was estimated to be 540 MT/yr.

The SWAT model provides an equation to estimate the reduction in sediment load due to the presence of a riparian buffer (Equation 6:1.11.2; Neitsch et al. 2005). Using this equation, a trapping efficiency of 1.4% is calculated for an assumed buffer width of 10 feet (3.0 m). Therefore, the **total reduction in sediment load is estimated as 7.6 MT/yr**.

Drainage Area Characteristics:

- Total drainage area: 91 acres (36.8 ha)
  - Edgewood Valley Farm: 18 acres
  - Just Enuff Angus Farm: 73 acres
- Average slope:
  - Edgewood Valley Farm: 7.5%
  - Just Enuff Angus Farm: 2.5%
- Hydrologic soil group:
  - Edgewood Valley Farm: “PA033” – type “C” (low infiltration rates), K = 0.24

- Just Enuff Angus Farm: "PA076" – type "B" (moderate infiltration rates), K=0.32

- Land use:
  - Edgewood Valley Farms:
    - 64% row crop (CN = 88, C_{usle} = 0.20)
    - 13% pasture – "fair" condition (CN = 79, C_{usle} = 0.06)
    - 11% low/medium-density residential
      - 80% pervious (CN = 79, C_{usle} = 0.06)
      - 20% impervious (CN = 98, C_{usle} = 0.00)
    - 10% open space (CN = 79, C_{usle} = 0.06)
  - Just Enuff Angus Farm:
    - 72% row crop (CN = 88, C_{usle} = 0.20)
    - 4% pasture – "fair" condition (CN = 79, C_{usle} = 0.06)
    - 9% low/medium-density residential
      - 80% pervious (CN = 79, C_{usle} = 0.06)
      - 20% impervious (CN = 98, C_{usle} = 0.00)
    - 15% open space (CN = 79, C_{usle} = 0.06)

Data Sources:

- Size of direct drainage area: 32.7 acres (13.2 ha) (estimated from GIS)
- Slope: 4% (estimated via GIS based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "B"
  - Characterized by moderate infiltration rates
  - Based on STATSGO soils database available through BASINS
- Meteorological data:
  - All meteorological data were obtained via USEPA's BASINS (version 4) software.
  - Hourly precipitation, air temperature, and PET data were obtained for Allentown, PA for the 1970-2006 period.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate an average soil erodibility factor (K) of 0.32 for use in the MUSLE equation.

Assumptions:

- Buffer width was assumed to be approximately 10 feet (3.0 m) on either side of the creek.
- Riparian buffer was assumed to be sufficiently mature in order to optimally filter sediment.
- The SWAT-based "CNCOEF" parameter was assumed to be 0.0 (parameter used to calculate change in soil moisture capacity based on daily PET).

OTHER BENEFITS NOT QUANTIFIED

- Reduction of instream bank sediment erosion
- Reductions in delivery of nutrients to the streams
- Improvements in quality of fish habitat

NOTES

REFERENCES

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

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PROJECT NAME: ClearWater Community Watershed Partnership – Scotia Barrens Halfmoon Wildlife Corridor (US PA)
PROJECT ID #: 16

DESCRIPTION OF ACTIVITY: Land protection and conservation

LOCATION: Adjoining land parcels in the Spring Creek watershed of Halfmoon Township near State College, PA. The land consists of 2 subparcels containing crop fields, mixed deciduous and coniferous forest:

- 40 acres (16.2 ha) previously was going to be converted to LDR
- 66 acres (26.7 ha) of forested, agricultural, and pasture land

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OBJECTIVES:

- Conservation/protection of a corridor for wildlife passage

BACKGROUND & ACTIVITY DESCRIPTION: "ClearWater Conservancy is working with the community to complete a critical conservation project. A pocket of ecological treasures, the Scotia Barrens is an exceptional ecosystem of rare natural community types. Many of the wildlife species which call the Scotia Barrens home would disappear from the region if the barrens habitat were lost. Because of its close proximity to the growing community of State College, residential development threatens to consume large pockets of this rare habitat and isolate it from other nearby nature areas. To balance this growth and to maintain our community's sense of place, ClearWater Conservancy has initiated the Scotia Barrens Conservation Project to prevent isolation of Scotia Barrens from encroaching development, to increase the size of protected barrens habitat, and to educate the community about this valuable resource.

As part of the larger Scotia Barrens Conservation Project, we are working to maintain natural connections between Scotia Barrens and Tussey and Bald Eagle Mountains. Significant development pressure from the north imminently threatens to isolate the Barrens from the large forested tracts of Bald Eagle Mountain, itself an important natural resource. Even though there appears to be open space remaining as one makes the drive from Route 322 west along Route 550 towards Stormstown, the fact is that future developments are on the books for all but a sliver between Scotia Barrens and the ridge. Ecological isolation of Scotia Barrens threatens viable populations of wildlife, including many neotropical bird species. According to the Pennsylvania Game Commission, Western Pennsylvania Conservancy, Audubon Pennsylvania, and Partners-in-Flight, connections between Scotia Barrens and Bald Eagle Mountain must be maintained to allow wildlife populations to flourish within Scotia Barrens.

Time is of the essence. There remains only one potential wildlife corridor connecting Scotia Barrens with Bald Eagle Mountain. ClearWater recognized this opportunity and has been working diligently over the past several years to proactively lay the foundations for land acquisitions to ensure that this wildlife corridor is maintained and protected. ClearWater Conservancy now has the opportunity to protect 106 acres of this last wildlife corridor through a combination of land purchase and the Halfmoon Township Open Space Preservation Program (lease of development rights). Protection of this 106-acre property is key to protecting two additional adjacent properties."

[Text and figure from ClearWater Conservancy website - http://www.clearwaterconservancy.org/Halfmoon%20Wildlife%20Corridor.htm]

ACTIVITY TIMELINE:

- Agreement of Sale signed March 2009
- Still fundraising; have until March 2010 to complete the purchase
- After purchase of the property and conservation easements are in place, intention is to work with adjoining conservation landowner on riparian buffer plantings, etc.

COCA-COLA CONTRIBUTION: 0.71%

- Total cost: $700,000 (confirmed by Rena Stricker, 5/22/09 email)
- TCCC contribution: $5,000 (reported in LTI CWP survey)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment load

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the change in runoff for the conversion of woodland area low-density residential development (40 acres) and open range/pasture (66 acres). Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre- and post-project conditions were estimated as follows based on information provided in the TR-55 document (USDA-NRCS, 1986):

For the 40-acre (16.2 ha) parcel:

- "Pre-project": low-density residential use (post-development)
    - Open space in "good" condition, >75% cover (CN = 74, soil group "C")
        - 80% of area (13.0 ha)
    - Impervious surfaces – roofs, pavement, etc. (CN = 98, soil group "C")
        - 20% of area (3.2 ha)
- "Post-project": woodlands
    - Woods in good condition (CN = 70, soil group "C")
        - Assume eventual complete reforestation of preserved area

For the 66-acre (26.7 ha) parcel:

- "Pre-project": open range (post-development)
    - Open space in "good" condition, >75% cover (CN = 74, soil group "C")

- "Post-project":
    - o Woods in good condition (CN = 70, soil group "C")
        - Assume eventual complete reforestation of preserved area

Hourly meteorological data for the weather station located at State College, PA were obtained from the database provided as part of USEPA's BASINS 4 watershed modeling software package. Hourly data were used to compute total daily precipitation, maximum hourly rainfall intensity, daily average and maximum air temperature, and daily total potential evapotranspiration (PET).

Curve numbers and processed meteorological data were used to compute daily runoff for the pre- and post-project cases for a 12-year period (1995-2006), including the effects of seasonal snow accumulation and melt. Total annual average runoff volumes and the resulting water quantity benefit were estimated as follows:

- "Pre-project" (post-development): 162.1 ML/yr
- "Post-project" (preserved, reforested): 150.2 ML/yr
- **Benefit (runoff reduction): 11.9 ML/yr**

Data Sources:

- Size of area targeted for conservation/reforestation: 106 acres (42.9 ha)
- Slope: 5% for 40-ac parcel, 15% for 66-ac parcel (estimated based on local topographic datasets)
- Soil type: predominantly hydrologic soil group (HSG) "C"
    - Characterized by low infiltration rates
    - Based on STATSGO soils database available through BASINS
- Meteorological data:
    - All meteorological data obtained via USEPA's BASINS version 4 software
    - Hourly meteorological data were obtained for State College, PA for the 1995-2006 period.

Assumptions:

- Of the conserved area, the 40-acre parcel was assumed to be subject to low-residential residential development, and the 66-acre parcel was assumed to be "open range".
- SWAT model parameter "CNCOEF" was set to 0.0 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting woodland to low-density residential and open range land. The meteorological and physical datasets described above for the runoff calculation were used. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were calculated based on hourly precipitation data for the 1970-1998 period.

The Cover/Management Factors (C_{usle}) for the MUSLE were estimated as follows based on Haith (1992):

- "Pre-project": post-development condition
  - Open space (80% grass cover): C = 0.01
  - Impervious area – roofs, pavement, etc.: C = 0.00 (conservatively assume minimal sediment availability)
- "Post-project": conserved condition
  - Woods with 75-100% canopy: C = 0.001

Total annual sediment yields for the cropland were estimated as follows:

- Pre-project: 248.1 MT/yr
- Post-project: 24.9 MT/yr
- **Benefit (reduced sediment yield): 223.2 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.
- STATSGO soils data obtained from USEPA BASINS 4 were used to estimate a soil erodibility factor (K) of 0.30 for use in MUSLE equation.

Assumptions:

- Land slope was assumed to be 5% on average for the 40-acre parcel and 15% on average for the 66-acre parcel.
- The Cover Factor (C_{usle}) was assumed to remain constant through time (both seasonally and among years).

OTHER BENEFITS NOT QUANTIFIED

- Terrestrial habitat benefits

NOTES

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REFERENCES

ClearWater Conservancy website - http://www.clearwaterconservancy.org/Halfmoon%20Wildlife%20Corridor.htm

Haith, D.A., R. Mandel, and R.S. Wu. 1992. “Generalized Watershed Loading Functions – Version 2.0 User’s Manual.” December. Cornell University. Ithaca, NY.

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Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Niles Community Rain Garden
PROJECT ID #: 18

DESCRIPTION OF ACTIVITY: Construction of a rain garden on a vacant urban land parcel

LOCATION: West Touhy Avenue, Niles, IL (42° 0' 43''N, 87° 48' 17''W)

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OBJECTIVES:

- Reduction of sediment and other pollutant run-off into storm sewers and North Branch of Chicago River
- Improved stormwater infiltration

BACKGROUND & ACTIVITY DESCRIPTION: The Village of Niles and Coca-Cola installed the Village's first municipal rain garden, which may be the largest of its kind in Cook County, according to the President of The Conservation Foundation. The first phase of the project transformed an under-utilized vacant lot on West Touhy Avenue into a specialized garden designed to soak up and filter rain water runoff from surrounding buildings and parking lots. The municipal property is where two structures once stood and was covered by various turf grass species and some areas with no vegetation due to disturbance or ponding water that killed the grass. Future planned work includes installation of three smaller rain gardens and a large area of prairie grass in order to accommodate all of the stormwater that the site receives. Once finalized, the site will not require use any fertilizer, herbicide or pesticide. In addition to the plantings, the plan calls for a permeable walking path, recycled content benches, educational signage, and some miscellaneous site work. Rain barrel installations collecting stormwater from an area of 1.5 acres are planned at a later date.

Total drainage area going to the rain garden is 1.5 acre (65,340 ft2). The rain garden will retain approximately the first inch of rainfall. This rain garden is approximately 1400 square feet and has over 560 native forbs (flowers) and grasses in the first phase. The plant mix (sand, topsoil, organic mulch) in the rain garden and bioswale area will significantly increase the absorption rate of the soils. Runoff from roofs, lawn fertilizers, pesticides, oil (and other fluids that typically leak from cars) are filtered in the rain garden. The native plants absorb and consume pollutants. This helps protect local streams and rivers from flooding and pollution problems. Rain garden and bioswale areas allow the rainwater to infiltrate and water is further cleansed through evapotranspiration by the native plants. The rain garden provides a new valuable habitat for butterflies, birds and other insects. Rain gardens attract dragonflies which consume mosquitoes at high rates. Once established, rain gardens are low maintenance and attractive landscapes.

Village of Niles Community Rain Garden conceptual plan (Source: Village of Niles website)

ACTIVITY TIMELINE:

- Percent complete as of December 31, 2008: 25%
- Completion schedule not avaialable. Assumed completed in 2009.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola ($22,000)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff into sewers and streams

1. DECREASE IN STORMWATER RUNOFF TO SEWERS/STREAMS

Approach & Results:

- Average annual rainfall captured by rain garden (rainfall up to a 1”/hour storm): 35.5 inches/year = 0.90 meters
- Drainage area: 1.5 acres = 6,070.3 square meters
- Volume of runoff captured by rain garden: 0.9 meters rainfall * 6,070 square meters area = 5472.85 cubic meters stormwater = 5.46 million liters stormwater/year
- **Benefit (runoff decrease): 5.5 ML/year**

Data Sources:

From village of Niles website and LTI CWP Survey:

- Drainage area: 1.5 acres
- Area of rain garden: 1,400 ft2
- Rain garden collects up to 1 inch of rainfall from surrounding 1.5-acre area.
- Slope of land surface: 0-2%
- Predominant soil type(s) in the project area: silt/clay
- Soil type(s) in the rain garden and bioswale area: sand, topsoil, organic mulch

Assumptions:

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Decreased pollutant loading to receiving waters.

NOTES

- Rain barrels are planned for the future.

REFERENCES

Village of Niles, IL Community Rain Garden website: http://www.vniles.com/Content/templates/?a=207&cat=62

PROJECT NAME: Chesapeake Bay Rain Barrel Donation Program
PROJECT ID #: 20

DESCRIPTION OF ACTIVITY: Rain barrel distribution for community household and school/business use.

LOCATION: Baltimore, MD and Charlottesville, VA

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OBJECTIVES:

- Reduction in stormwater runoff

BACKGROUND & ACTIVITY DESCRIPTION: The Coca-Cola Company is partnering with watershed groups in the Chesapeake Bay area to distribute Coca-Cola 55-gallon syrup drums for reuse as rain barrels. Our partner organizations are primarily supporting rain barrel use for residential properties. The use of collected water runs a relatively small gamut from use for light gardening work to exterior household cleaning needs (vehicle washing). A small portion of barrels are donated to local schools and businesses. By collecting rainwater that normally flows off a property, rain barrels save money on water bills, conserve water during dry periods and prevent polluted runoff. The reuse of these 55-gallon barrels will not only help in the effort to protect the Chesapeake Bay watershed, but also eliminate the energy Coca-Cola would expend recycling the plastic barrels. In 2008, 750 rain barrels were donated and it has been estimated that 600 barrels were distributed in the greater Baltimore, MD metropolitan area and 50 barrels were distributed in the Charlottesville, VA area.

ACTIVITY TIMELINE:

- 2008: 750 rain barrels were donated and it has been estimated that 600 barrels were distributed in the greater Baltimore, MD metropolitan region and 50 barrels were distributed in Charlottesville, VA.
- The activity is expected to continue for at least 3 years (through 2011), with an estimated 500 drums donated annually.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff

DECREASE IN STORMWATER RUNOFF

Approach & Results:

Delta Consultants developed and used a Microsoft Excel-based rain barrel calculator to estimate the water benefit from use of donated rain barrels. The calculator is founded upon a supply and demand methodology and includes geography-specific input data, as follows:

Supply Calculations:

To calculate the potential rainwater available for harvest, the calculator utilizes the following formula and variables:

Catchment Size X Number of Barrels X Total Precipitation X Catchment Efficiency Coefficient

Catchment Size – Based upon an assigned percentage of the average single family home and school. For example, the average single family roof size is 1,200 square feet with most houses having a peaked roof. Therefore, the calculator utilizes 600 square feet as the catchment site.

Number of Barrels – An estimate of the number of donated barrels actually distributed and in use.

Total Precipitation – Combined monthly rainfall and snowfall. Snowfall is converted to Snow Water Equivalent using a 0.20 density coefficient. Precipitation data is pre-loaded for select geographic locations.

Catchment Efficiency Coefficient - An 85% runoff coefficient was selected, meaning 85% of the rain falling on the catchment will run off to the gutter and rain barrel. The other 15% will be lost to evaporation, wind, leaks, infiltration into the catchment surface, etc.

Demand Calculations:

To calculate the demand or estimated barrel water use, the calculator utilizes the following formula and variables for both households and schools/businesses.

(Evapotranspiration X Landscape Coefficient X Landscape Area) + Estimated Other Use X Overflow Loss

Evapotranspiration - Data is pre-loaded for select geographic locations.

Landscape Coefficient - Also commonly referred to as the "Plant Factor" and the functional equivalent of the "Crop Coefficient." A factor of 0.55 was selected which is an average value for moderate watering needs. Turf grasses are commonly 0.6-0.8, whereas gardens and shrubs are closer to 0.40 on average.

Landscape Area – The estimated square footage of the landscape are serviced by the rain barrel. The household average is 300 square feet and the school/business is 700 square feet. The larger landscape area for schools/businesses accounts for designated grounds personnel.

Estimated Other Use – Estimates for the amount of water utilized in each given month for purposes other than landscaping or gardening (e.g., washing a vehicle).

Overflow Loss – A percentage reduction based upon the month-to-month probability of receiving more than 0.30" precipitation in a single day. This represents the approximate amount to fill a rain barrel.

Estimated annual capture (2008):

- Baltimore (600 barrels in 2008): 2,137,320 gallons = 8.09 ML/yr
- Charlottesville (50 gallons in 2008): 169,569 gallons = 0.642 ML/yr
- **Total benefit = 8.73 ML/yr**

Data Sources:

- Southeast Regional Climate Center **(**http://www.sercc.com)
- Harvesting Water for Landscape Use (http://ag.arizona.edu/pubs/water/az1052/harvest.html)
- Guide To Estimating Irrigation Water Need (http://www.owue.water.ca.gov/docs/wucols00.pdf)
- Crop Water Requirements (http://texaset.tamu.edu/coefs.php)
- CWP Survey completed by Curtis Etherly of Coca-Cola Enterprises (CCE)

Assumptions:

- Homeowners and school/business representatives that attend a workshop and receive a rain barrel through the donation program will use it consistently to collect rainwater from roofed areas and use the collected water for gardening, cleaning, and other outdoor uses.
- Given that 55 gallons is a relatively small storage amount, the key to estimating actual harvest is to estimate the amount of water removed from the barrel each month.
- Of the 750 total barrels donated to partner organizations, 650 are estimated to be in use.
- Additional assumptions incorporated into the calculator formulas and coefficients.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in municipal water usage due to use of water collected in rain barrels for gardening, and other activities.

NOTES:

- The calculator assumes that all donated barrels will be hooked up and used to harvest rainwater from rooftops. Currently no data exist to determine if this is true, or what the actual percentage might be.

REFERENCES

Alliance for the Chesapeake Bay website
http://www.alliancechesbay.org/pressrelease.cfm?id=248

City of Philadelphia Rain Barrel Program
http://www.phillywatersheds.org/rainbarrel/rb_map.htm

Nine Mile Run Rain Barrel Initiative - Final Report
http://www.harvesth2o.com/adobe_files/Runoff_Report.pdf

Virginia Cooperative Extension
Estimates that gardens require 65 to 130 gallons of water per 100 square feet once per week.

U.S. Environmental Protection Agency (Region 3)
Estimates that one barrel can save the average household approximately 1,300 gallons over the three peak summer months. http://www.epa.gov/Region3/p2/what-is-rainbarrel.pdf

Cornell Cooperative Extension of Onondaga County Rain Barrel Pilot Study
http://counties.cce.cornell.edu/onondaga/Rain%20Barrel%20Pilot%20Study%20Concludes%20in%20Skaneateles%20long%20version.pdf

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Removal of invasive plants and natural levees, bankline destabilization, and other restoration activities.

LOCATION: Middle Pecos River, New Mexico (Bitter Lake Restoration): Reaches 2 and 3

PRIMARY CONTACT:
Beth Bardwell
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(575) 640-3415

OBJECTIVES

- Reestablish channel morphology and river-floodplain connectivity

BACKGROUND & DESCRIPTION OF ACTIVITY:

The loss of floodplain connectivity in the Middle Pecos River contributes to degradation of the habitat of numerous aquatic and riparian species including the native New Mexico Pecos bluntnose shiner. Dense thickets of an invasive plant, salt cedar, pose a fire risk (FWS, 2007). Birds, fish, amphibians, and native riparian plant communities will benefit from a connected floodplain.

This project involves restoration of a 5.7 mile reach. The primary activities are "removal of bank line levees and associated tamarisk thickets, removal of tamarisk thickets on point bars, and the reconnection of a small oxbow lake at the north end of Reach 2." (FWS, 2007)

These modifications are "designed to work within the modern hydrology of the Pecos River." (FWS, 2007)

ACTIVITY TIMELINE: (based on FWS, 2007 and personal communications with B. Bardwell)

- Technical studies have been completed and project is ready to proceed.
- Final EA and FONSI- completed Feburary 2009
- Saltcedar Removal –completed Spring 2009
- Bankline Destabilization—anticipated Fall 2009
- Additional salt cedar removal, revegetation and construction anticipated through 2011.
- Adaptive management monitoring: 2009-2011 and beyond.

COKE CONTRIBUTION: TBD

- WWF matching funds from TCCC for state River Ecosystem Restoration Initiative Grant: $25,000 over life of grant
- WWF also used TCCC funds to lobby for New Mexico state appropriations to the River Ecosystem Restoration Initiative which awarded a $513,000 grant to U.S. FWS for this project: $25,000 including third party contracts for lobbyist and % of B.Bardwell's salary.
- Assumed 1% for current estimate.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in direct streamflow

1. INCREASE IN DIRECT STREAMFLOW

Approach and Results

The approach was to estimate the volume of anticipated floodplain inundation (the volume of water that would have otherwise flowed downstream without serving important floodplain functions). It is estimated that 100 acres of floodplain will be enhanced for annually-recurring floods between 1200 and 3700 cfs (FWS, 2007). The floodplain will also be flooded during rarer floods above 3700 cfs, but these were not included in the analysis, so the estimate is conservative.

100 acres flooded annually * 1 foot average depth = 100 ac-ft/yr
100 ac-ft/yr = 123 ML/yr

Data sources

- Acreage flooded under different flow conditions - provided in FWS, 2007.

Assumptions

- It was assumed that reoccurring floods between 1200 and 3700 cfs occur on average only once a year
- An average water depth of 1 foot in the floodplain was assumed.
- It was assumed that restoration will proceed according to the FWS proposed schedule.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Removal of invasive plants and revegetation with native species will expand habitat availability and quality, and lead to increased abundance of birds, mammals, reptiles, and fish.
- The risk of fire associated with dense salt cedar stands will be reduced.
- Reconnecting spring flows to the river.
- Attenuation of flooding downstream from restoration site from increased storage of flood flows on the floodplain

NOTES

- TCCC percent cost contribution is unknown – requires further investigation.

REFERENCES

FWS, 2007. Proposal for New Mexico's 2007 River Ecosystem Program: Pecos River Restoration, Phase II: Repairing Floodplain Connectivity.

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Removal of streamside invasive plants, quantifying and securing environmental flow pulses to remobilize channel sediments and promote channel conditions that are wide, shallow, and laterally unstable, leading to improved aquatic and riparian for a variety of native species.

LOCATION: Rio Grande, Texas (Big Bend)

PRIMARY CONTACT:
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OBJECTIVES

- Reestablish channel morphology and river-floodplain connectivity

BACKGROUND & DESCRIPTION OF ACTIVITY: The main objective of the current treatments along the Big Bend reach of the Rio Grande is to reestablish wide and shallow channel morphologic conditions that will provide significant active floodplain areas for replenishment under the current hydrologic regime of the river. Measures to reestablish floodplain connectivity are targeted at increasing the frequency and duration of overbank inundation through removal of invasive plants and natural levees, bankline destabilization, and other activities, which vary by location.

ACTIVITY TIMELINE: (per M. Briggs, WWF)

- Implementation through 2020, with annual increased area of newly established floodplain surfaces conducive to replenishment (see attached spreadsheet).

COKE CONTRIBUTION: TBD

- Assumed 30% for current estimate
- 29% TCCC -71% NOAA, National Park Service, and ALON

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase replenishment of hydrologically reconnected floodplain surfaces

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1. **Increase replenishment of hydrologically reconnected floodplain surfaces**

Approach and Results (per Mark Briggs)

The benefit was calculated as an estimate of transmission rates through floodplain surfaces that have been hydrologically reconnected to the river via conservation activities. .

Based on experience, WWF will be able to directly treat about one-third (due to access and channel morphologic conditions) of the river channel length along the Big Bend reach of the Rio Grande. The total length of the Big Bend reach from Presido through Boquillas Canyon is approximately 216 Km, which means just over 70 Km may ultimately be treated in the years to come. To date, WWF has treated just over 14 Km of river channel, which has resulted in reestablishing active floodplain surfaces along the treated reach that average 8 m wide on both sides of the channel.

WWF anticipates in the foreseeable future that they will be able to treat on average about 5 Km of river channel per year (both sides). In the current hydrologic regime, the newly reestablished active floodplain surfaces will be inundated on average about three days per year.

Alluvium along the Big Bend reach is a sandy loam to sandy, which equates to a seepage rate (or replenishment rate) of about 1.01 m^3 per m^2 per day of inundation for the newly established active floodplain surfaces.

Estimated replenishment rate:

- 2009: 616.79 ML/yr
- 2010: 837.076 ML/yr
- 2011: 1,057.36 ML/yr
- 2012: 1,277.64 ML/yr
- 2013: 1,497.93 ML/yr
- (estimates through 2020 provided in attached spreadsheet)

Data sources

- Calculations provided by M. Briggs, WWF (see attached spreadsheet)

Assumptions (see attached spreadsheet)

- Rating curves for floodplain surfaces are under development, so recurrence interval of the discharge required to inundate active floodplain surfaces that have been reestablished due to treatments is currently unknown. It was assumed (conservatively) that newly created floodplain surfaces will be inundated on average three days per year under the current hydrological regime.
- It is assumed that agreements are reached and projected water and water rights transfers will occur as anticipated.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Removal of invasive plants and revegetation with native species will expand habitat availability and quality, and lead to increased abundance of native birds, mammals, reptiles, and fish.
- Reduction of fire risk associated with dense salt cedar stands.
- Reduced flood frequency and flood hazard to streamside towns and infrastructure.

NOTES

- These are very preliminary and conservative estimates based on information available at the present time. More accurate estimates will be made as data becomes available and model refinements are completed.

- Approach used for the New Mexico reach would not be appropriate for Big Bend because water rights purchased for environmental flow purposes on the US side are run of river and would not benefit floodplain ecology without re-establishment of floodplain connectivity.

REFERENCES

WWF. 2007. Restoring a Desert Jewel – The Chihuahuan Desert's Big Bend and the WWF/Coca Cola Partnership. August.

Preliminary Estimates Subject to Revision
Prepared by Mark Briggs, WWF
5/15/2009

Estimated Replenish Rates Due to Reestablishment of Hydrologic Connectivity to Active Floodplain Surfaces Along the Big Bend Reach of the Rio Grande (liters/year)

Reasoning and Assumptions

The main objective of our current treatments along the Big Bend reach of the Rio Grande is to reestablish wide and shallow channel morphologic conditions that will provide significant active floodplain areas for replenishment under the current hydrologic regime of the river.

Based on experience, we have been able to treat about one-third (due to access and channel morphologic conditions) of the river channel length where we are working.

The total length of the Big Bend reach from Presido through Boquillas Canyon is approximately 216 Km, which means just over 70 Km will actually be treatable.

To date, we've treated just over 14 Km of river channel, which has resulted in reestablishing active floodplain surfaces along the treated reach that average 8 m wide on both sides of the channel.

We believe in the foreseeable future we'll be able to treat on average about 5 Km of river channel per year (both sides).

In the current hydrologic regime, the newly reestablished active floodplain surfaces will be inundated on average about three days per year.

Alluvium along the Big Bend reach is a sandy loam to sandy, which equates to a seepage rate (or replenishment rate) of about 1.01 m^3 per m^2 per day of inundation for the newly establishd active floodplain surfaces

The newly established active floodplain surfaces will be inundated on average about three days a year under the current hydrologic regime of the river.

Parameters	Anticipated Kilometers of Treated Channel											
	Apr-09	**Apr-10**	**Apr-11**	**Apr-12**	**Apr-13**	**Apr-14**	**Apr-15**	**Apr-16**	**Apr-17**	**Apr-18**	**Apr-19**	**Apr-20**
Anticipated Length of Newly Established Floodplain Surfaces Conducive to Replenishment (Km)	14	19	24	29	34	39	44	49	54	59	64	69
Anticipated Length of Newly Established Floodplain Surfaces Conducive to Replenishment (m)	14,000	19,000	24,000	29,000	34,000	39,000	44,000	49,000	54,000	59,000	64,000	69,000
Anticipated area of newly established floodplain surfaces conducive to replenishment (m^2)	224,000	304,000	384,000	464,000	544,000	624,000	704,000	784,000	864,000	944,000	1,024,000	1,104,000
Estimated average number of days per year that newly established floodplain surfaces will be inundated.	3	3	3	3	3	3	3	3	3	3	3	3
Average Minimum Seepage Rates for Canals (m^3/m^2) of wetted area per day	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Estimated replenishment rate (m^3/yr)	616,793	837,076	1,057,360	1,277,643	1,497,926	1,718,210	1,938,493	2,158,776	2,379,059	2,599,343	2,819,626	3,039,909
Estimated replenishment rate (liters/year)	**616,793,201**	**837,076,487**	**1,057,359,773**	**1,277,643,059**	**1,497,926,346**	**1,718,209,632**	**1,938,492,918**	**2,158,776,204**	**2,379,059,490**	**2,599,342,776**	**2,819,626,062**	**3,039,909,348**

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Modernization of Delicias Irrigation District to improve water use efficiency

LOCATION: Rio Conchos Basin, Mexico

PRIMARY CONTACT:
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OBJECTIVES

- Stabilize flows in the Rio Conchos and Rio Grande

BACKGROUND & DESCRIPTION OF ACTIVITY: Prolonged drought in 1994-2005 reduced river flows and led to shortages for irrigation. The drought, along with 1944 Treaty obligations led to conservation measures. Modernization of the Delicias Irrigation District (90,589 Ha) addressed water losses in transmission, distribution, and irrigation systems due to unlined canals, deteriorating infrastructure, and poor irrigation techniques.

Aerial view of the Delicias Irrigation District (photo by WWF/Pablo Cervantes - from February 16, 2009 Quarterly Report)

ACTIVITY TIMELINE:

- Project improvements began in 2002 and were completed in 2005
- Evaluation of interaction between surface and ground-water in the irrigation district (ongoing and to be completed in 2009)

COCA-COLA CONTRIBUTION: 0.03%

- Total cost: $143,600,000 (USD)
- TCCC contribution: Annual contribution in 2008 = $52,000

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface water use

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1. DECREASE IN SURFACE WATER USE

Approach

Water usage provided by WWF staff. The savings were computed as the difference between pre-project water usage and post-project usage:

2008 water savings based on farmers' estimates and project estimates (5/7/09 email from Alfredo Rodríguez, hydrologist of the WWF-Chihuahuan Desert Program).

According to NADBANK, the expected water savings for the three irrigation districts were 396 hm3 = 396 million m3/year = 396 billion liters/year. For the Delicias Irrigation district-05 the expected savings were 343 hm3. Actual savings are still unknown (WWF is currently requesting the official tally from CONAGUA).

Data sources

- No data used – water savings were reported.

Assumptions

- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

From NADB Fact Sheet:

- Reduction of agrochemicals in runoff
- Higher crop yields & better crop quality

NOTES

- The Mexican Water Agency (CONAGUA) has not yet released the official savings for 2008, so 2008 savings are based on best estimates.
- Higher land values & lower maintenance costs are other benefits mentioned in NADB Fact Sheet.

REFERENCES

North American Development Bank (NADB). Undated. Fact Sheet: Irrigation District 005 Delicias, Chihuahua.URL: (http://www.nadb.org/pdfs/state_projects/FS%20Delicias%20Irrigation%2010-02%20_Eng_.pdf)

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Acquisition of water rights, and conservation of spring and its endemic biota.

LOCATION: Rio Conchos Basin, Mexico (Pandeño Spring, Julimes)

PRIMARY CONTACT:
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OBJECTIVES

- Reestablish a viable population of endemic pupfish in Pandeño Spring
- Demonstration project for legal and administrative framework authorizing environmental flows
- Establish the spring as a protected area

BACKGROUND & DESCRIPTION OF ACTIVITY: The Pandeño Spring is a small (~200 square meters) thermal spring that is home to an endemic fish, the Julimes pupfish (*Cyprinodon julimes.), a new species being currently described and* considered to be among the three vertebrates that live at the highest temperatures on the planet (WWF, 2007). It is among several springs impacted by increasing pumping that depletes the local groundwater supply.

Technical studies to support water rights acquisition were conducted to determine the needs of the fish. It was determined that 70-80 L/sec in water rights needs to ultimately be secured.

Pandeño spring in Julimes and one of the land owners belonging to the San José de Pandos farmers association, main WWF partner (Photo Jürgen Hoth /WWF Mexico Program).

ACTIVITY TIMELINE:

- Basic technical studies completed by February, 2009 (WWF, 2009)
- As of April 2009, 50 L/sec have been secured (per M. De La Maza Benignos).
- Establish the Pandeño Spring Protected Area in 2009.
- Additional 20-30 L/sec water rights acquisition is anticipated by (2011)

COKE CONTRIBUTION: 51%

- Approximate total cost of project: ($1,294,200 pesos
- Coke contribution: ($664,200 pesos)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in groundwater pumping

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1. DECREASE IN GROUNDWATER PUMPING

Approach and Results

The 2009 savings was based on the quantity of water that was recently secured (50 L/sec). Projected future acquisitions 25 l/sec (resulting in a total of 75 L/sec) were assumed to take place by 2011.

50 L/sec = 1,580 ML/yr in 2009
75 L/sec = 2,370 ML/yr by 2011

Data sources

- Water acquisition estimates provided by WWF, and confirmed data provided by official documentation (National Water Commission)

Assumptions

- Future projections assume that a quantity of 75 L/sec is successfully secured by 2011.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Physical protection of the of the pupfish's habitat was achieved through voluntary designation of four hectares of land as a protected area and fencing of its perimeter. Its additional designation as a Federally recognized protected area is underway.
- The water that is acquired flows through the spring and into the river, and is available for downstream uses including irrigation.
- Establishment of a local NGO "Amigos del Paneño, A.C.", as a step to develop local water stewardship.

NOTES

- The framework developed for Pandeño Spring is a model for protection of other threatened springs, water-related areas and resources in Mexico.
- Many legal, social, and political challenges have been overcome. Support from local owners and municipal authorities has been the key of success

REFERENCES

WWF. 2007. Restoring a Desert Jewel – The Chihuahuan Desert's Big Bend and the WWF/Coca Cola Partnership. August.

WWF 2008, Conservación de *Cyprinodon nov sp.* Julmes: Taxonomía, filogenia molecular, etología reproductiva y coloración críptica comparada del Género Cyprinodon (Pisces: Cyprinidontidae) en la cuenca del Río Conchos, By Lourdes Lozano and Susana Favela, UANL,

WWF 2008 Plan de manejo del área natural protegida "el pandeño", en el municipio de julimes, chihuahua. By Castañeda G., G. Jiménez, J. Blando, M. Ortega and.M. Valencia, Biodesert A.C. Prepared for World Wildlife Fund

WWF. 2009. WWF-TCCC Partnership Quarterly Report: Chihuahuan Desert Ecoregion. February 16.

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo River Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Pilot wastewater bio-treatment plant

LOCATION: Rio Conchos Basin - Julimes, Chihuahua, Mexico

PRIMARY CONTACT:
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OBJECTIVES

- Reduce pollutant load in river from sewage discharges
- Demonstration project for wastewater treatment

BACKGROUND & DESCRIPTION OF ACTIVITY: Untreated sewage currently flows into the Rio Conchos. A pilot cost-effecitve (from 5 to 8 times less expensive compared to traditional water treatment plants) wastewater bio-treatment plant for 50 people will be operational by the end of 2009. The system will be designed as a primary treatment plant. Thanks to the use of earth worms as part of the treatment process the resulting sludge can be used as fertilizer and effluent will be used for irrigation. Based upon results from the pilot project, a larger plant will be constructed for up to 5,000 people over a 2 year timeframe.

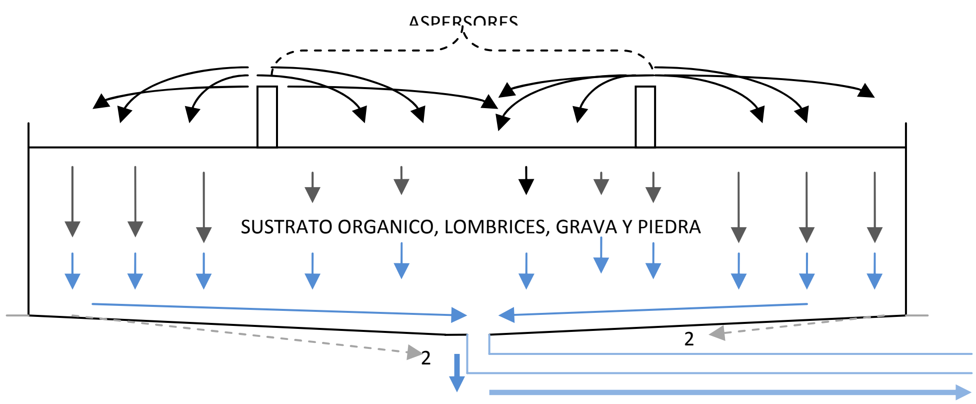

Diagram of water treatment process related to the biofilter (López. 2009).

ACTIVITY TIMELINE:

- Pilot plant for 50 people will be completed in August 2009
- Based upon pilot results, a larger plant serving up to 5,000 people (based on population growth projections from the current 2,500 inhabitants) will be built over a 2 year timeframe.

COKE CONTRIBUTION: 60%

- Total cost: $513,000 Pesos
- Coca-Cola contribution: 313,000 Pesos

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in pollutant load

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1. DECREASE IN POLLUTANT LOAD

Approach and Results

The decrease in pollutant load was calculated as the difference between the pollutant load in raw sewage (based typical concentrations and per capita water usage) and the pollutant load in treated effluent from a primary wastewater treatment plant. See attached spreadsheet for calculations.

Load reduction estimates (metric tons/50 persons/year):

- Biochemical oxygen demand (BOD): 0.2763
- Total suspended solids (TSS): 0.6143
- Total coliform: 0.0297
- Fecal coliform: 0.000297

Data sources

- The primary source of information was Metcalf and Eddy (2003). See attached Excel file.

Assumptions

- Pilot plant was assumed to function as a primary treatment plant.
- It is assumed that the system is maintained, so it continues to function over the 5-year period.

OTHER WATERSHED RESORATION BENEFITS NOT QUANTIFIED

- Improved aesthetics
- Reduced exposure to pathogens
- Reduced nutrient loadings

NOTES

- Based upon the results of the pilot plant, the plan is to expand these types of plants through the TCCC-funded Clean Basin Project over a 3-5 year period. The ultimate goal is to make this technology available to the 150,000 people living in rural areas within the entire basin.

REFERENCES

Arango , J. 2003. Evaluación ambiental del sistema tohá en la remoción de *Salmonella* en aguas servidas domésticas. Tesis de Maestría. Universidad de Chile. Santiago Chile

López, L. 2009. Diseño planta piloto tratamiento de aguas residuals Julimes, Chihuahua, México. Club Rotario Camargo.

Metcalf and Eddy. 2003. Wastewater Engineering, Treatment and Reuse. 4th Edition.

Preliminary Estimate of Pollutant Load Reduction
***Rio Conchos* - Pilot wastewater primary treatment plant (50 people)**

Water consumption in developing countries and areas [1]
Per capita water consumption

Units	Gal/d	L/d
Latin America and Caribbean	19-51	70-190

Water consumption in developing countries and areas
Per capita water consumption - Average Values

Gal/d	L/d	L/yr
35	130	47450

Typical wastewater constituent data for various countries - Constituent Ranges [2]

Countries	BOD [2]	TSS [2]	TKN [2]	NH3-N [2]	Total P [2]	Total Coliform [3]	Fecal Coliform [3]
Units	g/capita*d	g/capita*d	g/capita*d	g/capita*d	g/capita*d	No./100mL	No./100mL
Brazil	55-68	55-68	8-14	ND	0.6-1	n/a	n/a
Egypt	27-41	41-68	8-14	ND	0.4-0.6	n/a	n/a
India	27-41	ND	ND	ND	ND	n/a	n/a
Palestine (W. Bank & Gaza Strip)	32-68	52-72	4-7	3-5	0.4-0.7	n/a	n/a
Turkey	27-50	41-68	8-14	9-11	0.4-2	n/a	n/a
Uganda	55-68	41-55	8-14	ND	0.4-0.6	n/a	n/a
US	50-120	60-150	9-22	5-12	2.7-4.5	1E+7-1E+10	1E+5-1E+8

Typical wastewater constituent data for various countries - Average Values

BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
g/capita*d	g/capita*d	g/capita*d	g/capita*d	g/capita*d	No./100mL	No./100mL
61.5	61.5	11	ND	0.8	n/a	n/a
34	54.5	11	ND	0.5	n/a	n/a
34	ND	ND	ND	ND	n/a	n/a
50	62	5.5	4	0.55	n/a	n/a
38.5	54.5	11	10	1.2	n/a	n/a
61.5	48	11	ND	0.5	n/a	n/a
85	105	15.5	8.5	3.6	5.01E+09	5.01E+07

Estimated Typical Wastewater Constituent Data for Mexico
Average of Values for Brazil, Egypt, India, Palestine, Turkey and Uganda (above)

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform [4]	Fecal Coliform [4]
g/capita*d	46.6	56.1	9.9	7	0.71	3.25	0.033
kg/capita*d	0.046583	0.056100	0.009900	0.007000	0.000710	0.003253	0.000033
MT/capita*yr	0.017003	0.020477	0.003614	0.002555	0.000259	0.001187	0.000012

Estimated Typical Wastewater Consituent Loads for Rio Conchos WWTP

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
MT/50 persons*yr	**0.85**	**1.02**	**0.18**	**0.13**	**0.01**	**0.0594**	**0.000594**

Primary WWTP Plant Removal Efficiencies - Constituent Ranges [5]

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
Percent Removal	25-40	50-70	NA	NA	NA	25-75	25-75

Primary WWTP Plant Removal Efficiencies - Averages

BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
32.5	60	n/a	n/a	n/a	50	50

Estimated Wastewater Constituent Loading Change for Rio Conchos WWTP

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
MT/50 persons*yr	**0.2763**	**0.6143**	n/a	n/a	n/a	**0.0297**	**0.000297**

Notes
ND: not detected
n/a: not available

Unit Conversions
2E+12 cells/g [4]

Data Sources
[1] Table 3-9: Water consumption in developing countries and areas. Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[2] Table 3-14: Typical wastewater constituent data for various countries. Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[3] Table 3-15: Typical composition of untreated domestic wastewater at high strength concentration (based on wastewater flowrate of 60 gal/capita/day). Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[4] The conversion of fecal coliform count to mass concentration used a value of 2x10^12 cells/dry g based on reported properties of E. coli (Watson, J.D. 1970. Molecular Biology of the Gene. W.A. Benjamin, New York) (http://www.bvsde.paho.org/bvsaar/cdlodos/pdf/assessmentofrisk635.pdf)
[5] Primary WWTP plant removal efficiencies (Table 3-7: Primary treatment (without chemicals), Quantifying Water "Offsets" in Community Water Parnership Projects, LTI. Data from Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.; Shao J. Y., Advanced primary treatment: An alternative to biological secondary treatment. The city of Los Angeles hyperion treatment plant experience. Water Science and Technology, 1996(34), 223-233.)

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin – Rainwater harvesting for irrigation of orchards
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Rainwater harvesting

LOCATION: Tarahumara region, Rio Conchos Basin, State of Chihuahua, Mexico

PRIMARY CONTACT:
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OBJECTIVES

- Augment domestic and irrigation water supplies during the dry season using stored rainwater

BACKGROUND & DESCRIPTION OF ACTIVITY: A rainwater harvesting project was implemented in 2007 in the Tarahumara region of the southwestern portion of the Mexican State of Chihuahua. Rainwater is captured from the rooftops of 26 participating households with average roof size of 35 square meters each. The water is collected in a 10,000 liter domestic tank which usually completely fills during the rainy season. Prior to rainwater harvesting, the only source of water was Sisoguichi creek. The harvested rainwater is used in equal proportions to supply 60% of the domestic and orchard irrigation needs (the average orchard size is 50 square meters) during the four months of the dry season (March through June). An average Tarahumara household of 5 individuals consumes 70 liters of water per day or 8,400 liters of water during the dry season. The water tank provides 60% of their drinking needs (i.e., 5,040 l) and the remaining 40% (3,360 liters) is obtained from the creek. Similarly for orchard irrigation needs of approximately 8,500 liters during the dry season, the tank provides 4,960 liters and the remaining 3,570 liters are obtained from the creek.

Rainwater Harvesting in the Tarahumara region of Chihuahua, Mexico - orchard in foreground; tank and roof catchment in background (photo WWF-CDP. 2007).

ACTIVITY TIMELINE:

- Project implemented in 2007 and is ongoing

COCA-COLA CONTRIBUTION: 35%

- Total cost: $1,869,000 Pesos
- Coca-Cola contribution: 651,000 Pesos

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface water use

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1. DECREASE IN SURFACE WATER USE

Approach

Water harvesting and usage rates were provided by WWF staff. The water benefit is equal to the amount of water harvested in the 10,000 liter collection tank.

- **Total yearly benefit (decreased surface water use): 0.01 ML/year**

Data sources

- No data used – water savings were reported in email from Jurgan Hoth/WWF on May 17, 2009.

Assumptions

- Assumed no depreciation in savings over 5 years (system continues to function as in 2008).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED: None

NOTES: None

REFERENCES: None

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Reforestation in Upper Conchos Basin

LOCATION: Mexico: Río Conchos headwaters (Ejido Panalachi, Sierra Tarahumara); Upper portion of Ureyna micro-basin and Resonachi micro-basin of Panalachi

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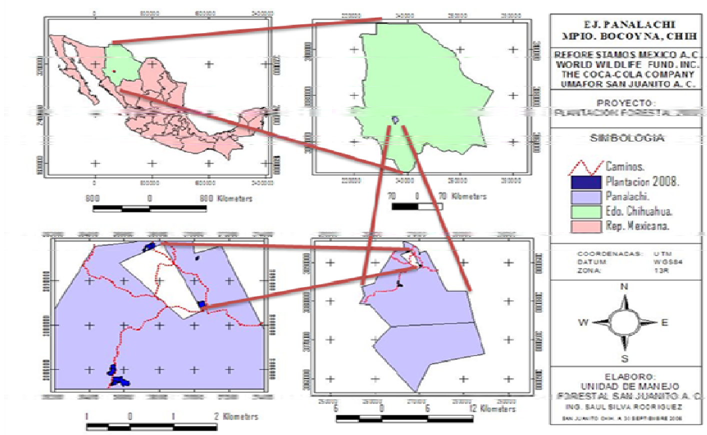
OBJECTIVES:

- Reduce erosion and associated sedimentation in river & above dams
- Restore forest habitat

BACKGROUND & ACTIVITY DESCRIPTION: Extensive forest fires in 2001 and 2003 cleared the land. A total of 122.5 ha of land was reforested with native pine (*Pinus arizonica*).



Areas showing 100 ha of reforestation efforts in the upper Conchos basin.
The remaining 22 hectares are scattered and located nearby.

ACTIVITY TIMELINE:

- 122.5 ha reforested in September**,** 2008
- Future reforestation goals will depend on the forestry management plan under development, so extent of future reforestation is currently unknown and was not quantified.

COKE CONTRIBUTION: 35%

- Total cost: 660,000 pesos
- Coca-Cola contribution: 320,000 pesos

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff water quantity
2. Decrease in sediment runoff

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1. DECREASE IN RUNOFF WATER QUANTITY

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
    - Hydrologic soil group (HSG) "B"
    - Herbaceous – grass/weeds/brush mixture in "fair" condition (CN = 71)
- Post-project:
    - Hydrologic soil group (HSG) "B"
    - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained from the meteorological database available from WaterBase (www.waterbase.org) for the 2000-05 period, although sufficiently complete precipitation data were only available for year 2000. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for year 2000. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space): 14.7 ML/yr (12 mm/yr)
- Post-project (reforested land): 0.1 ML/yr (0.1 mm/yr)
- **Benefit (runoff reduction): 14.6 ML/yr (12 mm/yr)**

Data Sources:

- Size of reforested land area: 122.5 ha (provided by contact)
- Slope: 12% (provided by contact)
- Soil type:
    - primarily Regosol eutrico, Luvisol, and feozem (provided by contact)
    - Available water content (AWC) = 8 mm/meter (hydrologic soil group "B")
- Daily precipitation data for year 2001 obtained from WaterBase meteorological database for Parral, Mexico (lat: 26.93, long: -105.66, elev: 1661 meters) for year 2000 (411 mm).

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- Precipitation data obtained for Parral, Mexico for year 2000 are generally representative of average annual precipitation conditions for the area where reforestation is occurring.
- Soil drainage properties can be represented using Hydrologic Soil Group (HSG) "B" for the purpose of runoff calculations.
- SWAT model parameter "CNCOEF" was set to 2.0 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass/weeds mixture, 60-80% cover (C_{usle} = 0.05)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (unforested): 220 MT/yr
- Post-project (forested): ~0 MT/yr
- **Benefit (reduced sediment yield): 220 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.28 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife
- Shading of streams lowers water temperatures and improves fishery
- Subsistence agricultural practices including low impact tilling and use of organic fertilizers will be proposed to local communities using native/traditional corn. Anticipated benefits include reduced runoff and reduced pollutant concentrations in runoff.

NOTES

- Quantification does not include future restoration efforts because details are not currently known.

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

WWF. undated. Annual Action Plan for the String of Pearls; Chihuahuan Desert Coca Cola Partnership. Filename: Rio Grande TCCC workplan SECOND Jan 9.xls

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Removal of invasive plants and natural levees, increasing high or pulse flows, bankline destabilization, and other restoration activities.

LOCATION: Rio Grande, New Mexico (Caballo Dam to American Dam)

PRIMARY CONTACT:
Beth Bardwell
elizabeth.bardwell@wwfus.org
(575) 640-3415

OBJECTIVES

- Enhance native riparian habitat and aquatic diversity, and reestablish river-floodplain connectivity

BACKGROUND & DESCRIPTION OF ACTIVITY: Following extensive scientific studies, a conceptual restoration plan was developed for up to 30 sites. The plan addresses problems due to alteration of the natural hydrograph, historical canalization, historical vegetative management, invasive plants, dam operations, and other causes.

Measures to reestablish floodplain connectivity are targeted at increasing the frequency and duration of overbank inundation through bank excavation, removal of invasive plants and natural levees, increasing high or pulse flows, bankline destabilization, and other activities, which vary by location.

ACTIVITY TIMELINE: (per B. Bardwell, WWF)

- Scientific studies and conceptual planning largely completed by March, 2009
- Final Record of Decision authorizing implementation anticipated in May-August, 2009 period.
- Implementation schedule for bringing 30 restoration sites online and undertaking environmental water transactions : 2-10 year timeframe
- Additional agreements needed to authorize environmental peak release – anticipated to occur over 5-10 year timeframe.

COKE CONTRIBUTION: TBD

- Assumed 30% for current estimate based on rough approximation from contact.
- WWF staff: 50% FTE Beth Bardwell

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in direct streamflow

1. INCREASE IN DIRECT STREAMFLOW

Approach and Results

The volume was computed as the total amount of water or water right transferred to restoration sites or for peak release. This is assumed to be equal to the projected volume of floodplain inundation (acre-ft/year). The floodplain will stay connected and water will flow through the site. Floodplain inundation that results from restoration activities may occur only periodically and not on an annual basis.

Changes in vegetation communities associated with the restoration activities (invasive plants to native plants) are anticipated to result in a net increase in annual depletions due to evapotranspiration (ET). This quantity is estimated to be 429 ac-ft. In some cases, supplemental annual irrigation of restoration sites will be necessary to sustain and enhance productivity of native riparian vegetation, because at some restoration sites the depth to groundwater has decreased as a result of canalization, irrigation drains and groundwater pumping. This quantity is estimated to be 227 ac-ft, but the quantity may increase under an adaptive management program.

The restoration plan includes voluntary water transactions (donations, leases and permanent acquisition) that would transfer water and/or water rights from farmland or lands taken out of production for housing development to offset annual depletions and/or irrigate restoration sites on an annual basis. If agreements with irrigators and federal agencies can be reached, there will also be periodic supplemental peak flows through dam releases. This quantity is estimated to be on average 9,500 ac-ft per augmentation event, and reoccur on the order of 3 to 5 years as determined under an adaptive management program.

Calculations

450 ac-ft/yr to offset depletion quantity
227 ac-ft/yr supplemental irrigation
2,375 ac-ft/yr peak flow release from dam (on annual basis assuming once every 4 years)
TOTAL = 3,052 ac-ft/yr = 3,765 ML/yr

Data sources

- Water transfer quantities provided by B. Bardwell, WWF.

Assumptions

- It is assumed that agreements are reached and projected water and water rights transfers will occur as anticipated.
- Peak flow release was converted into an annual volume for the purpose of estimating an annual average. This quantity of water will not be put in the river on an annual basis; rather it will be banked and the cumulative amount will be released periodically once every 3 to 5 years.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Removal of invasive plants and revegetation with native species will expand habitat availability and quality, and lead to increased abundance of birds, mammals, reptiles, and fish.
- The risk of fire associated with dense salt cedar stands will be reduced.

NOTES

- Project also involves establishment of a legal framework for these types of projects (WWF, 2007).

REFERENCES

WWF. 2007. Restoring a Desert Jewel – The Chihuahuan Desert's Big Bend and the WWF/Coca Cola Partnership. August.

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Acquisition of water rights to support environmental flows

LOCATION: Rio Bosque Wetland Park: El Paso, Texas

PRIMARY CONTACT:
Beth Bardwell
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(575) 640-3415

OBJECTIVES
- Secure a water supply for the park to sustain year-round wetland and native riparian habitat

BACKGROUND & DESCRIPTION OF ACTIVITY: Rio Bosque Wetland Park is 372 acres in size. It provides the "largest expanse of native habitat along a several hundred-mile-long stretch of the Rio Grande." While treated wastewater is routinely diverted to flow through the park in the late fall and winter, the park does not reliably receive water during the growing season and breeding season for resident waterfowl. No permanent no water rights are currently allocated to the park. (WWF, 2008).

The plan includes voluntary water transactions (donations, leases, and permanent acquisition) to transfer water and/or water rights from farmlands or public water utilities to flow through two wetland cells covering 30 acres.

The following photos represent depict temporal changes in plant composition and productivity along the 2-mile long old river channel that was rebuilt to deliver water to the wetland cells within Rio Bosque Park. 2002 was the last year that water was delivered to the Rio Bosque Wetland Park during the growing season. The park receives treated effluent during the fall and winter now, but has not received water during the growing season for seven years now.

These represent "before" pictures, the "after" pictures would document changes once an environmental water transactions program was in place to dedicate water to the Rio Bosque Wetland Park.

JUNE 2002

JUNE 2003

MARCH 2004 **APRIL 2008**

ACTIVITY TIMELINE: (per B. Bardwell, WWF)

- Scientific studies and conceptual planning largely completed by March, 2009
- Formal agreement has not yet been reached between Bureau of Reclamation, local irrigation district, and local public water utility, and university who manages the wetland.
- Once agreements are reached, the water delivery infrastucture and environmental water transactions could be implemented on a timeframe of 1-5 years.

COKE CONTRIBUTION: TBD

- Assumed 50% for current estimate
- WWF has contributed funding in the form of grants to UTEP and third party contracts for legal research, environmental education and communication, and other activities that benefit the Rio Bosque Wetland Park: $23,000
- WWF staff time: 5%-10% of FTE Beth Bardwell

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in direct streamflow

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1. INCREASE IN DIRECT STREAMFLOW

<u>Approach and Results</u>

The volume was computed as the total amount of water or water rights transferred to the park. The goal is to acquire 5,400 acre-ft/yr through acquisitions & donations. An estimated 2,552 acre-feet would flow through the park and be returned to the irrigation network for use by downstream irrigators. 2,862 acre-feet would percolate to groundwater, evaporate or be transpired by vegetation within the park (WWF, 2008).

5,400 acre-feet/year = 6,661 ML/year

Data sources

- Water transfer quantities provided by B. Bardwell, WWF.

Assumptions

- It is assumed that agreements are reached and projected water and water rights transfers will occur on schedule as anticipated.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved wetland and riparian habitat will provide important habitat for aquatic life and birds.

NOTES

- Consumptive use in the park (percolation to groundwater, evaporation, and transpiration) is projected to be 2,862 acre-feet/year.

REFERENCES

WWF. 2008. Rio Bosque: Just Add Water. April.

PROJECT NAME: Southeast Rivers and Streams

PROJECT ID #: 22

DESCRIPTION OF ACTIVITY: Rain barrel distribution for community household and school/business use.

LOCATION: Nashville, TN

PRIMARY CONTACT:

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Nick Martin
Senior Project Manger
Delta Consultants
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OBJECTIVES:

- Reduction in stormwater runoff

BACKGROUND & ACTIVITY DESCRIPTION: Coca-Cola Consolidated Nashville is partnering with World Wildlife Fund (WWF) and Cumberland River Compact in the Nashville, TN area to distribute Coca-Cola 55-gallon syrup drums for reuse as rain barrels. Rain barrels are primarily donated to residential properties with the use of collected water running a relatively small gamut from use for light gardening work to exterior household cleaning needs (vehicle washing). A small portion of barrels are donated to local schools and businesses. By collecting rainwater that normally flows off a property, rain barrels save money on water bills, conserve water during dry periods and prevent polluted runoff. The reuse of these 55-gallon barrels will not only help in the effort to protect Southeast Rivers and Streams, but also eliminate the energy Coca-Cola would expend recycling the plastic barrels. In 2008, 1,500 rain barrels were donated.

ACTIVITY TIMELINE:

- 2008: 1,500 rain barrels were donated.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by The Coca-Cola Company and Coca-Cola Consolidated Nashville

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff

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1. DECREASE IN STORMWATER RUNOFF

Approach & Results:

Delta Consultants developed and used a Microsoft Excel-based rain barrel calculator to estimate the water benefit from use of donated rain barrels. The calculator is founded upon a supply and demand methodology and includes geography-specific input data, as follows:

Supply Calculations:

To calculate the potential rainwater available for harvest, the calculator utilizes the following formula and variables:

Catchment Size X Number of Barrels X Total Precipitation X Catchment Efficiency Coefficient

Catchment Size – Based upon an assigned percentage of the average single family home and school. For example, the average single family roof size is 1,200 square feet with most houses having a peaked roof. Therefore, the calculator utilizes 600 square feet as the catchment site.

Number of Barrels – An estimate of the number of donated barrels actually distributed and in use.

Total Precipitation – Combined monthly rainfall and snowfall. Snowfall is converted to Snow Water Equivalent using a 0.20 density coefficient. Precipitation data is pre-loaded for select geographic locations.

Catchment Efficiency Coefficient - An 85% runoff coefficient was selected, meaning 85% of the rain falling on the catchment will run off to the gutter and rain barrel. The other 15% will be lost to evaporation, wind, leaks, infiltration into the catchment surface, etc.

Demand Calculations:

To calculate the demand or estimated barrel water use, the calculator utilizes the following formula and variables for both households and schools/businesses.

(Evapotranspiration X Landscape Coefficient X Landscape Area) + Estimated Other Use X Overflow Loss

Evapotranspiration - Data is pre-loaded for select geographic locations.

Landscape Coefficient - Also commonly referred to as the "Plant Factor" and the functional equivalent of the "Crop Coefficient." A factor of 0.55 was selected which is an average value for moderate watering needs. Turf grasses are commonly 0.6-0.8, whereas gardens and shrubs are closer to 0.40 on average.

Landscape Area – The estimated square footage of the landscape are serviced by the rain barrel. The household average is 300 square feet and the school/business is 700 square feet. The larger landscape area for schools/businesses accounts for designated grounds personnel.

Estimated Other Use – Estimates for the amount of water utilized in each given month for purposes other than landscaping or gardening (e.g., washing a vehicle).

Overflow Loss – A percentage reduction based upon the month-to-month probability of receiving more than 0.30” precipitation in a single day. This represents the approximate amount to fill a rain barrel.

Estimated annual capture (2008):

- Nashville (1,500 barrels in 2008): 4,872,412 gallons = 18.44 ML/yr
- **Total benefit = 18.44 ML/yr**

Data Sources:

- Southeast Regional Climate Center **(**http://www.sercc.com)
- Harvesting Water for Landscape Use (http://ag.arizona.edu/pubs/water/az1052/harvest.html)
- Guide To Estimating Irrigation Water Need (http://www.owue.water.ca.gov/docs/wucols00.pdf)
- Crop Water Requirements (http://texaset.tamu.edu/coefs.php)

Assumptions:

- Homeowners and school/business representatives that attend a workshop and receive a rain barrel through the donation program will use it consistently to collect rainwater from roofed areas and use the collected water for gardening, cleaning, and other outdoor uses.
- Given that 55 gallons is a relatively small storage amount, the key to estimating actual harvest is to estimate the amount of water removed from the barrel each month.
- Additional assumptions incorporated into the calculator formulas and coefficients.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in municipal water usage due to use of water collected in rain barrels for gardening, and other activities.

NOTES:

- The calculator assumes that all donated barrels will be hooked up and used to harvest rainwater from rooftops. Currently no data exist to determine if this is true, or what the actual percentage might be.
- A new rain barrel distribution project in the Auburn, Alabama area was started in November 2008, with 45 barrels distributed by year-end. This project is ongoing in 2009 with a total of 221 barrels distributed as of May 2009. Benefits from this project have not been generated.

REFERENCES

City of Philadelphia Rain Barrel Program
http://www.phillywatersheds.org/rainbarrel/rb_map.htm

Nine Mile Run Rain Barrel Initiative - Final Report
http://www.harvesth2o.com/adobe_files/Runoff_Report.pdf

Virginia Cooperative Extension
Estimates that gardens require 65 to 130 gallons of water per 100 square feet once per week.

U.S. Environmental Protection Agency (Region 3)
Estimates that one barrel can save the average household approximately 1,300 gallons over the three peak summer months. http://www.epa.gov/Region3/p2/what-is-rainbarrel.pdf

Cornell Cooperative Extension of Onondaga County Rain Barrel Pilot Study
http://counties.cce.cornell.edu/onondaga/Rain%20Barrel%20Pilot%20Study%20Concludes%20in%20Skaneateles%20long%20version.pdf

PROJECT NAME: Rio Chamelecon River Watershed Protection Initiative
PROJECT ID #: 25

DESCRIPTION OF ACTIVITY: Implementation of improved agricultural practices: cropland/farmland management

LOCATION: Manchaguala sub-watershed near San Pedro Sula, Cortes, Honduras- (15.5° N, 88.1° W)

- Specifically selected areas in seven communities (Nueva Santa Elena, Buena Vista, Guadalupe de Bañaderos, Laguna de Bañaderos, Santa Elena Viejo, Monte Alegre y San José Manchaguala)

PRIMARY CONTACT:
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World Wildlife Fund - Central America
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OBJECTIVES

- Increase infiltration/aquifer recharge and/or increase baseflows
- Reduce erosion and associated sedimentation of receiving waters

BACKGROUND & DESCRIPTION OF ACTIVITY: (from WWF, 2008; WWF, 2009)
The Chamelecon watershed encompasses 4,350 square kilometers in the Merendon mountains and provides water to industry and residents of San Pedro Sula (approximately 600,000 inhabitants), as well as 15 other municipalities which represent one fifth of Honduras's total population. The Merendon mountains host many subsistence agriculture farming communities, dedicated mainly to agriculture and livestock. The upper watershed is threatened by illegal logging, poor agriculture practices, and the presence of pests and diseases among its forests. The lower watershed is threatened by unregulated industrial and residential effluents, an ineffective water commission, and unplanned economic urban residential growth. WWF's commitment to conserving the integrity of the Mesoamerican Reef identifies effluent reduction as a fundamental conservation strategy and the Rio Chamelecon Watershed Protection Initiative project directly addresses this need by reducing farmland erosion and runoff.

This project is a pilot effort to implement the Payment for Watershed Services program in Honduras by establishing a community-based integrated watershed management program. Efforts to achieve this goal include engaging key communities in sustainable land-use management practices that reduce erosion, control water flow and protect water and soil integrity while sustaining local livelihoods. This project is expected to include the following results: 21 parcels under agro forestry systems implemented with the participation of 21 small producers, construction of 21 efficient fuel wood stoves and 2 kilometers of live barriers (from tcccgws.com project database).

ACTIVITY TIMELINE:

- Start Date: November 2008
- End Date: 2009

COCA-COLA CONTRIBUTION: 30.5%

- Total Cost of Project: $3,020,000USD
- Coca-Cola Foundation $920,000USD
- from tcccgws.com project database

WATERSHED RESTORATION BENEFITS CALCULATED:

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1. DECREASE IN RUNOFF

Approach & Results

The water quantity benefit from implementation of the improved agricultural practices was estimated for water quantity (runoff reduction) and water quality (soil erosion reduction) using data provided in the survey responses. The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unvegetated/eroded land to agroforestry land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) “B”
  - Grassland in “fair” condition (CN = 69)
- Post-project:
  - Hydrologic soil group (HSG) “B”
  - Orchard/tree farm in “good” condition (CN = 58)

Daily precipitation and air temperature data were obtained from the TuTiempo.net online meteorological database for the Tela, Honduras station during the 2006-08 time period (http://www.tutiempo.net/en/Climate/Tela/787060.htm). The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space) runoff volume: 201 ML/yr
- Post-project (agroforestry) runoff volume: 183 ML/yr
- **Benefit (runoff reduction): 18 ML/yr**

Data Sources/Site-specific Characteristics:

- Pre-project: eroded areas with no crop or forest cover
- Post-project: agroforestry with crop rotation practices, etc.
- Surface area: 21 hectares
- Slope: 32-55%
- Soil type: silty/clay soil (Franco)
- Daily precipitation and air temperature data were obtained from the online "TuTiempo.net" meteorological database (http://www.tutiempo.net/en/) for the Tela station (ID: 787060).

Assumptions:

- Precipitation data for the Tela station (2006-08) are representative of precipitation conditions for the unvegetated areas converted to cropland.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unvegetated/eroded land to agroforestry land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for years 2006-08.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: ~60% cover as grass (C_{usle} = 0.04)
- Post-project: 20-40% tree canopy cover (C_{usle} = 0.01)

Total annual sediment yields for the unvegetated/eroded land and crop land areas were estimated as follows:

- Pre-project (open space) sediment yield: 18,903 MT/yr
- Post-project (crop land) sediment yield: 4,332 MT/yr
- **Benefit (sediment yield reduction): 14,571 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Protection of forest cover through use of fuel efficient stoves to reduce firewood consumption (no data provided).
- Any benefits realized through the use of live barriers.

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

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PROJECT NAME: Conserving the Mekong
PROJECT ID #: 28

DESCRIPTION OF ACTIVITY: Reforestation

LOCATION: Chi River watershed in Thailand (Tha Sala, Kam Kan, Nong Pan, and Pon Pek districts)

PRIMARY CONTACT:
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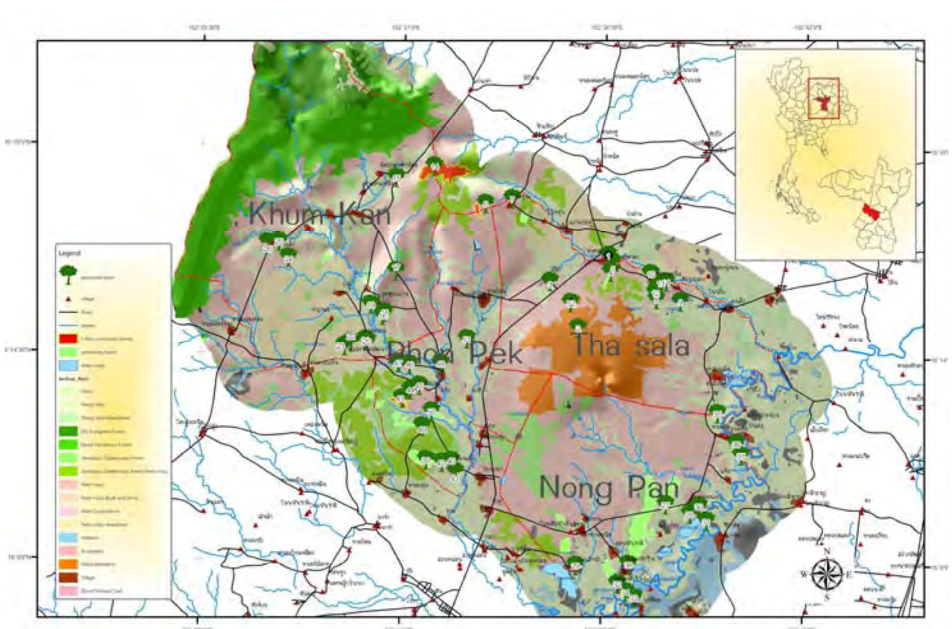
OBJECTIVES:
- Improve biodiversity
- Reduce sediment erosion & runoff (stabilize soils)

BACKGROUND & ACTIVITY DESCRIPTION:
The Chi River watershed includes a significant amount of agricultural lands, including plots for sugar cane, rubber plantations, and pulp and paper generation. Current farming practices in the region are generally poor and unsustainable and have resulted in a degraded condition for the watershed. Reforestation of the Chi River watershed is being undertaken to improve the condition of the watershed, included enhancing biodiversity and stabilizing soils to reduce sediment erosion and runoff.



Reforestation map for Chi River watershed.

ACTIVITY TIMELINE:

- Activity began in 2007 and continued through 2008.
- Future reforestation efforts are not known at this point.

COCA-COLA CONTRIBUTION: TBD

- No information available – assumed 50% for current estimate.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested (e.g., pasture/range) land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "B"
  - Pasture/grassland in "fair" condition: 50-75% vegetative cover (CN = 69)
    - Curve Number estimate is conservative for agricultural lands
- Post-project:
  - Hydrologic soil group (HSG) "B"
  - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained for the Kabinburi, Thailand for the 2003-04 period. Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for years 2003-04. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open range): 450 ML/yr (572 mm/yr)
- Post-project (reforested land): 322 ML/yr (409 mm/yr)
- **Benefit (runoff reduction): 128 ML/yr (163 mm/yr)**

Data Sources:

- Size of reforested land area: 492 rai = 78.7 hectares (provided by contact)
- Slope: variable, but 2% on average
- Soil type:
  - "Available water content" of ~8 mm per meter of soil depth (Batjes, 1996) – consistent with hydrologic soil group "B" characteristics.
- Daily precipitation data for years 2003-04 were obtained for Kabinburi, Thailand from the WaterBase meteorological database (http://www.waterbase.org).

Assumptions:

- Precipitation data obtained for years 2003-04 are generally representative of average annual precipitation conditions for the areas where reforestation is occurring.
- The pre-project land cover can be appropriately characterized as open pasture/rangeland with approximately 50-75% vegetative cover. (Note that this provides a conservative estimate of Curve Number for areas that have been utilized as crop land.)
- The slope conditions for the reforested area are approximately 2% on average.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass/weeds mixture, 60-80% cover (C_{usle} = 0.02)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (pasture/range): 177.0 MT/yr (2.2 MT/ha/yr)
- Post-project (forested): 6.3 MT/yr (0.1 MT/ha/yr)

- **Benefit (reduced sediment yield): 170.7 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Corresponding increases in infiltration and groundwater baseflow to local stream networks.
- Habitat improvements benefiting aquatic and terrestrial wildlife.

NOTES

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

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Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Conserving the Mekong
PROJECT ID #: 28

DESCRIPTION OF ACTIVITY: Water level management

LOCATION: Tram Chim National Park, Vietnam

PRIMARY CONTACT:
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OBJECTIVES
- Mitigate flood and drought impacts
- Maintain groundwater levels and reduce saline intrusion
- Demonstration project to change the way of thinking, management practices, and policy

BACKGROUND & DESCRIPTION OF ACTIVITY:
Tram Chim National Park (TCNP) in Vietnam is the site of a demonstration project of The Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme, a a joint programme of Cambodia, Lao PDR, Thailand, and Viet Nam that aims to strengthen capacity for wetland conservation and sustainable use in the Lower Mekong Basin by working at regional, national and local levels. Tram Chim is a depressed wetland area within the Plain of Reeds whose protected grasslands and *Melaleuca* forests and offer valuable habitat for many species, including the Sarus Crane (*Grus antigone*).

A comprehensive examination of water management in the park showed that prevalent fire prevention practices resulted in retention of extra water during the dry season in the largest (4700+ ha) zone of the park. At the same time, failure of control structures led to premature drying in two smaller zones (750+ ha). Optimization of water level management in the largest zone – moving towards a more natural hydroperiod – and repair of the control structures for the other two zones will lead to an estimated dry-season replenishment of more than 11 billion liters.

This replenishment volume will mitigate flood and drought impacts in the Plain of Reeds as well as the downstream Mekong Delta. It will also contribute to maintenance of groundwater levels in the Tram Chim vicinity and reduce saline intrusion at the edge of the Mekong Delta. In addition to increased water availability, these actions will lead to water quality improvements. In conjunction with mimosa eradication and *Melaleuca* restoration, water quality will improve through reduction of acidity and through increased filtration.

ACTIVITY TIMELINE:
- Project initiation: 2006
- Anticipated project completion: 2010

COCA-COLA CONTRIBUTION: 50%

- TBD – 50% was assumed until information becomes available

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Change in direct streamflow

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1. CHANGE IN DIRECT STREAMFLOW

Approach and Results

The replenishment volume for the largest zone (Zone A1) was calculated as the added volume of water discharged from Zone A1 when operating under the revised Tram Chim target water levels (Table 2 in Ni *et al*). Monthly discharge volumes under the revised levels were calculated as the difference between beginning-of-month and end-of-month volume as estimated from park elevation zone data (Table 1 in Thien *et al.*) in conjunction with the targets. The discharge volumes under the previous management plan were calculated using water levels for the years 2002-2006 reported in Figure 5 of Ni *et al.*). The discharge volumes for 2002-2006 were calculated by converting monthly water levels into volumes, then averaging.

The added January-April discharge volume for Zone A1 = 2.90 BG ≈ 10,980 ML

Replenishment for the smaller zones (A3 and A4) was calculated as the added volume of water stored in Zones A3 and A4, which were previously dry. Target water levels of 123 cm for Zone A3 and 137 cm for Zone A4 were selected as the comparison points.

The added volume of water stored in A3 = 7.32 million gallons ≈ 27.7 ML
The added volume of water stored in A4 = 116 MG ≈ 439 ML

Total volume = 10,980 + 27.7 + 439 ≈ 11,400 ML

Data sources

- All data and information were taken from references cited above.

Assumptions

- See references below

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved pH through reduction in water volume left to stagnate and additional mitigation from restored *Melaleuca* forest.
- Improved ecosystem health

NOTES

- [5/12/09 Email from Nguyen Huu Thien] “The ultimate goal of the work at Tram Chim is for ecosystem health and our approach is to demonstrate and change the way of thinking, management practices, and policy (uniformly applied across protected areas despite the differences in the needs of different ecosystems. The policy and management practices were originally developed for upland forests which are not suitable for wetlands and that's what should be counted as the "main feature" of the project."

REFERENCES

Nguyen. V.X and Wyatt. A (2006). *Situation Analysis: Plain of Reeds, Viet Nam*. Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme, Vientiane, Lao PDR. 60 pp.

Ni, D.V., Shulman, D., Thompson, J., Triet, T, Truyen, T, van der Schans, M. (2006). *Integrated Water And Fire Management Strategy - Tram Chim National Park.* Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme.

Thien, N.H., Quoi, L.P, and Marks, K. (2008?). *Protecting The Trees Or Conserving Wetland Health? A Case Study Of Tram Chim National Park, Mekong Delta, Vietnam*

PROJECT NAME: Conserving the Mekong
PROJECT ID #: 28

DESCRIPTION OF ACTIVITY: Pilot testing for a suite of improved agricultural practices, including pesticide reductions, fertilizer improvements, and strip cropping.

LOCATION: Chi River subwatershed in Thailand (including the Tha Sala, Kam Kan, Nong Pan, and Phon Pek districts). Longitude/Latitude: (102.56, 16.24)

PRIMARY CONTACT:
Rattaphon Pitakthepsombat
Project Manager
Chi Watershed Restoration Project, WWF Greater Mekong
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Tel: +66 43381158
Fax: +66 43381159
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Email: rpitakthepsombat@wwfgreatermekong.org
Website: http://thailand.panda.org/

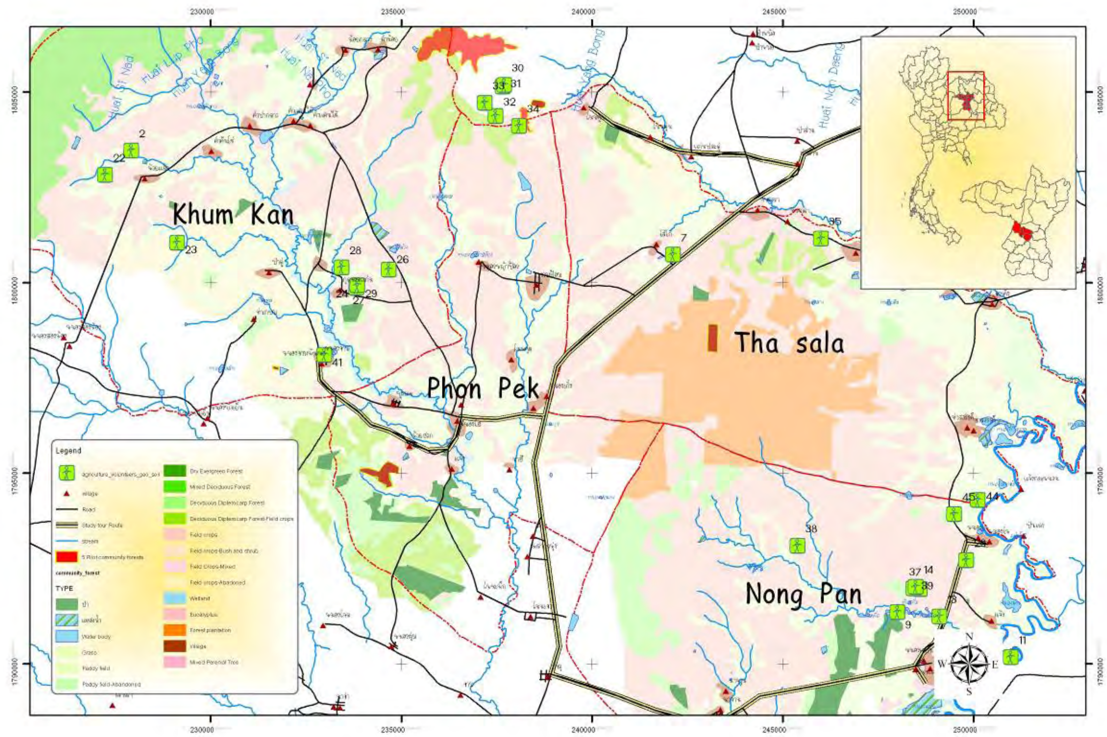
OBJECTIVES:
- Reduce nutrient loadings to receiving waters
- Reduce excess chemicals in runoff
- Reduce sediment erosion & runoff (stabilize soils)

BACKGROUND & ACTIVITY DESCRIPTION:

The Chi River watershed includes a significant amount of agricultural lands, including plots for sugar cane, Cassava, rice paddies, rubber plantations, and pulp and paper generation. Current farming practices in the region are generally poor and unsustainable and have resulted in degraded conditions for the watershed. Agriculture best management volunteers were mobilized to test a number of sustainable agricultural practices aimed at reducing chemical use on the farm and reducing soil erosion and runoff from agricultural fields into local water sources. The volunteers selected were all interested in establishing alternative agricultural plots on their farms. In each case, the alternative plot covers a portion of the total farm area and not the total land cultivated by each farmer. This is for two reasons: 1) to reduce the risk of each farmer to a level that the project can guarantee if the alternative plot crop fails, and 2) by only working on part of the farmers land they can compare and contrast between the alternative plot and their regular fields to better understand the costs and benefits of the alternative practice compared to regular practice. Once the volunteer farmers were selected, a study tour was organized to instruct the farmers about the alternative farming systems that are possible for each crop and land type.

The alternative agricultural practices were individually designed based upon the local conditions and the farmer's interests. For example, some farmers were interested in reducing their fertilizer costs so were keen on testing organic fertilizers, whereas other farmers wanted to try soil stabilization techniques to protect their soil. A total of 40 farmers are engaged in this activity with 144 Rai (23 ha) of rice, 49 Rai

(7.8 ha) of sugarcane and 123 Rai (20 ha) of Cassava represented. A working group has been established to support, advise and monitor these alternative agriculture practice activities comprising representatives from Khon Kaen University, Khon Kaen crop research center, Green Manja Kheio Kajee Network, the Sub-district councils, and the agriculture volunteer in each village assisted by project staff.



Agricultural areas within the Chi River watershed.

ACTIVITY TIMELINE:

- Pilot activities began in February 2008 and are ongoing.

COCA-COLA CONTRIBUTION: To be determined.

- No information available – assumed 50% for current estimate.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in sediment erosion/runoff

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1. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al., 2005) was used to estimate the original sediment erosion and washoff for the farm plots prior to implementation of the pilot projects. Supporting estimates of water runoff volume were based on the Curve Number method (USDA-NRCS, 1986), and daily maximum hourly rainfall intensities were estimated for years 2006-08 based on local meteorological data. Daily precipitation and air temperature data were obtained for the Khan Kaen, Thailand meteorological station for the 2006-08 period from TuTiempo.net (http://www.tutiempo.net/en/Climate/Khon_Kaen/483810.htm). Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

To date, strip cropping practices have been implemented for 20 rice paddy plots (16 ha), 19 Cassava plots (8.3 ha), and 6 sugar cane plots (8.5 ha) for a total crop land area of 32.8 ha. The Runoff Curve Numbers (CN) and the Cover/Management Factors (C_{usle}) used in the MUSLE was estimated for these farm plots as follows based on Haith et al. (1992):

- Curve Number:
    - Rice paddies: CN = 73 (small grains, "good condition", hydr. soil group "B")
    - Sugar cane / Cassava: CN = 75 (contoured row crop, "good condition", hydr. soil group "B")
- Cover/Management Factor (C_{usle}):
    - Rice paddies: C_{usle} = 0.40
    - Sugar cane / Cassava: C_{usle} = 0.10

Total annual sediment yields for the pre-project (i.e., no practices) and post-project (strip cropping practice) crop land areas were estimated as shown below. The post-project estimate is based on an assumed 70% reduction in soil erosion/runoff based on implementation of strip cropping practices (Table B-13 in Haith et al., 1992):

- Pre-project (no practices): 4,080 MT/yr (124 MT/ha/yr on average)
- Post-project (strip cropping): 1,224 MT/yr (37 MT/ha/yr on average)
- **Benefit (reduced sediment yield): 2,856 MT/yr**

Data Sources:

- Total area of farm land where strip cropping is being tested (32.8 ha) – provided by contact.
- Slope: variable (2% for rice paddies, 5-15% for Cassava and sugar cane plots) – provided by contact.
- Soil type:
    - Sand/clay mixture (provided by contact)
    - Available water content" of ~8 mm per meter of soil depth (Batjes, 1996) – consistent with hydrologic soil group "B" characteristics.
- Daily precipitation data for years 2006-09 were obtained for Khan Kaen, Thailand from TuTiempo.net (http://www.tutiempo.net/en/Climate/Khon_Kaen/483810.htm).

Assumptions:

- Precipitation data obtained for years 2006-08 (mean: 1,534 mm) are generally representative of average annual precipitation conditions for the areas where pilot testing is occurring.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- Selected values for the Cover/Management Factor (C_{usle}) were assumed to be representative of field conditions. In addition, these factors were assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Potential reduction in nutrient loadings to soils and to receiving waters resulting from the use of organic fertilizers in place of traditional fertilizers.
- Reduction in pesticide loadings to receiving waters (**note that pesticide loading data are required to support this estimate**).
- Possible water quantity and/or quality benefits associated with wetland conservation (**more information needed on this activity**).
- Habitat improvements benefiting aquatic and terrestrial wildlife.

NOTES

- None

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

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PROJECT NAME: Reconnecting the Lifeline
PROJECT ID #: 31

DESCRIPTION OF ACTIVITY: Restoration of the natural connection between the Gârla Mare wetland/floodplain area and the Danube River in Romania

LOCATION: Danube River near river kilometer 833 (total river length is 2,780 km)
Mehedinti County, Romania N 44^{o} 10'42", E 22^{o} 48'22"

PRIMARY CONTACT:
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OBJECTIVES

- Reconnect wetlands to a) increase biodiversity and habitat area, b) re-establish natural hydrological conditions, and c) retain waters during flood events.

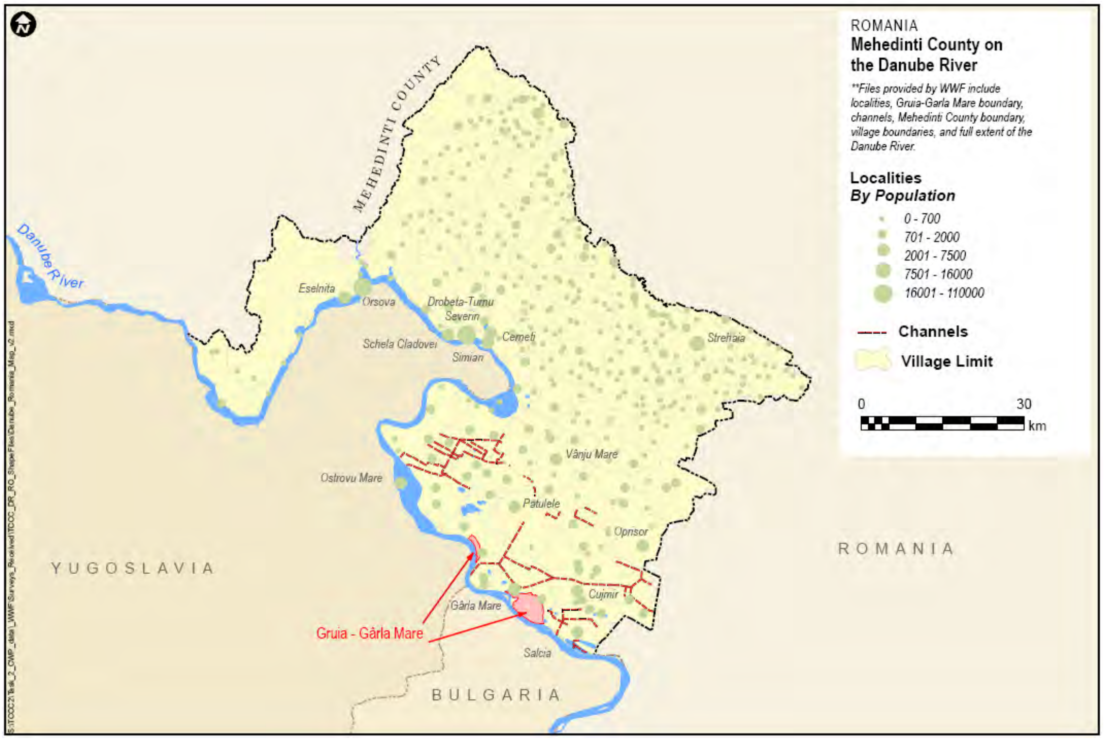
BACKGROUND & DESCRIPTION OF ACTIVITY:

The Danube River flows through ten countries and four capital cities. It serves as a source of drinking water for over 20 million people, and provides a host of other benefits and services including flood protection in its remaining floodplains, fisheries, tourism, and filtration of pollutants and nutrients. WWF has identified the Lower Danube and Danube Delta as one of the earth's 200 most valuable ecological regions (WWF Danube-Carpathian Programme Office, 2008).

Over 80% of the Danube's former floodplains have been disconnected from the river, reducing water management and flood protection benefits of these areas. Flooding in particular has become a concern on the Lower Danube in recent years due to an increase in extreme weather events. Between 1998 and 2002, Hungary and Romania experienced the most frequent flood events in Europe. Subsequent flash flooding occurred in Bulgaria and parts of Romania in 2005, and an approximately 100-year flood event occurred on the lower Danube in 2006. Across the entire Danube basin, at least 10 lives were lost, up to 30,000 people were displaced, and overall damage was estimated at a half billion Euro (WWF Danube-Carpathian Programme Office, 2008).

Rehabilitation is targeted at reconnecting former wetland areas and side arm systems. The area around Calafat in Romania and the corresponding area on the opposite river bank in Bulgaria (downstream Vidin up to Lom) were identified as having high potential for reconnecting former wetlands and former meanders with the current Danube watercourse (WWF Danube-Carpathian Programme Office, 2008).

A feasibility study is underway for the restoration and reconnection of a wetland complex (Gârla Mare) to the main river stem on the lower stretches of the Danube. This 2,746 hectare area is designated as on the European level as a Natura 2000 Special Protected Area. This effort is part of a larger project, which also includes activities on policy work, networking protected areas and sturgeon conservation initiatives (WWF Danube-Carpathian Programme Office, 2008).



Location of Gârla Mare Wetland Restoration and Reconnection Project

ACTIVITY TIMELINE: (based on WWF Danube-Carpathian Programme Office, 2008)

- In 2008, a pilot site was selected, a project proposal was written and a scoping study was developed.
- A feasibility study is planned for completion in the first quarter of 2009. The feasibility study will identify the technical works to be carried out for restoration of/re-linking the area to the river system.
- Implementation of the restoration work is planned to start in 2011. The schedule for completion of this work is dependent on natural, political and local factors and is anticipated between 2012 and 2015.

COKE CONTRIBUTION: 25-50%

- Total budget requested from WWF US/TCCC for wetland restoration is 250,000 USD (based on the original proposal of WWF Danube-Carpathian Programme Office in 2008). These funds will cover completion of a stakeholder analysis, staff and office costs, travel to and from the sites area, technical feasibility study, production of a virtual or model wetland for the site to be used as a communications and educational tool to gain stakeholder buy-in, means to prepare a project proposal to leverage additional funds for complete implementation of works, and development of a complete restoration plan (including goals and objectives, restoration activities, costs and a capacity building and communications plan).

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in storage volume restored in the floodplain

1. INCREASE IN DIRECT STREAMFLOW

Approach and Results

The approach was to estimate the annual storage volume that is restored in the floodplain due to reconnecting this wetland area to the main stem of the Danube River. This storage is a measure of the volume of water that would have otherwise flowed downstream without serving natural hydrologic functions in the floodplain. The calculation is based on a rough estimate for Gârla Mare of approximately 9 days of inundation per year for an average depth of 0.5-1.0 meters.

An additional 0.5 meter of water storage (conservative) over 2,750 ha of the Gârla Mare's surface area translates to a **water quantity benefit of 13,750 ML/yr**.

Data Sources

- Area flooded - provided in LimnoTech, 2009.
- Rough estimate of inundation frequency and average depth (0.5-1.0 m) – provided by contact based on extrapolations from an irregular elevation model and observations from spring 2009 floods.

Assumptions

- An average inundation depth of 0.5 meter in the floodplain was conservatively assumed based on information provided by the project contact.
- It was assumed that restoration will proceed according to the schedule in WWF Danube-Carpathian Programme Office, based on the initial project proposal submitted to WWF-US for river basin funding from the WWF-TCCC Global Partnership funds.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved habitat for migrating birds and spawning fish.
- Recreational benefits such as fishing and other water-based activities. Potential in increased fish catch, i.e. increase in revenue, for local inhabitants and fishermen.

NOTES

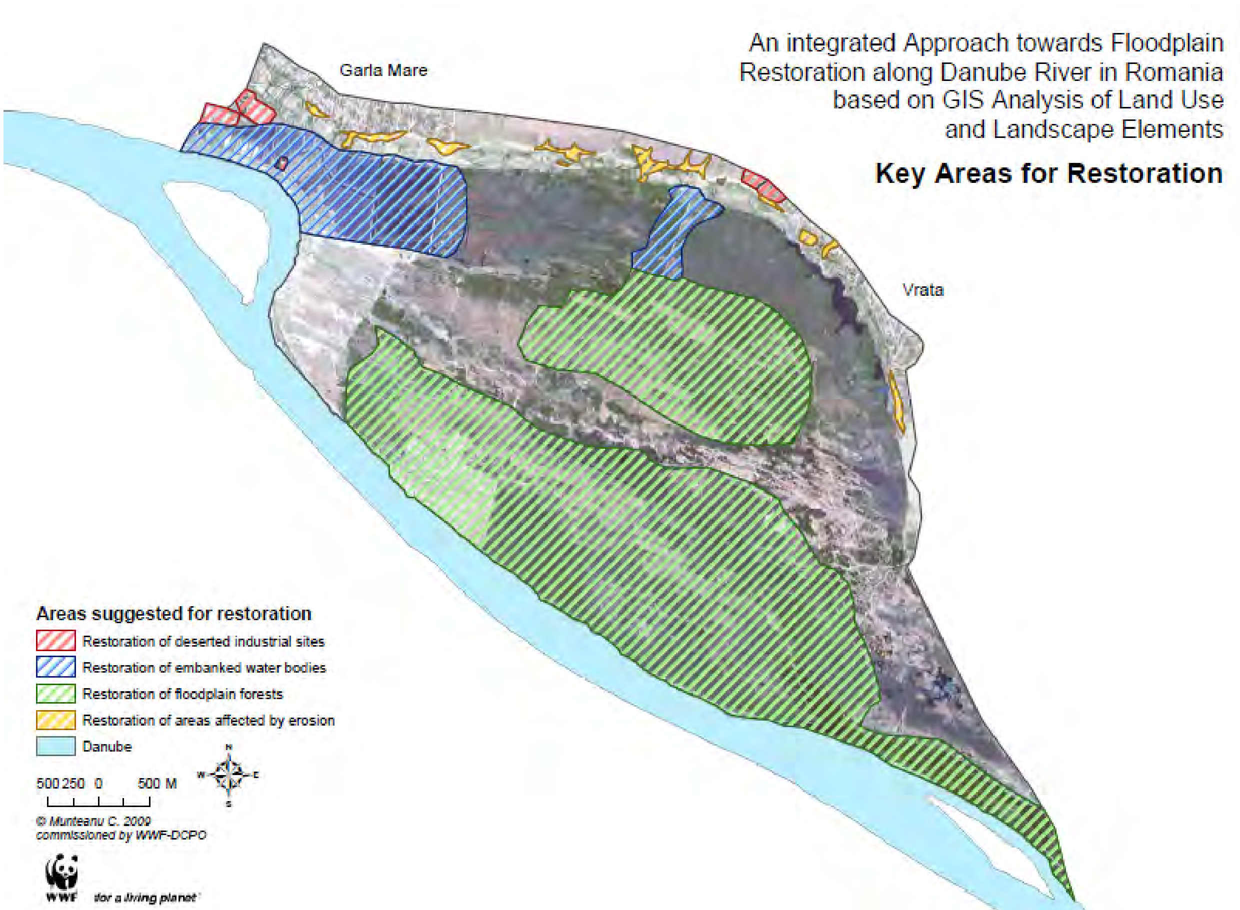
- None

REFERENCES

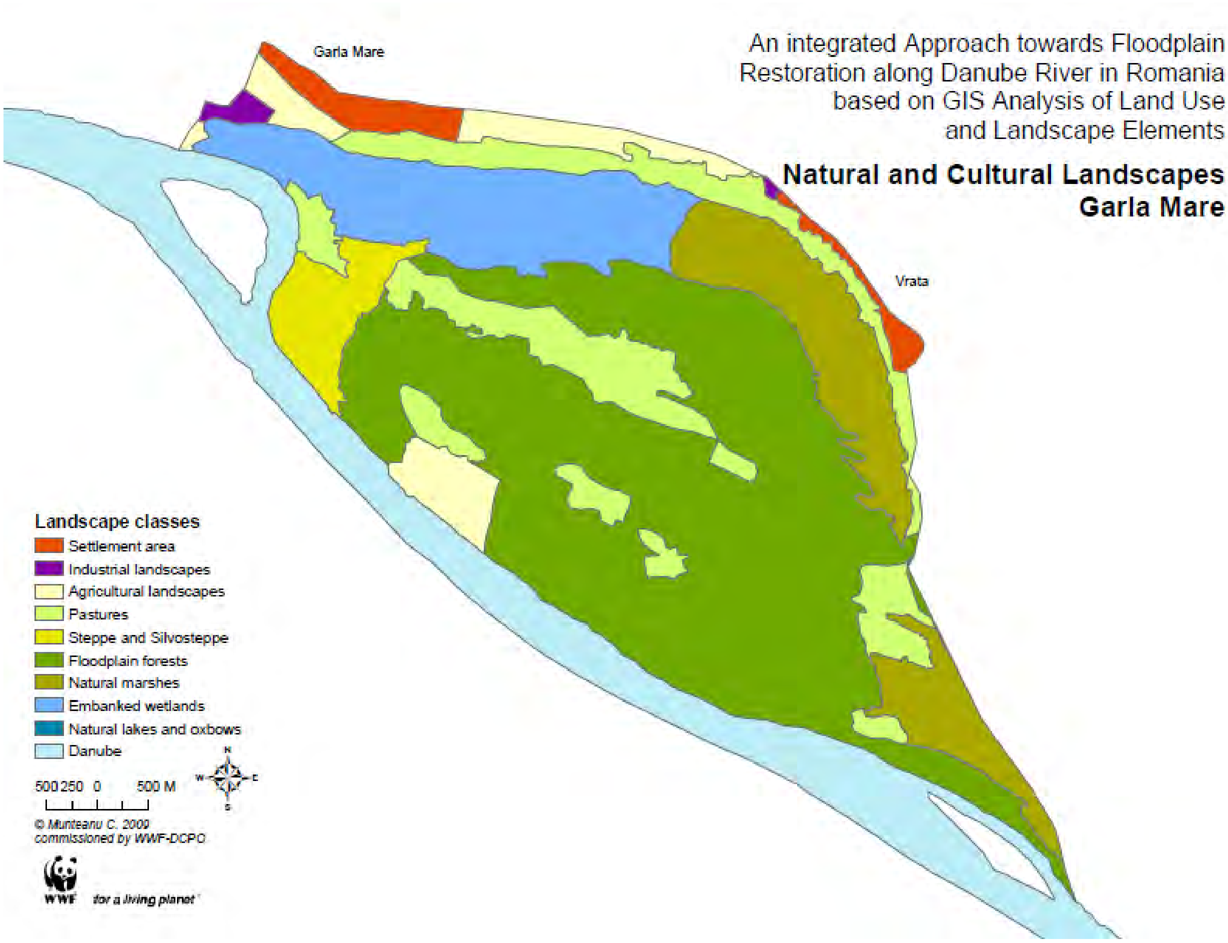
LimnoTech, 2009. Watershed Protection Activities: Data and Information Needs – Survey responses. April 3, 2009.

WWF Danube-Carpathian Programme Office, 2008. Europe's Lifeline – Reconnecting the Danube and its People. Project proposal submitted to WWF US.

MAPS



The areas likely to be targeted for restoration activities on the Gârla Mare restoration site. The feasibility study to be completed in the first quarter of 2010 will have specific technical plans and alternatives for restoration.



Map depicting the present land use of the Gârla Mare restoration site. The area in blue is where water used to naturally infiltrate the area, but now it is leveed off into a series of pools that are sometimes used for commercial fish production (fish ponds).

PROJECT NAME: WWF – Pakistan Western Himalayan Ecoregion
PROJECT ID #: 33

DESCRIPTION OF ACTIVITY: Revegetation of degraded hill slope

LOCATION: 1) Namli Mera Khurd subcatchment of Nala Mandri along Ayubia National Park, Pakistan (34^{o} 25' 40" N, 73^{o} 23' 52" E); 2) Namli Kundla (34^{o} 02' 14" N, 73^{o} 23' 08" E); 3) Saiful Malook Lake (34^{o} 52' N, 73^{o} 41' E).

PRIMARY CONTACT:
Fahad Qadir
Enterprise Communications
The Coca-Cola Company
fqadir@apac.ko.com

OBJECTIVES

- Revegetation to reduce runoff and associated sedimentation, to protect drinking water supply and to improve habitat/increase biodiversity.

BACKGROUND & DESCRIPTION OF ACTIVITY:

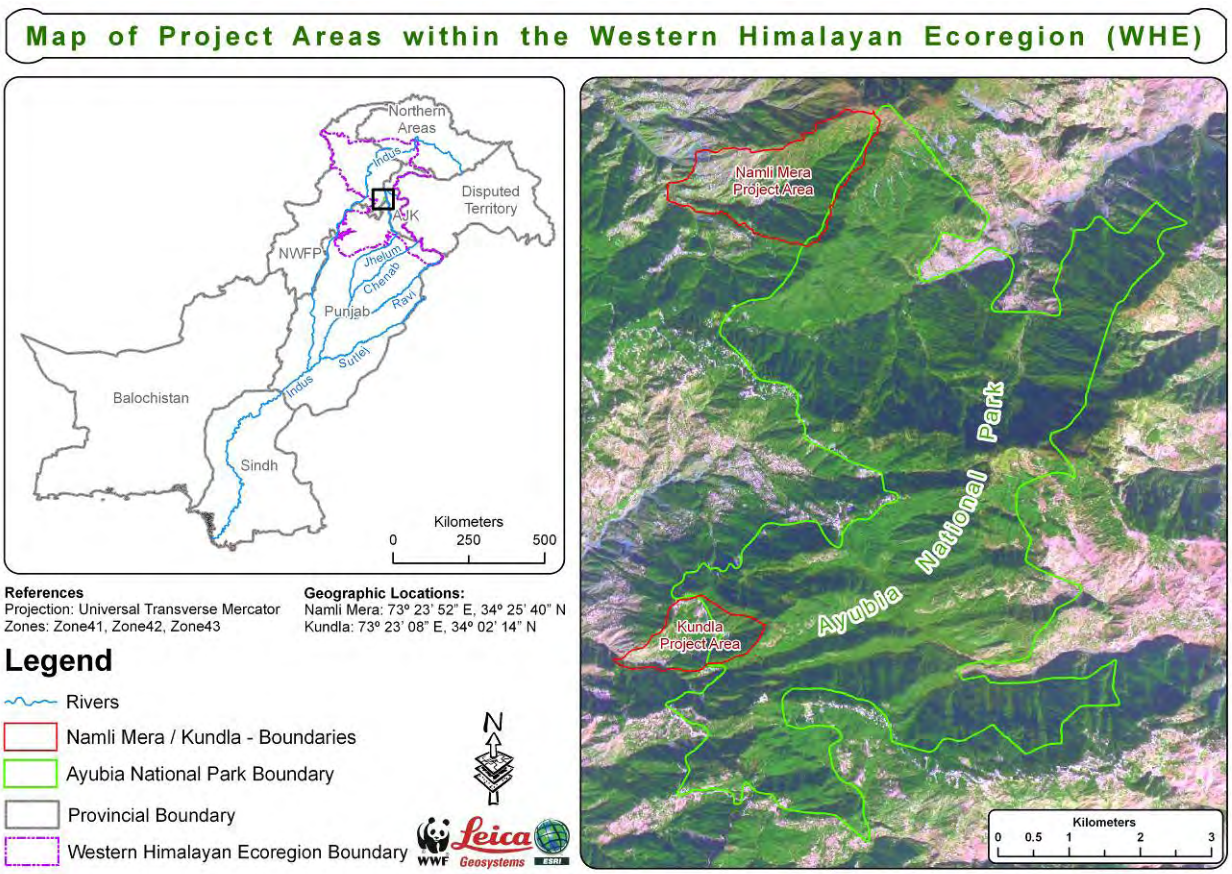
Ayubia National Park (ANP) covers an area of approximately 3,312 ha and is located within the Western Himalayan global ecoregion. The Western Himalayas is also the catchment area for 70-80% of water from the melting of snow and glaciers to the Indus Delta. Its significance in watershed management is critical; deforestation in the area will have far reaching consequences that will have negative impact in the Indus and Ganges deltas http://www.wwfpak.org/wwf-projects/ayubia_national_park.php) .

World Wide Fund for Nature-Pakistan (WWF-P) is working on subwatershed management, community development and awareness raising and capacity building involving communities that are dependent on the natural resources in and around the Ayubia National Park (TCCC, 2009). In support of this overall effort, WWF-P launched a "Sub-Watershed Management and Environmental Awareness Project in and around Ayubia National Park, North-West Frontier Province (NWFP)" with the financial collaboration of Coca-Cola Foundation. The project aims to improve and sustain the perennial flow of clean water in springs and streams of the area through an integrated watershed management approach. Moreover, it supports the key stakeholders in the waste management and cleaning of the Saif-ul-Malook National Park (http://www.wwfpak.org/101109_watershed_management.php). There are several activities underway in Namli Mera Khurd and Kundla that are working toward achievement of the project goals. These sites are situated on the Northwestern edge of Ayubia National Park in the North-West Frontier Province (NWFP) of Pakistan (LTI, 2009).

Within Namli Mera Khurd, several projects are underway to stabilize eroding slopes through revegetation, bioengineering and biological techniques, including revegetating 10 hectares of a previously bare hill slope with grass cover (see before and after photos below).

Before revegetation

After revegetation



ACTIVITY TIMELINE:

- Start Date: November 2008
- End Date: June 2010

COCA-COLA CONTRIBUTION: 100% (from CWP Project Information Sheet)

- Total Cost of Project: $233,000.00 USD
- Coca-Cola Foundation $233,000 USD

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Reduction in runoff
2. Decrease in sediment erosion/runoff

---

1. DECREASE IN RUNOFF

Approach & Results

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of degraded grassland to revegetated land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project: degraded grassland with no trees
  - Hydrologic soil group (HSG) "A"
  - CN = 68 (grassland in "poor" condition)
- Post-project:
  - Hydrologic soil group (HSG) "A"
  - CN = 49 (grassland in "fair" condition)

Daily precipitation and air temperature data were obtained for the Peshawar, Pakistan meteorological station for the 2006-08 period from TuTiempo.net. Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963). Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project runoff volume: 12.9 ML/yr
- Post-project runoff volume: 4.4 ML/yr
- **Benefit (runoff reduction): 8.5 ML/yr**

Data Sources/Site-specific characteristics:

- Total surface area for revegetation: 10 ha (provided by contact)
- Slope: 65% (provided by contact)
- Soil type: Sandy loam to gravel (provided by contact)
- Daily precipitation data for years 2006-08 were obtained for Peshawar, Pakistan from TuTiempo.net (http://www.tutiempo.net/en/Climate/Peshawar/415300.htm).

Assumptions:

- Precipitation data obtained for years 2006-08 (mean: 647 mm) are generally representative of average annual precipitation conditions for the revegetated area.
- SWAT model parameter "CNCOEF" was set to 2.0 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to estimate the original sediment erosion and washoff for the farm plots prior to implementation of the pilot projects. Supporting estimates of water runoff volume were based on the Curve Number method, and daily maximum hourly rainfall intensities were estimated for years 2006-08 based on local meteorological data. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated for the pre- and post-project condition based on Haith et al. (1992):

- Pre-project: C_{usle} = 0.100 (~60% cover as weeds)
- Pre-project: C_{usle} = 0.020 (60-80% grass cover)

Total annual sediment yields were estimated as shown below:

- Pre-project (degraded grassland): 4,507 MT/yr
- Post-project (revegetated): 32 MT/yr
- **Benefit (reduced sediment yield): 4,475 MT/yr**

Data Sources:

- See data sources discussion in the "Reduction in runoff" section above.

Assumptions:

- Selected values for the Cover/Management Factor (C_{usle}) were assumed to be representative of field conditions. In addition, these factors were assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. “Generalized Watershed Loading Functions – Version 2.0 User’s Manual.” December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. “Computation of Direct Runoff Amounts From Storm Rainfall.” Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

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Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. “Soil and Water Assessment Tool Theoretical Documentation: Version 2005.” January.

The Coca Cola Company (TCCC), 2009. The Coca Cola Company Replenish Report, “Achieving Water Balance through Community Water Partnerships.”

USDA-NRCS. 1986. “Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55).” 2nd Edition.

Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

PROJECT NAME: Brazilian Rainforest Water Program
PROJECT ID #: 35

DESCRIPTION OF ACTIVITY: Reforestation of 3,000 hectares of deforested land in two regions of the State of Sao Paulo, Brazil

LOCATION: The Japi and Martiqueria Mountain Corridor, and the Piracicamirim River Sub-Basin (watershed area of Piracicaba, Capivari and Jundia rivers) of the State of Sao Paulo, Brazil

PRIMARY CONTACT:
Helen Pedroso
Project Coordinator
Coca-Cola Brazil Institute
Phone: 55-21-2559-1166
Fax: 55-21-2559-1569
hpedroso@la.ko.com

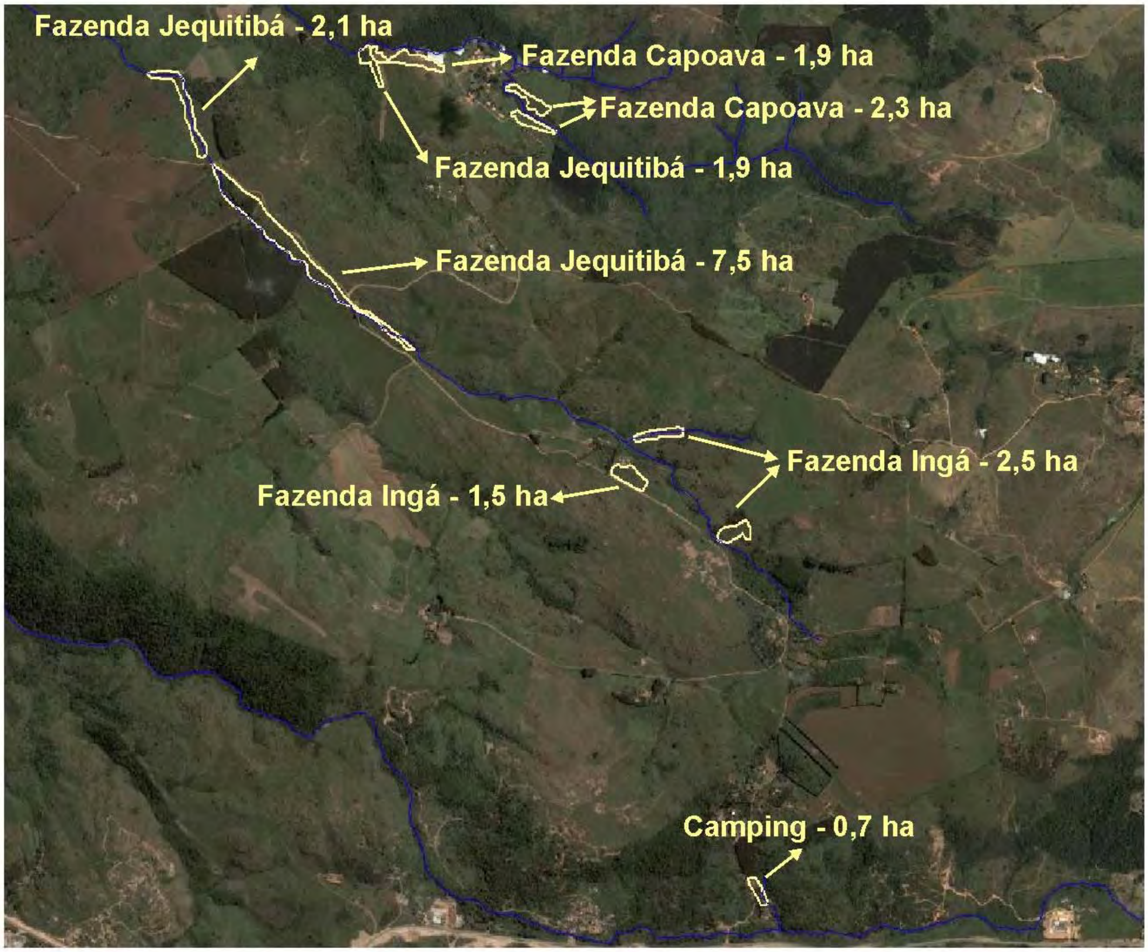
OBJECTIVES:

- Reduce sediment erosion/runoff
- Restore forest habitat (create wildlife corridors in the Japi and Matiqueira Mountain Corridor by connecting forest fragments and reforested riparian zones)
- Promote creation of reforestation-related jobs and mitigate poverty in local communities
- Test/validate scientific hypothesis that will allow for additional sustainable expansion in the Atlantic Rainforest and/or other tropical forests

BACKGROUND & ACTIVITY DESCRIPTION: The reforestation project is being implemented over a period of 5 years in Brazil's Atlantic Rainforest region along 3 different rivers running through 4 main municipalities with approximately 850,000 people. Rainforests once covered more than 80 percent of the state of Sao Paulo. In the project watersheds area, only 6.9% of the total 1,520,500 hectares remains forested. This project will provide an example for replication in other areas and will influence approximately 4-5 million people in a 100 mile radius around the reforestation sites. Goals and expected outcomes of reforestation include the following:

- **Watershed Improvement** — reduced river bank erosion and waterway sedimentation will improve water flow and habitats. Agricultural land bordering waterways are often highly degraded, leading to riverbank erosion and sedimentation of water sources. This project will reforest riparian buffer zones that include the Brazilian government mandated Areas of Permanent Protection (APPs), which extend 30-100 meters from the high water mark of water bodies.
- **Habitat Protection** — create wildlife corridors in the Japi and Matiqueira Mountain Corridor by connecting forest fragments and reforested riparian zones. The corridors will support biological exchanges and reduce endogamy and species endangerment. The Atlantic Rainforest contains a large number of highly endangered species and has been designated a World Biosphere Reserve. Reforested areas will also act as carbon sinks, mitigating the effects of global warming. Carbon offset credits produced by the project will be used to fund project expansion.
- **Socio-Economic Capacity Building** —nursery operations will create local jobs, strengthen local capacity for environmental services (including reforestation, watershed monitoring, and CO2 reduction efforts) and provide an additional revenue base of environmental services to support

ongoing, sustainable operations. The project will require 6 million seedlings and the establishment of large-scale commercial nurseries in the local communities.



Example reforestation locations for small riparian farmlands in the State of Sao Paulo, Brazil.

ACTIVITY TIMELINE:

- 2007: Project was launched
- 2008-2009: goal is to reforest 400 hectares
- 2009-2010: goal is to reforest 1,130 hectares
- 2010-2011: goal is to reforest 1,470 hectares

COCA-COLA CONTRIBUTION: 50% (provided by contact)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested (e.g., pasture/range) land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "B"
  - Pasture/grassland in "fair" condition: 50-75% vegetative cover (CN = 69)
- Post-project:
  - Hydrologic soil group (HSG) "B"
  - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained for the Sao Paulo airport from TuTiempo.net for the 2006-08 period. Data for this time period are generally representative of the long-term annual average meteorological conditions for the region. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for years 2006-08. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space): 14,692 ML/yr (490 mm/yr)
- Post-project (reforested land): 12,663 ML/yr (422 mm/yr)
- **Benefit (runoff reduction): 2,029 ML/yr (68 mm/yr)**

Data Sources:

- Size of reforested land area: 3,000 Ha (provided by contact)
- Slope: highly variable (0-75%) (provided by contact - there is a large variety of landscapes all over the Pirahy River Basin)
- Soil type:
  - "Available water content" of 8 mm per meter of soil depth (Batjes, 1996) – consistent with hydrologic soil group "B" characteristics.

- predominance of dystrophic (low fertility) and acid (pH < 5) Cambisols (provided by contact)

- Daily precipitation data for years 2006-08 were obtained for the Sao Paulo airport (station ID: 837800) from TuTiempo.net (http://www.tutiempo.net/en/Climate/Sao_Paulo_Aeropor-To/837800.htm).

Assumptions:

- Precipitation data obtained for Sao Paulo, Bazil for years 2006-08 are generally representative of average annual precipitation conditions for the areas where reforestation is occurring.
- The pre-project land cover can be appropriately characterized as open pasture/rangeland with approximately 50-75% vegetative cover. (Note that this provides a conservative estimate of Curve Number for areas that have been utilized as crop land.)
- The average slope conditions for the reforested area are approximately 15%.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass/weeds mixture, 60-80% cover (C_{usle} = 0.02)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (pasture/range): 190,293 MT/yr (63.4 MT/ha/yr)
- Post-project (forested): 8,268 MT/yr (2.8 MT/ha/yr)
- **Benefit (reduced sediment yield): 182,025 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Corresponding increases in infiltration and groundwater baseflow to local stream networks
- Habitat improvements benefiting aquatic and terrestrial wildlife

NOTES

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

Haith, D.A., R. Mandel, and R.S. Wu. 1992. “Generalized Watershed Loading Functions – Version 2.0 User’s Manual.” December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. “Computation of Direct Runoff Amounts From Storm Rainfall.” Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. “Soil and Water Assessment Tool Theoretical Documentation: Version 2005.” January.

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Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. “Predicting rainfall erosion losses: a guide to conservation planning.” USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Recycling Water Program - Hefei Plant
PROJECT ID #: 36

DESCRIPTION OF ACTIVITY: Recycling Coca-Cola plant treated water for beneficial non-potable community uses

LOCATION: Heifei Plant, China

PRIMARY CONTACT:
Denise Knight
The Coca-Cola Company
404-676-3638
deknight@na.ko.com

OBJECTIVES:

- Reduction of tap water use by community

BACKGROUND & ACTIVITY DESCRIPTION: The project goal was to encourage reduction of industrial water use and generate cost savings by recycling and reusing water. In 2007, 100,000 tons of recycled water was supplied to the Sanitary Bureau of Hefei Economic and Technological Development Zone for irrigation and cleaning the streets. Tap water was previously used for these purposes. The program was discontinued after 2007.

证　　明

Certification

兹证明，合肥太古可口可乐饮料公司于2007年以公益性价格（每吨0.2元）向区内园林绿化部门提供经处理的中水，用于冲洗街道和灌溉绿地。2007年累计使用中水达1000多吨。

This is to certify that Swire Coca-Cola Beverages Hefei Limited supplied treated recycle water to us at a price of RMB0.2 per ton for irrigation and cleaning the streets in 2007. Total 1000 tons of recycle water was used.

合肥市经济技术开发区环保分局
Environmental Bureau of Hefei
Economic and Technological
Development Zone

2008年12月9日
Dec. 9, 2008

Classified : internal use

ACTIVITY TIMELINE:

- Activity was conducted only in 2007

COCA-COLA CONTRIBUTION: 100%

- Project was fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surfacewater/groundwater usage

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1. 1. DECREASE IN SURFACEWATER/GROUNDWATER USAGE

Approach & Results:

- No calculations - Water savings was reported
- **Benefit (decrease in water usage): 1 million liters in 2007**

Data Sources:

- Data provided by Denise Knight (from Jasmine Tian responses in LTI CWP Survey)

Assumptions:

- Benefit attributed to 2008

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

NOTES

REFERENCES

PROJECT NAME: Reforestation of Nevado de Toluca
PROJECT ID #: 37

DESCRIPTION OF ACTIVITY: Reforestation

LOCATION: Nevado de Toluca National Park, Mexico

PRIMARY CONTACT:

Vivian Alegria Gallo
Directora Asuntos Comunitarios
Coca-Cola de Mexico
52-55-5262-2339 (phone)
valegria@la.ko.com

OBJECTIVES

- Increase recharge of local aquifer

BACKGROUND & DESCRIPTION OF ACTIVITY: El Nevado de Toluca Park is a recharge area for the city of Toluca. The goal of this reforestation project is to cover 1,000 hectares with 1,200 trees per hectare over 5 years.

ACTIVITY TIMELINE:

- Project initiation: 2005
- Anticipated project completion: 2010

COKE CONTRIBUTION: 20%

- Based on approximate funding split (TCCC, CIMSA, and FEMSA), per 4/27/09 email from V. Alegria Gallo.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in recharge rate

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1. INCREASE IN RECHARGE

Approach and Results:
According to an Acción Planeta fact sheet prepared for this project, it is expected that the aquifer will be replenished with 540 cubic meters per hectare as a result of the reforestation effort. The supporting technical studies for this rate were not available, but it is a reasonable estimate for the location.

Water Quantity Benefit:
1,000 hectares * 540 m^3/ha/yr = 540,000 m^3/yr = 540 ML/yr

Data sources:

- All information used in the estimate was provided in the fact sheet.

Assumptions:

- Assume reforestation occurs at the same rate each year (200 ha/yr) for 5 years.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved biodiversity

NOTES

- Estimated recharge rate can be re-evaluated if technical studies supporting the recharge rate of 540 m^3/ha, or site-specific information are provided.

REFERENCES

Accion Planeta. Fact Sheet on Nevado de Toluca project.

PROJECT NAME: Mexico Reforestation Program
PROJECT ID #: 38

DESCRIPTION OF ACTIVITY: Ground restoration (infiltration trenches)

LOCATION: Amecameca, Mexico

PRIMARY CONTACT:
Vivian Alegria Gallo
Directora Asuntos Comunitarios
Coca-Cola de Mexico
52-55-5262-2339 (phone)
valegria@la.ko.com

OBJECTIVES

- Increase infiltration

BACKGROUND & DESCRIPTION OF ACTIVITY: This ground restoration project has involved the digging of 162,500 infiltration trenches on 250 hectares. The trenches are hand dug in deforested areas, to maintain the humidity of the ground, increase infiltration, and reduce ground erosion. The trenches are 2 feet wide and 7 feet long. This activity is expected to expand along with reforestation efforts throughout Mexico, with the total area drained to infiltration trenches estimated to be approximately 15% of the total reforested area.

Photo of infiltration trenches, taken by Pronatura

ACTIVITY TIMELINE:

- Project for the initial 250 hectares was completed in 2008.

- As reforestation efforts expand in future years, infiltration trenches are expected to represent approximately 15% of the total reforested area. Therefore, infiltration trenches will ultimately be implemented for 3,750 ha (0.15 x 25,000 ha) by the end of 2012.

COKE CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in infiltration

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1. INCREASE IN INFILTRATION

Approach and Results:

The total infiltration rate was calculated as the sum of direct infiltration (the quantity of water that falls directly in each trench each year) plus infiltration of runoff from untrenched areas of the 250 ha (i.e., "drain surface").

Average annual rainfall = 800 mm/year (measured)

Direct infiltration = surface area of trenches (162,500 m^2) x annual precipitation (0.8 m/yr) = 130,000 m^3/yr.

Runoff/drainage surface = surface area (2,337,500 m^2) x average precipitation (0.8 m/yr) x runoff capture coefficient (0.6) = 1,122,000 m^3. (Runoff capture coefficient estimated based on slope and soil type.)

Total infiltration = (direct infiltration) + (drain volume) = (130,000 m^3/yr) + (1,122,000 m^3/yr) = 1,252,000 m^3/yr = **1,252 ML/yr (for 250 ha)**.

The above calculation applies to 250 hectares, or 6.67% of the ultimate estimated surface area of 3,750 ha for infiltration trenches. Therefore, the ultimate water quantity benefit is calculated as follows:

Total Benefit = (1,252 ML/yr) / (0.0667) = 18,780 ML/yr

Data Sources:

- All information used in the calculations was provided in the 3/5/09 PowerPoint presentation.

Assumptions:

- Assumed trenches will continue to function for 10 years (per information provided)

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Decreased sediment erosion/runoff.

NOTES

- This 250 ha project is part of the 25,000 hectares being reforested or restored under the program.

REFERENCES

TCCC. 2009. Cinas Tiegas. March 5, 2009 Powerpoint Presentation, Atlanta (provided by Vivian Alegria Gallo).

PROJECT NAME: Coca-Cola Mexico Reforestation Program (in partnership with CONAFOR and Pronatura)
PROJECT ID #: 38

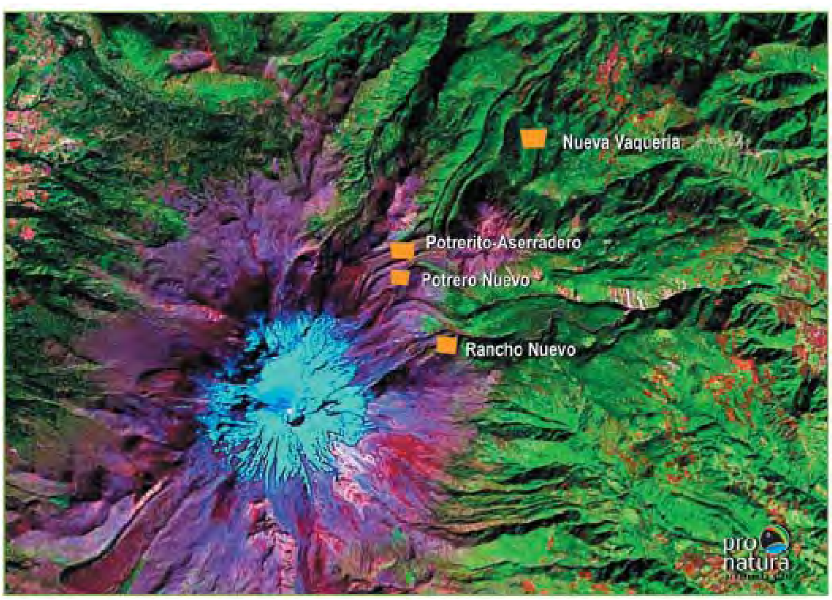
DESCRIPTION OF ACTIVITY: Reforestation of 25,000 hectares of deforested land in Mexico

LOCATION: Mexico (various locations, including Coahuila, Durango, Tlaxcala, Veracruz, and Zacatecas, etc.)

PRIMARY CONTACT:
Vivian Alegria Gallo
Director of Community Affairs
Coca-Cola of Mexico
Phone: 52-55-5262-2339
Fax: 52-55-5262-2016

OBJECTIVES:
- Reduce runoff / increase infiltration
- Reduce sediment erosion/runoff
- Restore forest habitat

BACKGROUND & ACTIVITY DESCRIPTION: Coca-Cola, the Comision Nacional Forestal (Conafor), and Pronatura Mexico are planning to reforest 25,000 hectares of priority ecosystems (forests, jungles, and wetlands) that supply water to different towns nationwide. Approximately 30 million trees will be planted in deforested lands to mitigate climate effects, restore habitat and biodiversity, rehabilitate aquifers and watersheds, and promote economic and community growth.



Locations for reforestation efforts for the Veracruz region of Central Mexico, including 700 hectares in 2008.

ACTIVITY TIMELINE:

- A total of 1,649 hectares were reforested in 2008
- Year 2009 goal is to reforest 8,162 hectares
- Ultimate goal is to reforest a total of 25,000 hectares by the end of 2012

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "B"
  - Herbaceous – grass/weeds/brush mixture in "fair" to "good" condition (CN = 67)
- Post-project:
  - Hydrologic soil group (HSG) "B"
  - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained from the TuTiempo.net online meteorological database for various locations during the 2000-2008 time period. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963). A concerted effort was made to insure that the precipitation data used for each reforestation location were representative of long-term annual average climate patterns for the region.

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space): 41,402 ML/yr
- Post-project (reforested land): 32,002 ML/yr
- **Benefit (runoff reduction): 9,400 ML/yr**

(It should be noted that only 85% of the total reforestation area was included in the runoff quantity estimate shown above. The remaining 15% of the 25,000 ha reforestation area will involve infiltration trenches. The water quantity benefit associated with infiltration resulting from the presence of these trenches is calculated as a separate activity.)

Data Sources:

- Size of reforested land area: 25,000 ha (provided by contact)
- Slope: highly variable and site-dependent (0-40%) (provided by contact)
- Soil type: highly variable, but generally characterized by "available water content" (AWC) of 7 to 8 mm per meter of soil depth (Batjes, 1996).
- Daily precipitation and air temperature data were obtained from the online "TuTiempo.net" meteorological database (http://www.tutiempo.net/en/) for representative locations throughout Mexico, including Jalapa, Cuernavaca, Chihuahua, Queretaro, and Puebla. A summary table is provided below.

Table 1. Meteorological Stations for Water Runoff Analysis

Station Location	Station ID	Selected Years[1]	Average Rainfall for Selected Years (mm)
Jalapa	766870	2000-02	1,402
Cuernavaca	767260	2003-08	1,018
Chihuahua	762250	2000, 2006-08	335
Queretaro	766250	2003-04, 2007	601
Puebla	766850	2000-01, 2004-05	718

[1]Years selected based on recent data availability, completeness, and representativeness.

Table 2. Summary of Reforestation Locations

Location	Area Fraction[1]	Assigned Met. Station	Assumed Slope
Chihuahua	5.1%	Chihuahua	8%
Baja California Sur	3.0%	Chihuahua	8%
San Luis Potosi	5.2%	Chihuahua	8%
Zacatecas	1.0%	Chihuahua	8%
Durango	6.1%	Chihuahua	8%
Coahuila	5.3%	Chihuahua	8%
Aguascalientes	3.1%	Queretaro	10%
Queretaro	0.3%	Queretaro	10%
Nuevo Leon	6.1%	Queretaro	10%
Guanajuato	7.2%	Queretaro	10%
Hidalgo	2.0%	Puebla	10%
Estado de Mexico	8.0%	Puebla	10%

Michoacan	20.2%	Cuernavaca	15%
Tlaxcala	6.1%	Cuernavaca	15%
Puebla	3.6%	Cuernavaca	15%
Morelos	0.7%	Cuernavaca	15%
Jalisco	3.6%	Cuernavaca	15%
Veracruz	13.3%	Jalapa	20%

[1]Based on actual reforestation areas for 2008 and stated goals for year 2009.

Assumptions:

- The 2008-09 distribution of reforested land among the various locations is representative of the ultimate distribution for the reforested 25,000 hectares (Table 2).
- Precipitation patterns for meteorological stations are representative of conditions for reforested areas. In reality, we expect that the precipitation data are biased low and the air temperature data biased high relative to actual conditions at reforestation sites occurring on mountain slopes at higher elevations. Therefore, it is reasonable to expect that the current estimates are conservative relative to actual runoff reduction benefits for the reforested areas. Collection of daily precipitation data for specific reforestation locations would allow for a refined estimate of runoff reduction.
- The pre-project land cover can be appropriately characterized by herbaceous (grass/weeds/brush) with approximately 30-80% vegetative cover. (Note that this provides a conservative estimate of Curve Number for areas that have been utilized as crop land.)
- Land slopes were conservatively assumed to be ~10% unless otherwise determined based on available latitude/longitude locations and global slope datasets. Slope estimates (e.g., 10%) are likely conservative relative to actual slope conditions for some sites; specific latitude/longitude coordinates for all reforestation locations would be required to refine slope estimates.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: grass/weeds, 60-80% cover (C_{usle} = 0.02)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (pasture/rangeland): 803,048 MT/yr
- Post-project (forested): 32,577 MT/yr
- **Benefit (reduced sediment yield): 770,472 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER BENEFITS NOT QUANTIFIED

- Corresponding increases in infiltration and groundwater baseflow to local stream networks
- Habitat improvements benefiting terrestrial wildlife

NOTES

- Collection of daily precipitation data for specific reforestation locations would allow for a more accurate estimate of runoff reductions and sediment erosion/yield.
- Specific latitude/longitude coordinates could be used to better estimate local slope conditions.

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

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Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Reforestation Efforts at the Monarcha Butterfly Bioreserve
PROJECT ID #: 39

DESCRIPTION OF ACTIVITY: Reforestation

LOCATION: Monarch Butterfly Reserve, Michoacan, Mexico

PRIMARY CONTACT:
Vivian Alegria Gallo
Directora Asuntos Comunitarios
Coca-Cola de Mexico
52-55-5262-2339 (phone)
valegria@la.ko.com

OBJECTIVES

- Rehabilitate degraded forest areas
- Protect wintering habitat for monarch butterfly

BACKGROUND & DESCRIPTION OF ACTIVITY: Project involves the production of 100,000 Oyamel trees/year for planting on 1,000 hectares of the reserve each year during a 2-year program.

ACTIVITY TIMELINE:

- Project initiation: 2007
- Current status: 2-year program was completed in 2009. Program is ongoing but no information currently available related to future production.

COKE CONTRIBUTION: 100%

- TCCC supported nursery, FEMSA supported tree plantings

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in recharge rate

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1. INCREASE IN RECHARGE

Approach and Results
According to an Acción Planeta fact sheet prepared for the nearby Nevado de Toluca project, it is expected that the aquifer will be replenished with 540 cubic meters per hectare as a result of a reforestation effort. The supporting technical studies for this rate were not available, but it is considered a reasonable estimate for the location.

Water Quantity Benefit:
2,000 hectares * 540 m^3/ha/yr = 1,080,000 m^3/yr = 1,080 ML/yr

Data sources:

- All information used in the estimate was provided in the fact sheets, and in a 4/27/09 email from V. Alegria Gallo.

Assumptions

- Assumed reforestation is completed in 2009.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved biodiversity

NOTES

- Estimated recharge rate can be re-evaluated if technical studies are provided.
- Oyamel trees are difficult to find in Mexico, and the local government is going to buy the trees for other areas that need “oyamel.” The nursery supports the local economy.

REFERENCES

Accion Planeta. Fact Sheet on Monarca Butterfly project.

Accion Planeta. Fact Sheet on Nevado de Toluca project.

PROJECT NAME: Ilagan Watershed Conservation Project in Isabela
PROJECT ID #: 40
DESCRIPTION OF ACTIVITY: Implementation of improved agricultural practices: cropland/farmland management

LOCATION: Abuan River sub-watershed, City of Ilagen, Isabela Province, Philippines
(17.089 N, 122.068 E)

PRIMARY CONTACT:
Edgardo Tongson
World Wildlife Fund – Philippines
etongson@wwf.org.ph

OBJECTIVES

- Increase infiltration/aquifer recharge and/or increase baseflows
- Reduce erosion and associated sedimentation of receiving waters

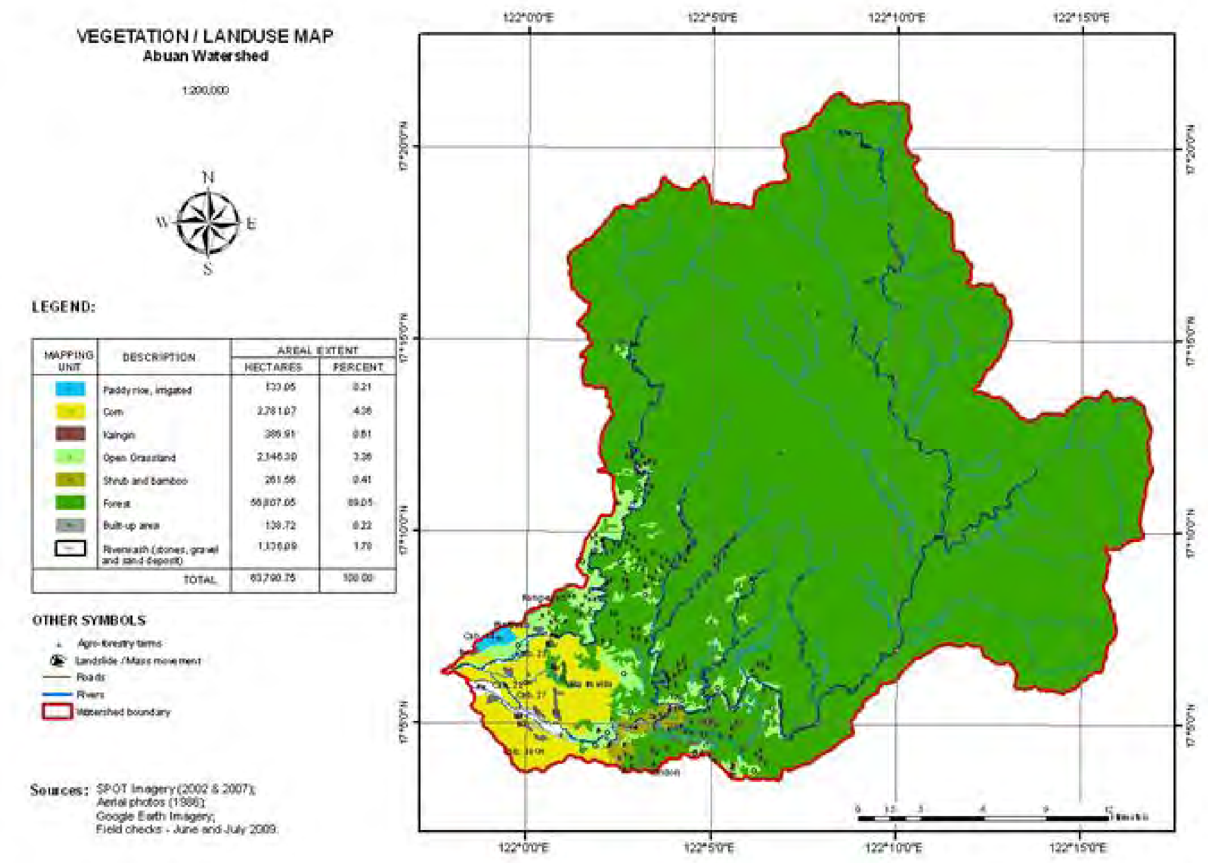
BACKGROUND & DESCRIPTION OF ACTIVITY:
This project will help to protect the Abuan River watershed, near the City of Ilagan, and benefit water users in the province of Isabela, Philippines including industries, irrigation farmers, water districts, recreationists/eco-tourists and future mini-hydro project(s). The goals of the project are to:

- Identify and assess threats to the watershed and facilitate stakeholder planning for the conservation and sustainable use of the watershed.
- Develop plans to rehabilitate denuded areas in this watershed of the Northern Sierra Madre through agro-forestry schemes and assisted natural regeneration.
- Develop schemes for Payments for Watershed Services involving user/buyers to provide sustainable financing for watershed activities.
- Increase awareness of local communities on the importance of protecting watersheds and conserving water resources.

The Abuan watershed is located on the western edge of the Northern Sierra Madre and is characterized by mountainous to hilly terrain. Annual rainfall in this area is 2900 mm. Of this, 67% ends up as surface runoff, 28% as evapotranspiration and only 5% goes into groundwater recharge. The 63.79 sq km watershed is still well forested with 89% forest cover. The remainder consists of lands planted to corn (4.35%), open grasslands (3.36%), and less than one percent each of kaingin (swidden or slash and burn farms), shrubs, built-up area and rice lands. Some 5,581 residents live in 5 villages, or barangays, in the lower catchment area.

Soil erosion from illegal logging is threatening the watershed, and the resulting water pollution and sedimentation are reducing the amount of water available to farmers and other users. Achievements of the program include the following:

- Characterized the watershed as to geology, soils, land use, hydrology, hydro-geology; including population, farming practices, water supplies.
- Distributed 16,000 fruiting seedlings to 29 farmer household beneficiaries covering 58 hectares.
- Completed reconnaissance, field research and tour packages for eco-tourism.
- Deployed the collection and planting of some 90,000 seedlings in designated reforestation sites.

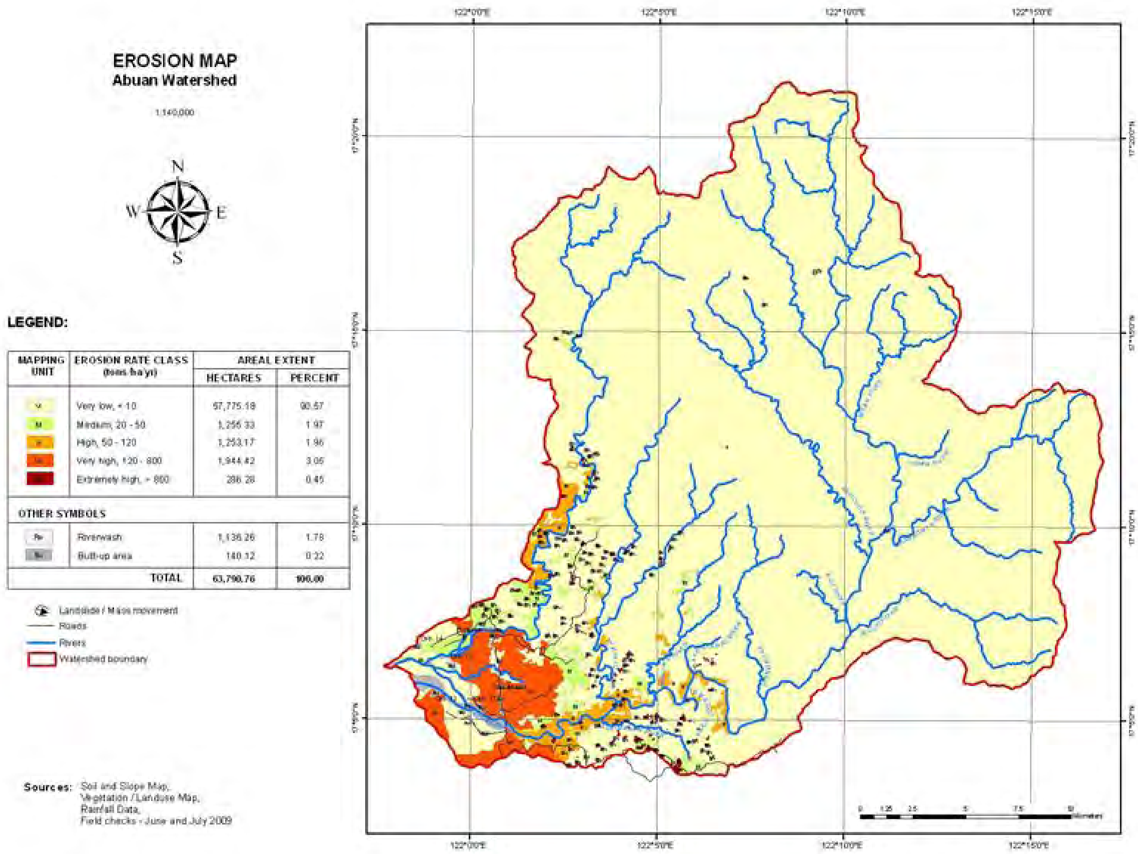


Impact on Water Quantity

The project facilitated the planting of 16,000 seedlings on 58 hectares of farm land within a Community Based Forest Management area. This is located in sub-basin no. 1410 with an area of 1099 hectares. The present land use of the sub-basin is 60% agro-forest, 11% corn land and 29% consisting of open grass lands and or swidden farms (*kaingin)*. Assuming 20% or 220 has of the existing grasslands and swidden farms in the sub-basin are converted to agro-forestry, and assuming a 24 hour 50-year storm return period, the hydrograph shows a reduction in peak discharge by 6 cubic meters per second and reduction in run off by 80,450 cubic meters per day. Adding vegetation cover will reduce flood risks downstream during a heavy rainfall event.

Impact to Water Quality

Soil erosion is major threat to the watershed. Topsoil removal reduces soil productivity, infiltration capacities and diminishes base flows. Siltation also reduces capacities of irrigation canals and hydropower plants and pollutes drinking water. Swidden farming is the biggest contributor to soil erosion with erosion rates ranging from 2617 tons/ha-year. This is followed by open grassland with erosion rates ranging from 20 to 97 tons/ha-year. In contrast, a well maintained forest cover has an erosion rate ranging from 1.54 to 7.49 tons/ha-year. Converting open grasslands into mango areas in the sub-basin can reduce erosion rates from 69.44 to 18.52 tons/ha-year. For 220 hectares of grasslands converted to mango tree farms, this means 11,202 tons of soil material conserved. This volume of soils holds a sizable volume of infiltrated water in the form of interflow which then contributes to base flows.



ACTIVITY TIMELINE:

- Start Date: February 2009
- End Date: February 2010

COCA-COLA CONTRIBUTION: 72.3%

- Total Cost of Project: $154,918 USD
- Coca-Cola Foundation $112,000 USD

WATERSHED RESTORATION BENEFITS CALCULATED:

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1. DECREASE IN RUNOFF

Approach & Results

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of existing grasslands and swidden farms to agro-forestry land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986) and Haith et al. (1992):

- Pre-project:
  - Hydrologic soil group (HSG) “B”
  - Grassland in “fair” condition (CN = 69)
- Post-project:
  - Hydrologic soil group (HSG) “B”
  - Mango orchard/tree farm in “good” condition (CN = 58)

Daily precipitation and air temperature data were obtained from the TuTiempo.net website for the Casiguran station (http://www.tutiempo.net/en/Climate/Tuguegarao/983360.htm) during the 2006-08 time period. The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space) runoff volume: 4,383 ML/yr
- Post-project (agro-forest land) runoff volume: 4,247 ML/yr
- **Benefit (runoff reduction): 136 ML/yr**

Data Sources/Site-specific characteristics:

- Pre-project: open grasslands in fair condition with no forest cover
- Post-project: agro-forested land (mango orchard/tree farms)
- Surface area: 220 ha (total area targeted) – planting of mango trees on 58 ha so far.
- Slope: Terrain is steep to very steep with 54% of the area having slopes of 30-50% followed by 35% of the area with slopes exceeding 50%. Milder slopes of less than 30% are found in the lower catchment area in the flood zone, alluvial plains and upper banks to the right of the Abuan river.
- Soil type: Rugao clay loam, found in 30-50% slopes is a well drained moderately deep (≥ 60 cm depth) with moderate permeability subangular blocky structured clay loam soils. Soil surface is fairly stony.
- Daily precipitation and air temperature data were obtained from TuTimpo.net for the Casiguran station (ID: 983360).

Assumptions:

- Used future projection of 220 ha of grassland converted to agro-forestry (mango trees)
- Used approximate average slope of 50%.

- Precipitation data for the Casiguran station (2006-08) are representative of precipitation conditions for the agro-forested areas. Average annual precipitation for these 3 years was 3,226 mm, which is similar to the 2,900 mm cited in the project survey.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- Soil erodibility factor (K) was assumed to be 0.24 for both pre- and post-project conditions.

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results (per the CWP survey response):

Soil erosion is major threat to the watershed. Topsoil removal reduces soil productivity, infiltration capacities and diminishes base flows. Siltation also reduces capacities of irrigation canals and hydropower plants and pollutes drinking water. The EStimation of ONsite ERosion or ESONER, a GIS-based model developed by the Bureau of Soils and Water Management for Philippine conditions was adapted and used for this study. The ESONER model enables the estimation of the source erosion rate from the product of four parameters considered such as rainfall data, topographic or slope condition, soil characteristics and the vegetative cover or land use.

Kaingin (i.e., swidden farms) is the biggest contributor to soil erosion with erosion rates ranging from 2,617 tons/ha-year. This is followed by open grassland with erosion rates ranging from 20 to 97 tons/ha-year. In contrast, a well maintained forest cover has an erosion rate ranging from 1.54 to 7.49 tons/ha-year. Converting open grasslands into mango areas in the sub-basin can reduce erosion rates from 69.44 to 18.52 tons/ha-year. For 220 hectares of grasslands converted to mango tree farms, this means **11,202 tons** of soil material conserved.

Benefit (sediment yield reduction): 11,200 MT/yr

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- See above discussion in "Approach & Results" section.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. “Computation of Direct Runoff Amounts From Storm Rainfall.” Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

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Williams J.R. 1975. “Sediment yield prediction with USLE using runoff energy factor.” In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

PROJECT NAME: Every Drop Matters - in Saraykoy and Beypazari
PROJECT ID #: 41

DESCRIPTION OF ACTIVITY: Leak repair

LOCATION: Saray district of Ankara, Turkey

PRIMARY CONTACT:
Omar Bennis
Public Affairs and Communications
Coca-Cola Eurasia & Africa Group
Tel. +90.216.556.2039
ombennis@eur.ko.com

OBJECTIVES

- Reduce water loss from aging water distribution system

BACKGROUND & DESCRIPTION OF ACTIVITY: This project is replacing aging water mains to reduce water loss (50,000 tons per year) and ensure water safety.

ACTIVITY TIMELINE:

- Pilot implemented in 2006 and is ongoing

COCA-COLA CONTRIBUTION: 89%

- Project total cost: 360,000
- Coca-Cola contribution: 320,000

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in surface water/groundwater usage

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1. DECREASE IN SURFACE WATER USE

Approach

- Water saved from leak repairs (water main replacement), as reported in survey
- Leak repairs save 50,000 tons of water per year = 100,000,000 lbs water / 62.4 lb/ft3 = 1,602,564 ft3 water * 28.3 L/ft3 = 45,379,562 L water savings after 2007
- **Total yearly benefit (decreased surface water use): 45.38 million L/year**

Data sources

- No data used – water savings were reported in survey.

Assumptions

- Assumed no depreciation in savings over 5 years (systems continues to function as in 2008).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED: None

NOTES: None

REFERENCES: None

PROJECT NAME: Island Sanitation in the Maldives
PROJECT ID #: 42

DESCRIPTION OF ACTIVITY: Pilot wastewater bio-treatment plant

LOCATION: Dhambidhoo Island, Laamu Atoll, Maldive Islands

PRIMARY CONTACT:
John Gacutan and Arun Kashyap, Ph.D, Officer in Charge
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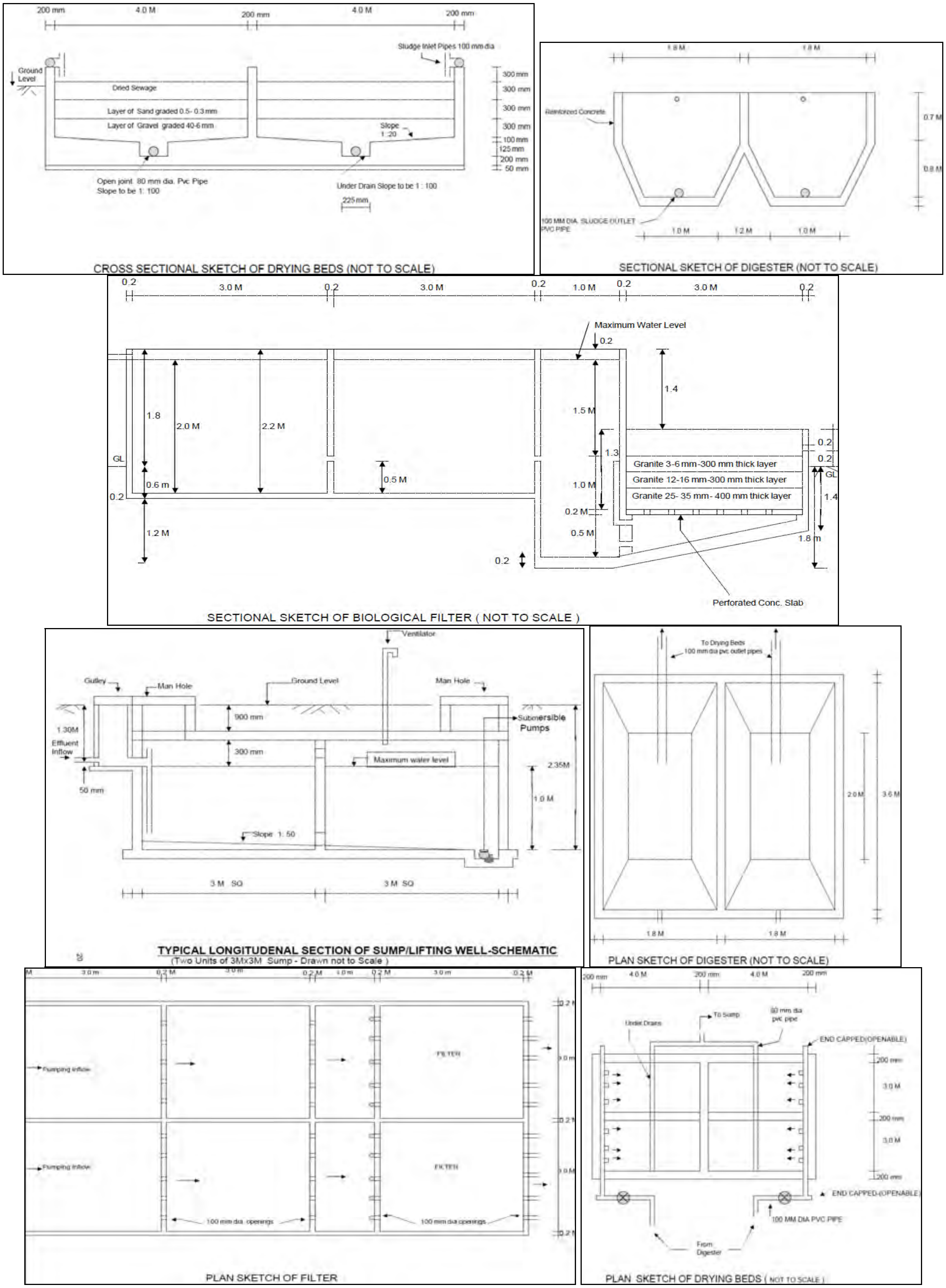
OBJECTIVES

- Reduce pollutant load in marine waters and groundwater from sewage discharges

BACKGROUND & DESCRIPTION OF ACTIVITY: (UNDP, 2006a; UNDP, 2006b)
Providing a sustainable sanitation system for the residents of Dhambidhoo Island, Laamu Atoll in the Maldives, this project supports the government's post tsunami sanitation efforts and improves the quality of the groundwater on the island. The Dhambidhoo project includes the installation of a sustainable sanitation system for all 526 residents of the island. (Note: When the tsunami struck, the island's population was 856, but 330 have since relocated to the capital, Male', and other islands.) At the completion of this project, all households and public buildings will be fitted with a durable, water-tight septic tank and connected to a sewage network. Through this water-borne sanitation model, the discharge will be channeled safely through a network of pipes to a second-stage purification facility and then into the deep waters beyond the island-encircling reef. This will bring an end to the pre-tsunami practice of discharging raw sewage directly into the island's lagoon or into the groundwater.

Prior to the 2004 tsunami, there was no waste-water treatment system in place on the Island of Dhambidhoo; in most households, there were pit toilets, and others didn't have any toilet facilities. The soakage pits in the households that had pit toilet facilities were designed to dispose of the waste directly to the fresh water lanes of the coral islands, which are around 0.5-1 m deep in most areas. After the project, the sanitation system included specially-designed septic tanks in each household. These tanks hold all the solid particles and sludge and disburse the wastewater, which is collected at the pump stations and sent to a treatment facility. At the treatment facility, the wastewater is filtered using a biological filtration system. No ground water quality data are available for Dhambidhoo Island prior to the tsunami.



Diagrams of water treatment process (UNDP. 2006b).

ACTIVITY TIMELINE:

- September 9, 2007 - Project launch and preliminary activities
- December 2007 - Procurement and shipping of equipments and materials, delivery to the site
- October 2007 - July 2008 - Construction work
- May - July 2008 - Training, operation and maintenance
- July 31, 2008 - Project completion

COKE CONTRIBUTION: 39%

- Total cost: $1,152,664 USD
- Coca-Cola contribution: $450,000 USD

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in pollutant load

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1. DECREASE IN POLLUTANT LOAD

Approach and Results

The decrease in pollutant load was calculated as the difference between the pollutant load in raw sewage (based typical concentrations and per capita water usage) and the pollutant load in treated effluent from a primary wastewater treatment plant. See attached spreadsheet for calculations.

Load reduction estimates (metric tons/526 persons/year):

- Biochemical oxygen demand (BOD): 7.8
- Total suspended solids (TSS): 9.4
- Total coliform: 0.3
- Fecal coliform: 0.003

Data sources

- The primary source of information was Metcalf and Eddy (2003). See attached Excel file.

Assumptions

- The wastewater plant was assumed to function as a secondary treatment plant.
- It is assumed that the system is maintained and properly functions over its lifespan.

OTHER WATERSHED RESORATION BENEFITS NOT QUANTIFIED

- Improved aesthetics
- Reduced exposure to pathogens
- Reduced nutrient loadings

NOTES

- None

REFERENCES

Metcalf and Eddy. 2003. Wastewater Engineering, Treatment and Reuse. 4th Edition.

United Nations Development Programme (UNDP). 2006a. Post-tsunami recovery — Island sanitation in the Maldives (project fact sheet)

United Nations Development Programme (UNDP). 2006b. UNDP Maldives Tsunami Recovery — Dhambidhoo Island Project Update (December 2006)

Preliminary Estimate of Pollutant Load Reduction
Dhambidhoo Island, Maldives **- Sanitation project (526 people)**

Water consumption in developing countries and areas [1]
Per capita water consumption

Units	Gal/d	L/d
Western Pacific	8-24	30-90

Water consumption in developing countries and areas
Per capita water consumption - Average Values

Gal/d	L/d	L/yr
16	60	21900

Typical wastewater constituent data for various countries - Constituent Ranges [2]

Countries	BOD [2]	TSS [2]	TKN [2]	NH3-N [2]	Total P [2]	Total Coliform [3]	Fecal Coliform [3]
Units	g/capita*d	g/capita*d	g/capita*d	g/capita*d	g/capita*d	No./100mL	No./100mL
Brazil	55-68	55-68	8-14	ND	0.6-1	n/a	n/a
Egypt	27-41	41-68	8-14	ND	0.4-0.6	n/a	n/a
India	27-41	ND	ND	ND	ND	n/a	n/a
Palestine (W. Bank & Gaza Strip)	32-68	52-72	4-7	3-5	0.4-0.7	n/a	n/a
Turkey	27-50	41-68	8-14	9-11	0.4-2	n/a	n/a
Uganda	55-68	41-55	8-14	ND	0.4-0.6	n/a	n/a
US	50-120	60-150	9-22	5-12	2.7-4.5	1E+7-1E+10	1E+5-1E+8

Typical wastewater constituent data for various countries - Average Values

BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
g/capita*d	g/capita*d	g/capita*d	g/capita*d	g/capita*d	No./100mL	No./100mL
61.5	61.5	11	ND	0.8	n/a	n/a
34	54.5	11	ND	0.5	n/a	n/a
34	ND	ND	ND	ND	n/a	n/a
50	62	5.5	4	0.55	n/a	n/a
38.5	54.5	11	10	1.2	n/a	n/a
61.5	48	11	ND	0.5	n/a	n/a
85	105	15.5	8.5	3.6	5.01E+09	5.01E+07

Estimated Typical Wastewater Constituent Data
Average of Values for Brazil, Egypt, India, Palestine, Turkey and Uganda (above)

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform [4]	Fecal Coliform [4]
g/capita*d	46.6	56.1	9.9	7	0.71	1.50	0.015
kg/capita*d	0.046583	0.056100	0.009900	0.007000	0.000710	0.001502	0.000015
MT/capita*yr	0.017003	0.020477	0.003614	0.002555	0.000259	0.000548	0.000005

Estimated Typical Wastewater Consituent Loads

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
MT/526 persons*yr	**8.94**	**10.77**	**1.90**	**1.34**	**0.14**	**0.29**	**0.003**

Secondary WWTP Plant Removal Efficiencies - Constituent Ranges [5]

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
Percent Removal	85-90	85-90	NA	NA	NA	90-99	90-99

Secondary WWTP Plant Removal Efficiencies - Averages

BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
87.5	87.5	n/a	n/a	n/a	94.5	94.5

Estimated Wastewater Constituent Loading Change

	BOD	TSS	TKN	NH3-N	Total P	Total Coliform	Fecal Coliform
MT/526 persons*yr	**7.8256**	**9.4243**	n/a	n/a	n/a	**0.2724**	**0.002724**

Notes
ND: not detected
n/a: not available

Unit Conversions
2E+12 cells/g [4]

Data Sources

[1] Table 3-9: Water consumption in developing countries and areas. Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[2] Table 3-14: Typical wastewater constituent data for various countries. Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[3] Table 3-15: Typical composition of untreated domestic wastewater at high strength concentration (based on wastewater flowrate of 60 gal/capita/day). Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, 4th Edition, 2003.
[4] The conversion of fecal coliform count to mass concentration used a value of 2x10^12 cells/dry g based on reported properties of E. coli (Watson, J.D. 1970. Molecular Biology of the Gene. W.A. Benjamin, New York) (http://www.bvsde.paho.org/bvsaar/cdlodos/pdf/assessmentofrisk635.pdf)
[5] Primary WWTP plant removal efficiencies (Table 3-7: Primary treatment (without chemicals), Quantifying Water "Offsets" in Community Water Parnership Projects, LTI, 2008. [Data compiled from Wastewater Engineering, Treatment and Reuse, Metcalf & Eddy, 4th Edition, 2003; and Design of Municipal Wastewater Treatment Plants, 4th Edition, Water Environment Federation and American Society of Civil Engineers, 1998]

PROJECT NAME: Conservation and Rehabilitation of the Klong Yan Watershed in Surat Thani
PROJECT ID #: 43

DESCRIPTION OF ACTIVITY: Conservation of forest land (3,040 hectares)

LOCATION: Surat Thani, Thailand (latitude: 9.10°-9.42°, longitude: 98.80°-99.00°)

PRIMARY CONTACT:
Budsayada Youngfhuengmontra (Nan)
Corporate Citizenship Manager
Coca-Cola (Thailand) Limited.

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Mobile. 66-81-752-1787
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E-mail: ybudsayada@apac.ko.com

OBJECTIVES:
- Conservation of existing forest land
- Reduce runoff
- Conserve local watershed and promote environmental awareness

BACKGROUND & ACTIVITY DESCRIPTION: Villagers in the Surat Thani region intrude on tropical rain forest land in order to expand their farmland. The activity that could be quantified involves conserving 19,000 rais (3,040 hectares) of forest area, thereby preventing further expansion of agricultural areas.

ACTIVITY TIMELINE:
- Conservation action was completed by August 2008.

COCA-COLA CONTRIBUTION: 100%
- Fully funded by Coca-Cola.

WATERSHED RESTORATION BENEFITS CALCULATED:
1. Decrease in runoff water quantity
2. Decrease in sediment runoff

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1. DECREASE IN RUNOFF WATER QUANTITY

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project": agricultural development
    - Hydrologic soil group (HSG) "B"
    - Pasture in "fair" condition (CN = 69)
- "Post-project": conserved forest land
    - Hydrologic soil group (HSG) "B"
    - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained for Surat Thani, Thailand (station ID: VTSB, #485510) from the meteorological database available from WaterBase (www.waterbase.org) for the 2000-05 period, although sufficiently complete precipitation data were only available for years 2003-04. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases for year 2000. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- "Pre-project" (agricultural land): 11,729 ML/yr (386 mm/yr)
- "Post-project" (conserved forest land): 9,651 ML/yr (318 mm/yr)
- **Benefit (runoff reduction): 2,078 ML/yr (68 mm/yr)**

Data Sources:

- Size of reforested land area:
    - 3,040 ha (provided by contact)
- Slope:
    - 27-47% (15-25°) in most areas, 60-70° in steepest areas (provided by contact)
    - Average slope of 37% used for all calculations (conservative)
- Soil type:
    - Described as "loose" soil by contact
    - Available water content (AWC) = 8 mm/meter (hydrologic soil group "B")
- Meteorological data:
    - Daily precipitation and air temperature data for years 2003-04 obtained from WaterBase meteorological database for Surat Thani, Thailand.
    - Precipitation totals for 2003 and 2004 are 2,174 mm and 2004 1,364 mm, respectively.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- 100% of conserved forest land area would have been developed for agricultural use (eventually).

- The agricultural land for the "post-project" condition was conservatively assumed to be represented by pasture land in "fair" condition (CN = 69). In reality, the Curve Number could be higher for more intensive agricultural use, including farming of row crops, etc.
- SWAT model parameter "CNCOEF" was conservatively set to 0.0 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 2000.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- "Pre-project": agricultural land (C_{usle} = 0.10)
- "Post-project": woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (unforested): 2,701,900 MT/yr (889 MT/ha/yr)
- Post-project (forested): 22,300 MT/yr (7 MT/ha/yr)
- **Benefit (reduced sediment yield): 2,679,600 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- 100% of conserved forest land area would have been developed for agricultural use (eventually).
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was conservatively assumed to be 0.17 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Rainwater Harvesting and Aquifer Recharge in India (8 projects: 1.) Checkdam for Groundwater Recharge, 2.) Rain Water Harvesting, Aquifer Recharge and Improved Access to Water, 3.) Rainwater Harvesting and Aquifer Recharge, 4.) Rainwater Harvesting Project in 39 Villages, 5.) Rainwater Harvesting Project in Varanasi, 6.) Recharge Shafts for Sustainable Groundwater, 7.) Rejuvenation of a pond in Karnataka, 8.) Maintenance of Rainwater Harvesting Structures across India)
PROJECT ID #: 51

DESCRIPTION OF ACTIVITY: Construction, use and maintenance of rainwater harvesting structures for water supply and aquifer recharge

LOCATION: Locations throughout India

PRIMARY CONTACT:

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Coca-Cola India
Gurgaon, India
paggarwal@apac.ko.com

Nick Martin, Sr. Project Manager
Delta Consultants
804-332-6401
nmartin@deltaenv.com

OBJECTIVES:

- Collect rainwater for multiple uses including aquifer recharge

BACKGROUND & ACTIVITY DESCRIPTION: Coca-Cola India, in conjunction with partner organizations, is installing, restoring and maintaining rainwater harvesting and aquifer recharge structures to increase access to clean water and provide water for aquifer recharge. Currently, there are approximately 600 rainwater harvesting structures at approximately 270 locations in communities throughout India. Structures include rooftop and surface rainwater catchments that collect water for storage and distribution and/or infiltration to recharge aquifers. Examples of these structures include storage tanks, check dams, ponds, traditional step-wells and aquifer recharge shafts. Maintenance activities are conducted at the structures to promote efficient operation and prolonged lifespan.

ACTIVITY TIMELINE:

- Construction, restoration and maintenance activities were initiated in 2006

COCA-COLA CONTRIBUTION: 100%

- Projects are fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in recharge

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1. INCREASE IN RECHARGE

Approach & Results:

The India Division has estimated the rainwater harvesting potential and estimated recharge of RWH and AAR projects utilizing the following equation and coefficients:

Catchment Surface Area X Annual Precipitation X Catchment Coefficient

Catchment Area – The area of the catchment(s) utilized to harvest precipitation for a given project. Measured in square meters (m2). The Division utilizes three categories of catchments within calculations, including: Roof; Paved; and Open.

Annual Precipitation – The best available annual rainfall data for a given location. Measured in meters (m).

Catchment Coefficient – A coefficient representing the estimated efficiency for each catchment type. The Division utilizes the following coefficients:

- Roof: 0.80
- Paved: 0.60
- Open: 0.30

For projects that utilize collected precipitation for artificial aquifer recharge (AAR) and/or aquifer storage and recovery (ASR), the Division assumes that this value is equal to the value calculated using the above equation. In essence, 100% of the precipitation captured is recharged.

India Division estimates are summarized within the attached spreadsheet entitled *RWH Master Data Only Of Community 090428 Minus Unverified Data.* Cells highlighted in yellow refer to projects that the India Division is in the process of verifying and have not been included in summary results provided below.

Results:

2008 estimated total harvested = 2,658,109 cubic meters/yr = 2,658.11 ML/yr
2009 projected total harvested= 3,249,439 cubic meters/yr = 3,249.44 ML/yr

The India project data will be further analyzed May-June 2009 through probabilistic model developed by Delta Consultants. The model more rigorously estimates the volume of rainwater captured by a rainwater harvesting (RWH) project and artificially recharged to the aquifer (AAR), if applicable, over the period of one year using readily available and limited site-specific information. The model is currently under revision based upon a Subject Matter Expert (SME) review process instituted in March-April 2009. RWH/AAR Probabilistic Model (Version 1.1) will be completed in May 2009. Upon finalization, India project data will be analyzed through the model providing for more robust impact estimates.

The RWH/AAR Probabilistic Model (Version 1.0) was developed in 2008 using Microsoft Excel Version 2003 and Crystal Ball ® Version 7.2. Crystal Ball ® is Monte Carlo simulation software that allows the user to specify variation, or uncertainty, in multiple parameters used in a calculation. The model uses the collection of parameters and coefficients to calculate the volume of water harvested and artificially recharged to the aquifer approximately 10,000 times. Each time the model assigns values to the parameters and coefficients based upon the probabilistic distribution specified by the user and records the volume of water calculated. The results are reviewed and interpreted statistically, in order to estimate the expected results and the uncertainty caused by the variation in the input parameters. By statistically interpreting these results, users can estimate the most likely volume of water that will be harvested and recharged by a specific RWH/AAR system and estimate the potential uncertainty associated with the volume calculated.

Detailed information, references, and value tables are provided in a document produced by Delta Consultants entitled *Probabilistic Model Formulas and Associated Documentation - Version 1.1.* (Currently under revisions and will be finalized in early June 2009).

Questionnaire Project Name	Project Type (Roof; Paved; Open/Unpaved)	Model Estimate for Rainwater Collected (m^3)	India RWH Potential Estimate (m^3)
Goa University	Roof	25,681	20,000
New Building of Krishi Vigyan Kendra, Kallipur, Varanasi	Roof	802	1,600
Resident Welfare Association (RWA), Vasant Kunj, C Block, 9, New Delhi	Roof	735	2,000
Kaladera Village, Jaipur	Open/Unpaved	198,313	190,000
Pond Desilting at Ramnagar Taluk, Bangalore, Karnataka	Open/Unpaved	116,759	45,000

In early 2009, Version 1.0 of the model was used to analyze five select India projects representing the diversity of project design configuration utilized by the India Division. Based upon this analysis, the following provides an output comparison for the five India projects:

Data Sources:

- Delta RWH Surveys completed by the India Division for five representative sample projects.
- Spreadsheets provided by the India Division, including:
  - Rwh_status_July_2008
  - RWH Master Data Only Of Community 09042
- RWH purpose: supplemental water source
- Previous water source: surface water and ground water
- Precipitation data: provided by project coordinators, including the following data files:
  - Average Annual Rainfall: http://indiawaterportal.org/
  - India Division submitted annual rainfall values

Assumptions:

- Catchment coefficients as defined above, including: Roof: 0.80; Paved: 0.60; and Open: 0.30.
- Assumptions and limitations of the probabilistic model as defined within a document developed by Delta Consultants entitled *Probabilistic Model Formulas and Associated Documentation - Version 1.1.* (Currently under revisions and will be finalized in early June 2009).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in stormwater runoff and associated pollutant load

NOTES:

- The probabilistic model is currently under revision based upon a Subject Matter Expert (SME) review process instituted in March-April 2009. RWH/AAR Probabilistic Model (Version 1.1) will be completed in May 2009. Formulas and parameters detailed within this fact sheet are subject to modification prior to finalization.

REFERENCES

Rain Water Harvesting (RWH)/Artificial Aquifer Recharge (AAR) Metrics Methodology Questionnaires for five representative India projects. Supplied by Praveen Aggarwal in December 2008.

Probabilistic Model Formulas and Associated Documentation - Version 1.1. methodology documentation. Produced by Delta Consultants, May 2009.

PROJECT NAME: La Guadiana Sub Basin
PROJECT ID #: 70

DESCRIPTION OF ACTIVITY: Reforestation of 10 hectares recently affected by fire

LOCATION: The River Ruecas, a tributary to the Guadiana River watershed in Spain (UTM Coordinates ED50, 29 North): 297065, 4361219

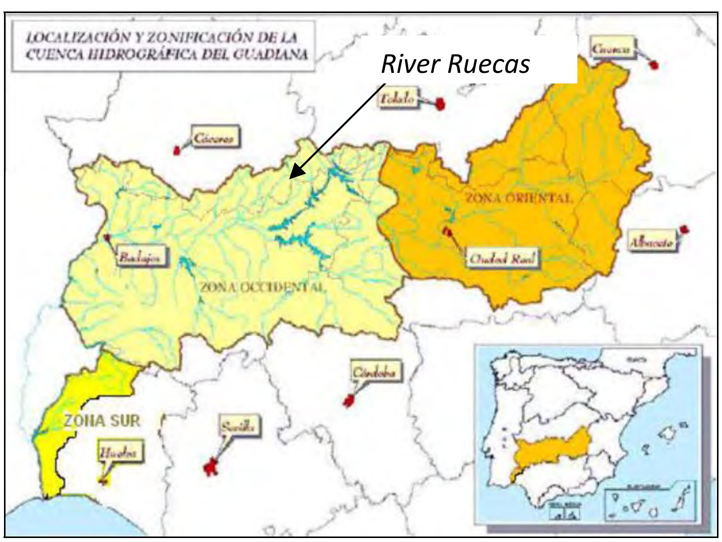
PRIMARY CONTACT:
Beatriz Arribas Santori
E-mail: barribassantori@eur.ko.com

OBJECTIVES:
- Restoration of stream corridors and biodiversity
- Slope and river bank erosion control

BACKGROUND & ACTIVITY DESCRIPTION:
The Guadiana River basin is located in Spain and Portugal. Portions of this basin are highly impacted by intensive flow regulation, groundwater extraction, water contamination, loss of biodiversity and territory fragmentation (Coca Cola España, 2009).

The River Ruecas is a tributary within the Guadiana River basin, located within the Spanish district of Cañamero, in the Southeast portion of the Cáceres province (Autonomic Community of Extremadura). This area is home to endangered fauna including the Golden and Spanish Imperial Eagles, and Griffon, Black and Egyptian Vultures (Villeta, 2009). The River Ruecas contains extensive Holm and cork oak pastures and dense oak and chestnut tree forests. In 2005, this area suffered a devastating fire that destroyed approximately 13,000 hectares. Plantation pine forests and natural oak forests were destroyed, along with a magnificent alder grove (Coca Cola España, 2009).

In 2008, WWF Spain conducted reforestation planting near the River Ruecas. More than 9,000 plants have been planted on a total of 15 hectares (Villeta, 2009).



Location of the River Ruecas within the Guadiana River Basin

Reforestation in La Guadiana River Basin

ACTIVITY TIMELINE:

- A total of 15 hectares were reforested in 2008

COCA-COLA CONTRIBUTION: To be determined.

- No information available – assumed 50% for current estimate.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

<u>Approach & Results</u>

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers (CN) for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project: deforested
  - Hydrologic soil group (HSG) “D”
  - CN = 83 (grass/weeds/brush mixture – “poor” condition)
- Post-project:
  - Hydrologic soil group (HSG) “D”
  - CN = 79 (woods in “fair” condition)

Daily precipitation and air temperature data were obtained for the Martim Longo (Portugal) meteorological station for the 2000-02 period from the SNIRH meteorological website (http://snirh.pt/). The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project runoff volume: 19.7 ML/yr
- Post-project runoff volume: 16.1 ML/yr
- **Benefit (runoff reduction): 3.6 ML/yr**

Data Sources/Site-specific characteristics:

- Total surface area for revegetation: 15 ha (provided by contact)
- Slope: variable, 5-50% (provided by contact) – approximate average slope of 25% used for calculations.
- Soil type:
  - Quartzite and hard soil, with low thickness (provided by contact)
  - Hydrologic soil group “D” selected based on Batjes (1996)
- Daily precipitation data for years 2000-02 were obtained for Martim Longo, Portugal from the SNIRH meteorological website (http://snirh.pt/).

Assumptions:

- Precipitation data obtained for years 2000-02 (mean: 594 mm) are generally representative of average annual precipitation conditions for the reforested area.
- SWAT model parameter “CNCOEF” was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to estimate the original sediment erosion and washoff for the farm plots prior to implementation of the pilot projects. Supporting estimates of water runoff volume were based on the Curve Number method, and daily maximum hourly rainfall intensities were estimated for years 2000-02 based on meteorological data obtained for Martim Longo.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated for the pre- and post-project condition based on Haith et al. (1992):

- Pre-project: C_{usle} = 0.020 (60-80% grass cover)
- Pre-project: C_{usle} = 0.003 (40-75% tree canopy cover)

Total annual sediment yields were estimated as shown below:

- Pre-project (degraded grassland): 290 MT/yr
- Post-project (revegetated): 36 MT/yr
- **Benefit (reduced sediment yield): 254 MT/yr**

Data Sources:

- See data sources discussion in the "Reduction in runoff" section above.

Assumptions:

- Selected values for the Cover/Management Factor (C_{usle}) were assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER BENEFITS NOT QUANTIFIED

- Corresponding increases in infiltration and groundwater baseflow to local stream networks
- Habitat improvements benefiting terrestrial and aquatic wildlife.

NOTES

- None.

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

Coca Cola España. 2009. Restoration Project Guadiana River Basin. May 13, 2009.

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Villeta, M. 2009. E-mail correspondence from Mayte Villeta to Beatriz Santori. May 27, 2009.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

PROJECT NAME: Coca-Cola Enterprises / Cobb County Rain Barrel Donation Program

PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Rain barrel distribution for community household and school/business use.

LOCATION: Atlanta, GA

PRIMARY CONTACT:

Rena Stricker	Nick Martin	Larry Hill
Watershed Coordination for Coca-Cola North America	Senior Project Manger	Coordinator for Barrel Donations
Delta Consultants	Delta Consultants	Coca-Cola Enterprises
404-723-2433 (cell)	804-332-6401	770-795-4122
rstricker@deltaenv.com	nmartin@deltaenv.com	larrhill@cokecce.com

OBJECTIVES:

- Reduction in stormwater runoff

BACKGROUND & ACTIVITY DESCRIPTION: Coca-Cola Enterprises (CCE) is partnering with community and watershed groups in the Atlanta, GA area to distribute Coca-Cola 55-gallon syrup drums for reuse as rain barrels. The donation program is coordinated with the Cobb County Water Stewardship program. Rain barrels are primarily donated to residential properties with the use of collected water running a relatively small gamut from use for light gardening work to exterior household cleaning needs (vehicle washing). A small portion of barrels are donated to local schools and businesses. By collecting rainwater that normally flows off a property, rain barrels save money on water bills, conserve water during dry periods and prevent polluted runoff. The reuse of these 55-gallon barrels will not only help in the effort to protect the local watershed, but also eliminate the energy Coca-Cola would expend recycling the plastic barrels. In 2008, 250 rain barrels were donated.

ACTIVITY TIMELINE:

- 2008: 250 rain barrels were donated.
- The activity is re-evaluated on a yearly basis, but is currently expected to continue for at least 3 years (through 2011).

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola (Coca-Cola Enterprises)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff

1. DECREASE IN STORMWATER RUNOFF

Approach & Results:

Delta Consultants developed and used a Microsoft Excel-based rain barrel calculator to estimate the water benefit from use of donated rain barrels. The calculator is founded upon a supply and demand methodology and includes geography-specific input data, as follows:

Supply Calculations:

To calculate the potential rainwater available for harvest, the calculator utilizes the following formula and variables:

Catchment Size X Number of Barrels X Total Precipitation X Catchment Efficiency Coefficient

Catchment Size – Based upon an assigned percentage of the average single family home and school. For example, the average single family roof size is 1,200 square feet with most houses having a peaked roof. Therefore, the calculator utilizes 600 square feet as the catchment site.

Number of Barrels – An estimate of the number of donated barrels actually distributed and in use.

Total Precipitation – Combined monthly rainfall and snowfall. Snowfall is converted to Snow Water Equivalent using a 0.20 density coefficient. Precipitation data is pre-loaded for select geographic locations.

Catchment Efficiency Coefficient - An 85% runoff coefficient was selected, meaning 85% of the rain falling on the catchment will run off to the gutter and rain barrel. The other 15% will be lost to evaporation, wind, leaks, infiltration into the catchment surface, etc.

Demand Calculations:

To calculate the demand or estimated barrel water use, the calculator utilizes the following formula and variables for both households and schools/businesses.

(Evapotranspiration X Landscape Coefficient X Landscape Area) + Estimated Other Use X Overflow Loss

Evapotranspiration - Data is pre-loaded for select geographic locations.

Landscape Coefficient - Also commonly referred to as the "Plant Factor" and the functional equivalent of the "Crop Coefficient." A factor of 0.55 was selected which is an average value for moderate watering needs. Turf grasses are commonly 0.6-0.8, whereas gardens and shrubs are closer to 0.40 on average.

Landscape Area – The estimated square footage of the landscape are serviced by the rain barrel. The household average is 300 square feet and the school/business is 700 square feet. The larger landscape area for schools/businesses accounts for designated grounds personnel.

Estimated Other Use – Estimates for the amount of water utilized in each given month for purposes other than landscaping or gardening (e.g., washing a vehicle).

Overflow Loss – A percentage reduction based upon the month-to-month probability of receiving more than 0.30” precipitation in a single day. This represents the approximate amount to fill a rain barrel.

Estimated annual capture (2008):

- Atlanta (250 barrels in 2008): 1,075,467 gallons = 4.07 ML/yr
- **Total benefit = 4.07 ML/yr**

Data Sources:

- Southeast Regional Climate Center **(**http://www.sercc.com)
- Harvesting Water for Landscape Use (http://ag.arizona.edu/pubs/water/az1052/harvest.html)
- Guide To Estimating Irrigation Water Need (http://www.owue.water.ca.gov/docs/wucols00.pdf)
- Crop Water Requirements (http://texaset.tamu.edu/coefs.php)
- Georgia Water Balance Calculator (Zip Code: 30313) (http://www.georgiaweather.net)

Assumptions:

- Homeowners and school/business representatives that attend a workshop and receive a rain barrel through the donation program will use it consistently to collect rainwater from roofed areas and use the collected water for gardening, cleaning, and other outdoor uses.
- Given that 55 gallons is a relatively small storage amount, the key to estimating actual harvest is to estimate the amount of water removed from the barrel each month.
- Additional assumptions incorporated into the calculator formulas and coefficients.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in municipal water usage due to use of water collected in rain barrels for gardening, and other activities.

NOTES:

- The calculator assumes that all donated barrels will be hooked up and used to harvest rainwater from rooftops. Currently no data exist to determine if this is true, or what the actual percentage might be.

REFERENCES

City of Philadelphia Rain Barrel Program
http://www.phillywatersheds.org/rainbarrel/rb_map.htm

Nine Mile Run Rain Barrel Initiative - Final Report
http://www.harvesth2o.com/adobe_files/Runoff_Report.pdf

Virginia Cooperative Extension
Estimates that gardens require 65 to 130 gallons of water per 100 square feet once per week.

U.S. Environmental Protection Agency (Region 3)
Estimates that one barrel can save the average household approximately 1,300 gallons over the three peak summer months. http://www.epa.gov/Region3/p2/what-is-rainbarrel.pdf

Cornell Cooperative Extension of Onondaga County Rain Barrel Pilot Study
http://counties.cce.cornell.edu/onondaga/Rain%20Barrel%20Pilot%20Study%20Concludes%20in%20Skaneateles%20long%20version.pdf

PROJECT NAME: Upper Chattahoochee Riverkeeper Rain Barrel Donation Program

PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Rain barrel distribution for community household and school/business use.

LOCATION: Atlanta, GA

PRIMARY CONTACT:

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Nick Martin
Senior Project Manger
Delta Consultants
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OBJECTIVES:

- Reduction in stormwater runoff

BACKGROUND & ACTIVITY DESCRIPTION: Coca-Cola North America's Atlanta Syrup Plant is partnering with watershed groups in the Atlanta, GA area to distribute Coca-Cola 55-gallon syrup drums for reuse as rain barrels. The donation program is coordinated by the Upper Chattahoochee Riverkeeper (UCR). Rain barrels are primarily donated to residential properties with the use of collected water running a relatively small gamut from use for light gardening work to exterior household cleaning needs (vehicle washing). A small portion of barrels are donated to local schools and businesses. By collecting rainwater that normally flows off a property, rain barrels save money on water bills, conserve water during dry periods and prevent polluted runoff. The reuse of these 55-gallon barrels will not only help in the effort to protect the Upper Chattahoochee watershed, but also eliminate the energy Coca-Cola would expend recycling the plastic barrels. In 2008, 150 rain barrels were donated. To date (May 2009), 350 rain barrels have been donated in 2009.

ACTIVITY TIMELINE:

- 2008: 150 rain barrels were donated.
- 2009: 350 rain barrels have been donated to date in 2009.

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola (Coca-Cola North America)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff

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1. DECREASE IN STORMWATER RUNOFF

Approach & Results:

Delta Consultants developed and used a Microsoft Excel-based rain barrel calculator to estimate the water benefit from use of donated rain barrels. The calculator is founded upon a supply and demand methodology and includes geography-specific input data, as follows:

Supply Calculations:

To calculate the potential rainwater available for harvest, the calculator utilizes the following formula and variables:

Catchment Size X Number of Barrels X Total Precipitation X Catchment Efficiency Coefficient

Catchment Size – Based upon an assigned percentage of the average single family home and school. For example, the average single family roof size is 1,200 square feet with most houses having a peaked roof. Therefore, the calculator utilizes 600 square feet as the catchment site.

Number of Barrels – An estimate of the number of donated barrels actually distributed and in use.

Total Precipitation – Combined monthly rainfall and snowfall. Snowfall is converted to Snow Water Equivalent using a 0.20 density coefficient. Precipitation data is pre-loaded for select geographic locations.

Catchment Efficiency Coefficient - An 85% runoff coefficient was selected, meaning 85% of the rain falling on the catchment will run off to the gutter and rain barrel. The other 15% will be lost to evaporation, wind, leaks, infiltration into the catchment surface, etc.

Demand Calculations:

To calculate the demand or estimated barrel water use, the calculator utilizes the following formula and variables for both households and schools/businesses.

(Evapotranspiration X Landscape Coefficient X Landscape Area) + Estimated Other Use X Overflow Loss

Evapotranspiration - Data is pre-loaded for select geographic locations.

Landscape Coefficient - Also commonly referred to as the "Plant Factor" and the functional equivalent of the "Crop Coefficient." A factor of 0.55 was selected which is an average value for moderate watering needs. Turf grasses are commonly 0.6-0.8, whereas gardens and shrubs are closer to 0.40 on average.

Landscape Area – The estimated square footage of the landscape are serviced by the rain barrel. The household average is 300 square feet and the school/business is 700 square feet. The larger landscape area for schools/businesses accounts for designated grounds personnel.

Estimated Other Use – Estimates for the amount of water utilized in each given month for purposes other than landscaping or gardening (e.g., washing a vehicle).

Overflow Loss – A percentage reduction based upon the month-to-month probability of receiving more than 0.30” precipitation in a single day. This represents the approximate amount to fill a rain barrel.

Estimated annual capture (2008):

- Atlanta (150 barrels in 2008): 645,280 gallons = 2.44 ML/yr
- **Total benefit = 2.44 ML/yr**

Estimated annual capture (2009)

- Atlanta (350 barrels in 2009): 1,503,000 gallons =5.69 ML/yr
- **Total benefit = 5.69 ML/yr**

Data Sources:

- Southeast Regional Climate Center **(**http://www.sercc.com)

- Harvesting Water for Landscape Use (http://ag.arizona.edu/pubs/water/az1052/harvest.html)
- Guide To Estimating Irrigation Water Need (http://www.owue.water.ca.gov/docs/wucols00.pdf)
- Crop Water Requirements (http://texaset.tamu.edu/coefs.php)
- Georgia Water Balance Calculator (Zip Code: 30313) (http://www.georgiaweather.net)

Assumptions:

- Homeowners and school/business representatives that attend a workshop and receive a rain barrel through the donation program will use it consistently to collect rainwater from roofed areas and use the collected water for gardening, cleaning, and other outdoor uses.
- Given that 55 gallons is a relatively small storage amount, the key to estimating actual harvest is to estimate the amount of water removed from the barrel each month.
- Additional assumptions incorporated into the calculator formulas and coefficients.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in municipal water usage due to use of water collected in rain barrels for gardening, and other activities.

NOTES:

- The calculator assumes that all donated barrels will be hooked up and used to harvest rainwater from rooftops. Currently no data exist to determine if this is true, or what the actual percentage might be.

REFERENCES

City of Philadelphia Rain Barrel Program
http://www.phillywatersheds.org/rainbarrel/rb_map.htm

Nine Mile Run Rain Barrel Initiative - Final Report
http://www.harvesth2o.com/adobe_files/Runoff_Report.pdf

Virginia Cooperative Extension
Estimates that gardens require 65 to 130 gallons of water per 100 square feet once per week.

U.S. Environmental Protection Agency (Region 3)
Estimates that one barrel can save the average household approximately 1,300 gallons over the three peak summer months. http://www.epa.gov/Region3/p2/what-is-rainbarrel.pdf

Cornell Cooperative Extension of Onondaga County Rain Barrel Pilot Study
http://counties.cce.cornell.edu/onondaga/Rain%20Barrel%20Pilot%20Study%20Concludes%20in%20Skaneateles%20long%20version.pdf

PROJECT NAME: Great Barrier Reef Project (PROJECT CATALYST)

PROJECT ID #: 73

DESCRIPTION OF ACTIVITY: Implement GPS based precision agriculture involving soil, nutrient, pesticide and irrigation management with 19 innovative sugar cane farmers

LOCATION: Mackay Whitsunday region of Australia.

PRIMARY CONTACT:

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OBJECTIVES:

- Reduce sediment, nutrient and chemical loss in freshwater entering the Great Barrier Reef Lagoon
- Reduce runoff and increase infiltration/baseflow

BACKGROUND & ACTIVITY DESCRIPTION:

Working with 19 individual sugar cane growers (16 enterprises) to fast track the development and implementation of innovative, cutting edge (A Class) management practices. The 16 enterprises account for 4,784 hectares of sugarcane within six priority sub-catchments (Rocky Dam Creek, Sandy Creek, Bakers Creek, Murray Creek, O'Connell River and Myrtle Creek). Implementing A class soil management is expected to: 1) reduce loss of sediment, particulate nitrogen and particulate phosphorus, and 2) reduce runoff quantities and enhance groundwater baseflow. Implementing A class nutrient management is expected to reduce loss of dissolved inorganic nitrogen and filterable reactive phosphorus. Implementing A class pesticide management is expected to reduce loss of residual herbicides (eg. atrazine, diuron and hexazinone). Implementing A class irrigation management is expected to: 1) improve the effectiveness (placement and timing) of the soil, nutrient and pesticide management activities, and 2) reduce irrigation losses to runoff and deep drainage.

ACTIVITY TIMELINE:

- Year 1 of the project has been implemented during the 2009 calendar year. Subject to continued funding, the project has a 5 year workplan up to the end of 2013.

COCA-COLA CONTRIBUTION: 50%

- Project would not have occurred without TCCC funding. In the 2009 calendar year, the Australian Government's Reef Rescue Program has contributed $380,000AU for individual landholder water quality grants and 370,000AU for paddock scale modeling and monitoring.

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in soil, nutrients, chemicals entering the GBR Lagoon

1. DECREASE IN SOIL, NUTRIENTS, CHEMICALS ENTERING THE GBR LAGOON

Approach & Results:

Reinterpretation of existing catchment scale modeling (SedNet and Annex) developed to set water quality targets and objectives for the Mackay Whitsunday region was used to estimate the reduction in end of catchment loads resulting from this project. The SedNet and Annex models predict long term annual average loads of sediment and nutrients at the end of catchment and as such are useful for predicting the long term benefits of different management practice scenarios. Details of the modeling used to support the Water Quality Improvement Plan (Drewry et al 2009) are presented in (Drewry, Higham, Mitchell, Rohde, 2008).

As the project progresses it is proposed to use a combination of paddock scale monitoring, rainfall simulation and paddock scale modeling to estimate the paddock scale benefits of the project. It is anticipated that the paddock scale monitoring and modeling data will be synthesized to update the estimates of benefits every October (the first synthesis will occur in October 2010). It is important to note that the end of catchment benefits presented below are likely to be more conservative (i.e. much lower) than paddock scale benefits that will be calculated in the future.

Table 1: Year 1 Outputs expressed as ha's of improved management and Year 1 outcomes expressed as annual End of Catchment load reductions

Year 1 Outputs (2009)	Year 1 Outcomes
1. Adoption of A Class soil management on 4784 ha 2. Adoption of A & some B Class nutrient management on 4784 ha 3. Adoption of A & some B Class pesticide management on 4784 ha 4. Adoption of some A & B Class irrigation management on 4784 ha	• Particulate Nitrogen load reduced by **17** t/yr • Particulate Phosphorus load reduced by **7.6** t/yr • Dissolved Inorganic Nitrogen load reduced by **15** t/yr • Filterable Reactive Phosphorus load reduced by **2.3** t/yr • Total pesticide loads reduced by **134** kg/yr

OTHER BENEFITS NOT QUANTIFIED:

1 Annual decrease in soil, nutrients, chemicals leaving the paddock
2 Annual decrease in runoff leaving the paddock
3 The volume of freshwater improved by the project

NOTES: This is a preliminary end of catchment estimate. Paddock scale monitoring and modeling are being conducted as part of the project. It is anticipated that up to date estimates of benefits will be calculated in October each year (starting in 2010).

REFERENCES

Drewry, J., Higham, W., Mitchell, C. 2008. Water quality improvement plan. Final report for Mackay Whitsunday Region. Mackay Whitsunday Natural Resource Management Group.

Drewry, J., Higham, W., Mitchell, C., Rohde, K., Masters, B., Galea, L. 2008. Water quality improvement plan. Turning environmental values into water quality objectives and targets. Mackay Whitsunday Natural Resource Management Group.

Drewry, J., Higham, W., Mitchell, C., Rohde, K. 2008. Water quality improvement plan. Modeling sediment and nutrient exports and management scenarios. Mackay Whitsunday Natural Resource Management Group.

PROJECT NAME: Coca-Cola Beverages Belorussiya: "Let's Save Yelnya Together!"
PROJECT ID #: 74

DESCRIPTION OF ACTIVITY: Canals that artificially drain Yelnya Bog have been blocked to increase the local groundwater storage/level, thereby reducing the threat of significant habitat destruction caused by annual fires.

LOCATION: Vitebsk region (Miory, Sharkovshina District), Belarus (coordinates: 55° 34' N, 27° 55' E)

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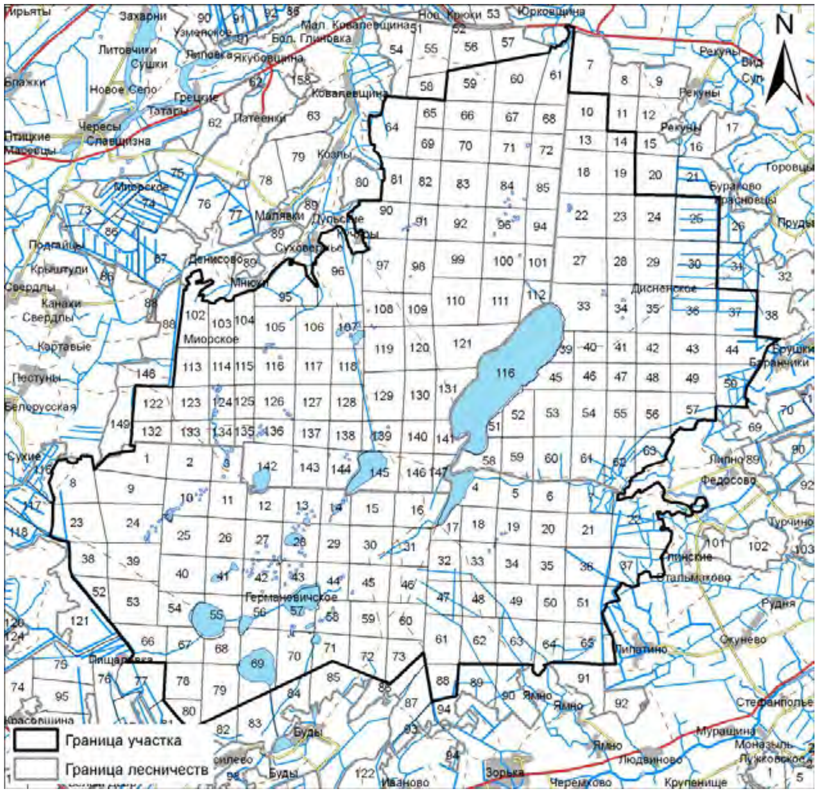
OBJECTIVES

- Protect habitat by preventing further damage to Yelnya Bog's natural cover and peat layer caused by annual forest fires.
- Restore bird populations and natural vegetative cover.

BACKGROUND & DESCRIPTION OF ACTIVITY:
The Yelnya Bog, which is one of Europe's largest peat bogs, covers 24,000 hectares in northern Belarus. The bog is a designated Nature Preserve, an Important Bird Area (IBA), and a Ramsar territory, and it provides habitat for 98 bird species (including 23 endangered) and 11 plant species listed in the National Red Data Book.

Irrigation canals constructed in the early 20th century caused a significant drop in Yelnya's groundwater table, resulting in annual fires that significantly affect vegetative cover and habitat for birds and other fauna. In 2002, a major fire destroyed approximately 70% of the bog's natural vegetative cover. Subsequent major fires likely would have burned the peat layer, resulting in irreparable ecological damage.

Beginning in October 2007, Coca-Cola Beverages Belorussiya organized volunteer teams to manually construct dams out of damaged trees and peat material to block flow through the three main irrigation canals. By the end of 2008, groundwater levels in the 14,000 hectares of the bog affected by the restoration efforts had increased by 1 meter. The success of the project has been further evidenced by the lack of destructive fires during the summers of 2008 and 2009.



Map Showing the Yelnya Bog Area

ACTIVITY TIMELINE:

- Volunteer organization and work initiated in October 2007.
- Recovery efforts are ongoing as of 2009.
- Local Coca-Cola employees took part in three missions per season (May-October)
- Total about 150 other volunteers took part in the project.

COKE CONTRIBUTION: 100%

- 50% Coca-Cola company
- 50% Coca-Cola Hellenic Belarus – local bottler
- New sponsors committed to more conservation efforts in 2010

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Increase in water storage

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1. INCREASE IN WATER STORAGE

Approach and Results:

The increase in groundwater storage was calculated based on the estimated 1-meter increase in groundwater levels over the 14,000 ha bog area affected by the blocking of irrigation canals. This corresponds to a water quantity benefit of 140,000 ML/yr.

Data Sources:

- Estimates of areal coverage and increases in ground water levels were provided by Alexander Yaroshevich (Coca-Cola Belarus)

Assumptions:

- Canals will remain blocked by the constructed dam structures for the foreseeable future.
- The 1-meter increase in groundwater levels within the bog can be expected to be maintained for each year that the irrigation canals remain blocked.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Preservation of unique habitat for many bird species and other fauna.
- *CO_2 impact*: every hectare of over-dry bog discharges up to 10 tonnes of CO_2 per year. The full restoration of the bog in the future will completely reverse the CO_2 dynamic from emission towards absorbing a minimum 1 tonne of greenhouse gases per one hectare per year.

NOTES

- Restoration efforts are ongoing, which may result in increases in water storage/water levels for the remaining bog area (10,000 ha) not affected by the canal blocking efforts completed to date. However, these potential additional water quantity benefits are not included in the estimate provided within this fact sheet.

REFERENCES

http://www.foodbev.com/news/coca-cola-hellenic-receives-special-commendation-for-water-s

PROJECT NAME: Protection of Water Sources in El Carmen
PROJECT ID #: 75

DESCRIPTION OF ACTIVITY: Reforestation of 120 ha of high mountain communal area to protect natural springs.

LOCATION: Pita River watershed near the village of El Carmen in Pintag, Pichincha, Ecuador (UTM system: Latitude 9946000 Longitude 794200)

PRIMARY CONTACT:

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Fundación Coca-Cola de Ecuador
Av.República del Salvador N36-230 y Naciones Unidas Edificio Citybank, 1er piso
Quito, Ecuador

OBJECTIVES:
- Reduce runoff / increase infiltration
- Reduce sediment erosion/runoff
- Restore forest habitat

BACKGROUND & ACTIVITY DESCRIPTION:
The objective of this project is to protect and maintain the Pita River sub-watershed through reforestation that will help improve the future quantity and quality of these water resources. This area provides water for El Carmen and neighboring communities, locally, and also the Metropolitan District of Quito. The project will also assure sustainability by involving the El Carmen community in safeguarding the watershed and in other activities that will increase their income by improving agro-ecological production capacity. Phase I of the project accomplished reforestation of 50 hectares with 50,000 trees planted in the communal high mountain degraded lands and in the community farms to create natural shields. Additionally, at least 25 farmers who are involved in the Integrated Self-sufficient Farms (ISF model) were organized and trained. Phase II will accomplish additional reforestation of at least 70 hectares with 70,000 trees and native shrubs planted, and protection of micro water springs in the area. Maintenance activities will be conducted for at least three years after planting to provide a guarantee of the sustainability and results of the project. The reforested high mountain degraded lands are in the Páramo of the Sincholagua Volcano. This area is a neotropical ecosystem located at high elevation between the upper forest line (about 3800 m altitude) and the permanent snow line (about 5000 m). This ecosystem consists, in general, of mostly glacier formed valleys and plains with a large variety of lakes, peat bogs and wet grasslands intermingled with shrublands and forest patches.

ACTIVITY TIMELINE:
- **Phase 1: November 2008 to September 2009 -** Reforestation of 50 hectares (50,000 trees planted) and organization of at least 25 farmers in the Integrated Self-sufficient Farms.
- **Phase 2: November 2009 to October 2010 -** Reforestation of at least 70 hectares (70,000 native trees and shrubs planted) and protection of micro water springs.

COCA-COLA CONTRIBUTION: 53%

- Phase I: $105,340USD total with $60,000USD from Coca-Cola Foundation of Ecuador (56.96%)
- Phase II (estimated from grant proposal): $122,475USD total with $60,000USD from Coca-Cola Foundation of Ecuador (48.99%)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "B"
  - Pasture/grassland in "poor" condition (CN = 79)
- Post-project:
  - Hydrologic soil group (HSG) "B"
  - Woodland in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained from the TuTiempo.net online meteorological database for the Guayaquil station during the 1985-1991 time period (http://www.tutiempo.net/en/Climate/Guayaquil_Simon_Bolivar/842030.htm). However, many of these years had annual rainfall totals less than 50% of the long-term average rainfall for the El Carmen area (1,113 mm). Therefore, year 1987 (precip: 1,308 mm) was selected as a single representative year for the modeling analysis. The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space) runoff volume: 711 ML/yr
- Post-project (reforested land) runoff volume: 288 ML/yr
- **Benefit (runoff reduction): 423 ML/yr**

Data Sources:

- Size of reforested land area: 120 ha (provided by contact)
- Slope: 40% (provided by contact)
- Soil type: sandy loam and Andean black clay (assigned as HSG "B" per Batjes, 1996)
- Daily precipitation and air temperature data were obtained from the online "TuTiempo.net" meteorological database (http://www.tutiempo.net/en/) for the Guayaquil station (ID: 842030).

Assumptions:

- Precipitation data for the Guayaquil station (for year 1987 only) are representative of precipitation conditions for the reforested areas near El Carmen.
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- Soil erodibility factor (K) was assumed to be 0.24 for both pre- and post-project conditions.

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for year 1987.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: pasture/grassland 80% cover as grass/weeds (C_{usle} = 0.01)
- Post-project: woodland with 75-100% tree canopy (C_{usle} = 0.001)

Total annual sediment yields for the unforested and forested land areas were estimated as follows:

- Pre-project (open space) sediment yield: 16,491 MT/yr
- Post-project (forested) sediment yield: 632 MT/yr
- **Benefit (sediment yield reduction): 15,860 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The tree canopy in the reforested areas was assumed to be mature.
- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER BENEFITS NOT QUANTIFIED

- Corresponding increases in infiltration and groundwater baseflow to local stream networks
- Habitat improvements benefiting terrestrial wildlife

NOTES

- None

REFERENCES

Batjes, N. H. (ed.). 1996. Documentation to ISRIC-WISE global data set of derived soil properties on a 1/2 deg by 1/2 deg grid (Version 1.0). Working paper and Preprint 96/05. International Soil Reference and Information Centre (ISRIC), Wageningen, The Netherlands.

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: Protecting the Mesoamerican Reef – Pueblo Viejo sub-watershed, Guatemala
PROJECT ID #: 76

DESCRIPTION OF ACTIVITY: Implement management practices for agroforestry lands

LOCATION: Three communities in the Pueblo Viejo sub-watershed, Panzo, Alta Verapaz, Guatemala -

- Pueblo Viejo (15° 16' 6.925" N, 89° 41' 3.166" W)
- Cancoy (15° 14´ 26.677" N, 89° 42´ 32.386" W)
- Rio Chiquito (15° 14´ 326.925" N, 89° 40´ 21.676" W)

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OBJECTIVES

- Reduce erosion and associated sedimentation of receiving waters

BACKGROUND & DESCRIPTION OF ACTIVITY:

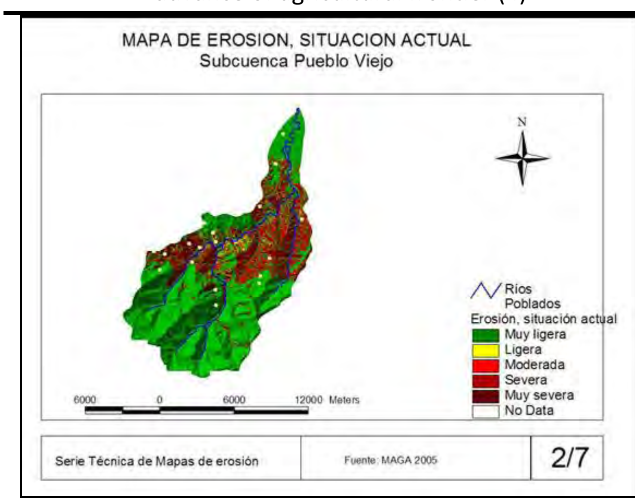
A project aligned with the results of the first phase of the Program of Compensation by Hydrologic Services facilitated by WWF and CARE, and with the objectives of the Water Fund, which involves land use and conservation, was carried out in the Pueblo Viejo River watershed in Guatemala. The Pueblo Viejo watershed (14,892.5 hectares in area) is one of the 63 sub-basins of the Motagua-Polochic River complex in northern Guatemala, which in turn affects the health of the Mesoamerican Reef, the second longest barrier reef in the world. The primary problem in this watershed is soil erosion and sedimentation to the Pueblo Viejo River caused by inadequate agricultural and soil conservation practices that contribute to elevated erosion rates (38.7 TM/ha/year) that are three times that of the natural system. The erosion will ultimately reduce cropland soil quality and local crop yields. The resulting sedimentation to streams contributes to increased flooding and crop loss downstream along the Polochic River.

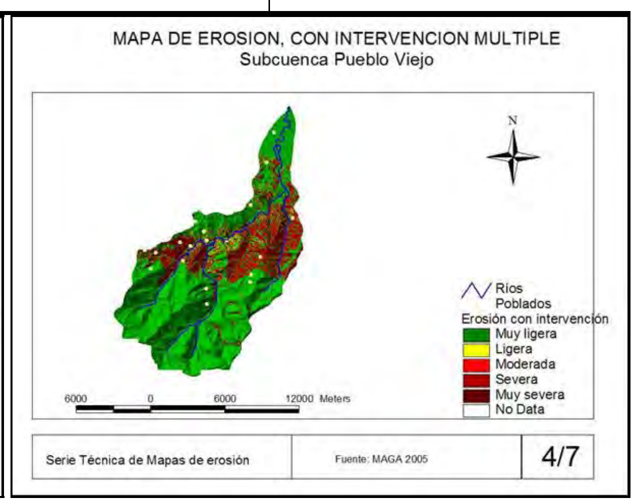
The communities in the Pueblo Viejo watershed that contribute most to the erosion problem include Pueblo Viejo, Cancoy, Santo Toribio, and Rio Chiquito I and II. These communities include 2,715 persons (from the 6,759 people living in the river basin) that are of Mayan origin (Q´eqchi´ ethnic group) whose primary occupation is agriculture, producing subsistence crops (maize and kidney beans) and commercial crops (cardamom, rubber, coffee and citrus). The land area of these communities comprises 29% of the total river basin and corresponds to 42% of the area that has a negative impact on water quality. The annual precipitation in this area is 4,357.7 mm/year, with area soil types and rates of rainfall volume and frequency that facilitate cropland erosion. The program is designed to implement sound practices for soil conservation, agroforestry, and reforestation in critical areas of the watershed that have the greatest erosion. A major program goal is to achieve a sedimentation reduction of 12%, from 138,061 MT/year (14.868 m^3/year) to 121,818 MT/year (1,749 m^3/year).

Pueblo Viejo Sub-watershed (Lower Part) (Photo Credit: © Claudio VÁSQUEZ BIANCHI, © Peter ROCKSTROH; Photo Source: Figure 4, WWF 2007b)

Erosion Evaluation Results for the Pueblo Viejo Sub-Watershed
(Table 1, Figure 1 & Figure 3 from WWF 2007a)

No.	Scenario	Erosion		Sedimentation		
		TM total	Change TM	m^3	Change m^3	%
1	**Present situation**	**138,061**		**14,868**		
2	Contrast Situation (without forest)	331,176	+193,114	35,665	+20,797	+140%
3	**Scenario with intervention**	**121,818**	**-16,244**	**13,119**	**-1,749**	**-12%**
4	Deforestation by advance of agricultural frontier in 600 has	154,922	+16,861	16,684	+1,816	+12%
5	Total reforestation of the river basin	11,820	-126,242	1,273	-13,595	-91%
6	Scenario with intervention (3) and to avoid advance of agricultural frontier (4)	104,957	-33,104	29,803	-3,565	-24%





ACTIVITY TIMELINE:

- Start Date: July 2007
- End Date: June 2009

COCA-COLA CONTRIBUTION: 30%

- Total Cost of the Project: US$142,929
- Coca-Cola's share: US$42,488

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in sediment erosion/runoff

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1. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

Cropland management practices are being implemented for 60.9 ha of coffee agroforestry land in the Pueblo Viejo subwatershed (terracing) and 140 ha of cardamom-coffee-agroforestry land in the Cancoy subwatershed (contoured strip cropping). The CWP survey responses indicated that 15% and 12% reductions in sediment yield have been estimated for the Pueblo Viejo and Cancoy locations, respectively (WWF, 2008).

The hydrologic evaluation report developed for the region indicated that sediment yields for Pueblo Viejo and Cancoy are 10-50 MT/ha/yr and 50-150 MT/yr, respectively (WWF, 2008). The water quality benefits were calculated in terms of sediment reduction using the midpoint of the sediment yield range reported for Pueblo Viejo and Cancoy:

- Pre-project: **15,827 MT/yr**
  - Pueblo Viejo: [30 MT/ha/yr] * [60.9 ha] = **1,827 MT/yr**
  - Cancoy: [100 MT/ha/yr] * [140 ha] = **14,000 MT/yr**

- Post-project: **13,873 MT/yr**
  - Pueblo Viejo: [1,827 MT/yr] * [0.85] = **1,552.95 MT/yr**
  - Cancoy: [14,000 MT/ha/yr] * [0.88] = **12,320 MT/yr**

- **Benefit (reduced sediment yield): 1,954 MT/yr**
  - Pueblo Viejo: [1,827 MT/yr] * [0.15] = **274 MT/yr**
  - Cancoy: [14,000 MT/ha/yr] * [0.12] = **1,680 MT/yr**

Data Sources:

- Estimates of present-day sediment yield and anticipated percent reductions obtained from project contact and the hydrologic evaluation report (WWF, 2008).

Assumptions:

- The estimated reductions in sediment yield (12-15%) will be achieved through the planned management actions and stay in effect for the foreseeable future.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Possible reductions in water runoff volumes due to implementation of best management practices for agricultural land areas.

NOTES

- None

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WWF 2007a. Propuesta de Negocios a ser presentada al Ingenio Guadalupe y Comunidades de Pueblo Viejo por parte de WWF-Centroamérica y CARE-Guatemala. Programa Global "Compensación Equitativa por Servicios Hidrológicos", Financiado por los Gobiernos de Holanda (DGIS) y Dinamarca (DANIDA). Junio, 2007

WWF 2007b. Evaluación hidrológica de las subcuencas Pasabién y Pueblo Viejo, Guatemala. Compensación Equitativa por Servicios Hidrológicos. Oscar Ávalos, Juan Carlos Rosito. Producido por: Programa de Comunicaciones WWF Centroamérica 2007.

WWF 2008. Evaluación hidrogeológica de los ríos Pasabién y Pueblo Viejo, Guatemala. CORDILLERA S.A. Producido por: Programa de Comunicaciones WWF Centroamérica 2008.

PROJECT NAME: Protecting the Mesoamerican Reef – Pueblo Viejo sub-watershed, Guatemala
PROJECT ID #: 76

DESCRIPTION OF ACTIVITY: Conservation of forest land

LOCATION: Three communities in the Pueblo Viejo sub-watershed, Panzo, Alta Verapaz, Guatemala -

- Pueblo Viejo (15° 16′ 6.925″ N, 89° 41′ 3.166″ W)
- Cancoy (15° 14´ 26.677″ N, 89° 42´ 32.386″ W)
- Rio Chiquito (15° 14´ 326.925″ N, 89° 40´ 21.676″ W)

PRIMARY CONTACT:

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OBJECTIVES

- Reduce erosion and associated sedimentation of receiving waters
- Maintain hydrologic condition

BACKGROUND & DESCRIPTION OF ACTIVITY:

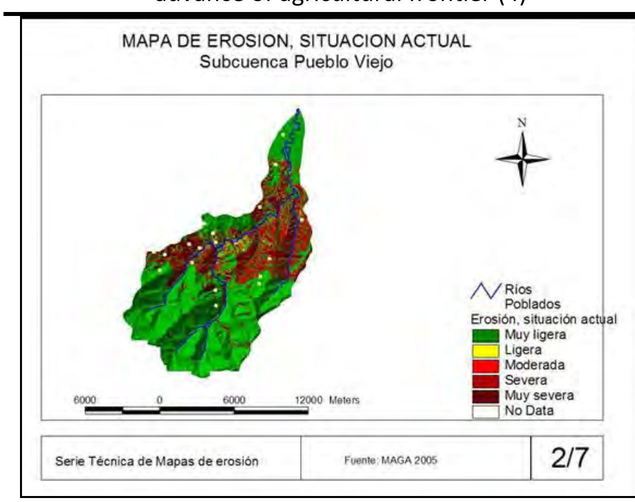
A project aligned with the results of the first phase of the Program of Compensation by Hydrologic Services facilitated by WWF and CARE, and with the objectives of the Water Fund, which involves land use and conservation, was carried out in the Pueblo Viejo River watershed in Guatemala. The Pueblo Viejo watershed (14,892.5 hectares in area) is one of the 63 sub-basins of the Motagua-Polochic River complex in northern Guatemala, which in turn affects the health of the Mesoamerican Reef, the second longest barrier reef in the world. The primary problem in this watershed is soil erosion and sedimentation to the Pueblo Viejo River caused by inadequate agricultural and soil conservation practices that contribute to elevated erosion rates (38.7 TM/ha/year) that are three times that of the natural system. The erosion will ultimately reduce cropland soil quality and local crop yields. The resulting sedimentation to streams contributes to increased flooding and crop loss downstream along the Polochic River.

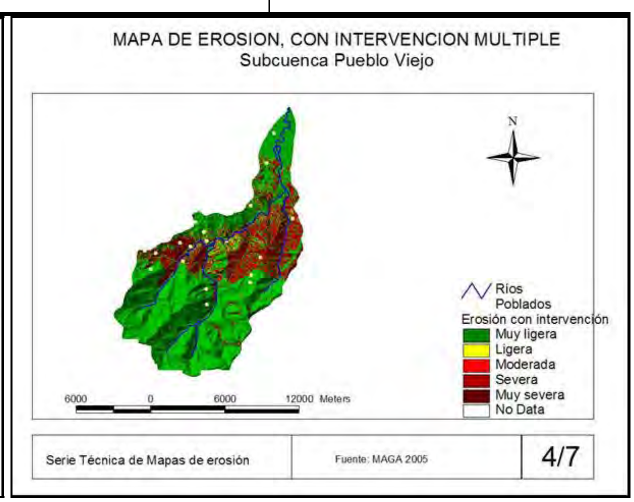
The communities in the Pueblo Viejo watershed that contribute most to the erosion problem include Pueblo Viejo, Cancoy, Santo Toribio, and Rio Chiquito I and II. These communities include 2,715 persons (from the 6,759 people living in the river basin) that are of Mayan origin (Q´eqchi´ ethnic group) whose primary occupation is agriculture, producing subsistence crops (maize and kidney beans) and commercial crops (cardamom, rubber, coffee and citrus). The land area of these communities comprises 29% of the total river basin and corresponds to 42% of the area that has a negative impact on water quality. The annual precipitation in this area is 4,357.7 mm/year, with area soil types and rates of rainfall volume and frequency that facilitate cropland erosion. The program is designed to implement sound practices for soil conservation, agroforestry, and reforestation in critical areas of the watershed that have the greatest erosion. A major program goal is to achieve a sedimentation reduction of 12%, from 138,061 MT/year (14.868 m^3/year) to 121,818 MT/year (1,749 m^3/year).

Pueblo Viejo Sub-watershed (Lower Part) (Photo Credit: © Claudio VÁSQUEZ BIANCHI, © Peter ROCKSTROH; Photo Source: Figure 4, WWF 2007b)

Erosion Evaluation Results for the Pueblo Viejo Sub-Watershed (Table 1, Figure 1 & Figure 3 from WWF 2007a)

No.	Scenario	Erosion		Sedimentation		
		TM total	Change TM	m^3	Change m^3	%
1	**Present situation**	**138,061**		**14,868**		
2	Contrast Situation (without forest)	331,176	+193,114	35,665	+20,797	+140%
3	**Scenario with intervention**	**121,818**	**-16,244**	**13,119**	**-1,749**	**-12%**
4	Deforestation by advance of agricultural frontier in 600 has	154,922	+16,861	16,684	+1,816	+12%
5	Total reforestation of the river basin	11,820	-126,242	1,273	-13,595	-91%
6	Scenario with intervention (3) and to avoid advance of agricultural frontier (4)	104,957	-33,104	29,803	-3,565	-24%





ACTIVITY TIMELINE:

- Start Date: July 2007
- End Date: June 2009

COCA-COLA CONTRIBUTION: 30%

- Total Cost of the Project: US$142,929
- Coca-Cola's share: US$42,488

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

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1. DECREASE IN RUNOFF

Approach & Results:

A total of 1,021 hectares of forest land is being conserved in the Pueblo Viejo (593 ha) and Cancoy (428 ha) subwatersheds. The water quantity benefit from implementation of the conservation efforts was estimated for water quantity (runoff reduction) and water quality (soil erosion reduction) using data provided in the survey responses. The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the "decrease" in runoff associated with avoiding the development of forested land to agroforestry land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- "Pre-project": (developed condition)
  - Hydrologic soil group (HSG) "B"
  - Agroforestry land (i.e., orchard/tree farm) in "good" condition (CN = 58)
- "Post-project": (conserved forest condition)
  - Hydrologic soil group (HSG) "B"
  - Woods in "good" condition (CN = 55)

Daily precipitation and air temperature data were obtained for the Aeropuertola, Guatemala meteorological station for the 2006-08 period from TuTiempo.net (http://www.tutiempo.net/en/Climate/Guatemala_Aeropuertola_Aurora/786410.htm). The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- "Pre-project" runoff volume: 2,853 ML/yr
- "Post-project" runoff volume: 2,702 ML/yr
- **Benefit (runoff reduction): 151 ML/yr**

Data Sources / Site-specific Characteristics:

- Surface area: 1,021 hectares
- Slope: 32-55% (average of 44% used)
- Soil type: silty/clay soil (Franco)
- Daily precipitation and air temperature data were obtained from the online "TuTiempo.net" meteorological database (http://www.tutiempo.net/en/) for the Aeropuertola station (ID: 786410). (Note that data for this station and time period (mean precip: 1,014 mm) appear to be conservative relative to site conditions; however, this dataset appears to be best local data available at this time.)

Assumptions:

- If not conserved, the forested land area would eventually be converted to agroforestry (e.g., coffee, cardamom).
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would avoided as a result of preventing the conversion of forested land to agroforestry land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for years 2006-08.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- "Pre-project": Agroforestry, with ~20-70% tree canopy cover (C_{usle} = 0.003)
- "Post-project": Woods with 75-100% canopy cover (C_{usle} = 0.001)

Total annual sediment yields for the unvegetated/eroded land and crop land areas were estimated as follows:

- "Pre-project" sediment yield: 25,091 MT/yr
- "Post-project" sediment yield: 7,931 MT/yr
- **Benefit (sediment yield reduction): 17,160 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

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Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

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WWF 2007b. *Evaluación hidrológica de las subcuencas Pasabién y Pueblo Viejo, Guatemala*. Compensación Equitativa por Servicios Hidrológicos. Oscar Ávalos, Juan Carlos Rosito. Producido por: Programa de Comunicaciones WWF Centroamérica 2007.

WWF 2008. Evaluación hidrogeológica de los ríos Pasabién y Pueblo Viejo, Guatemala. CORDILLERA S.A. Producido por: Programa de Comunicaciones WWF Centroamérica 2008.

PROJECT NAME: Protecting the Mesoamerican Reef – Teculutan sub-watershed, Guatemala
PROJECT ID #: 76

DESCRIPTION OF ACTIVITY: Irrigation Water Management - flood irrigation system converted to drip irrigation

LOCATION: Teculutan sub-watershed, Teculutan, Zacapa, Guatemala - (14° 58´ 10" N, 89° 41´ 30" W)

PRIMARY CONTACT:
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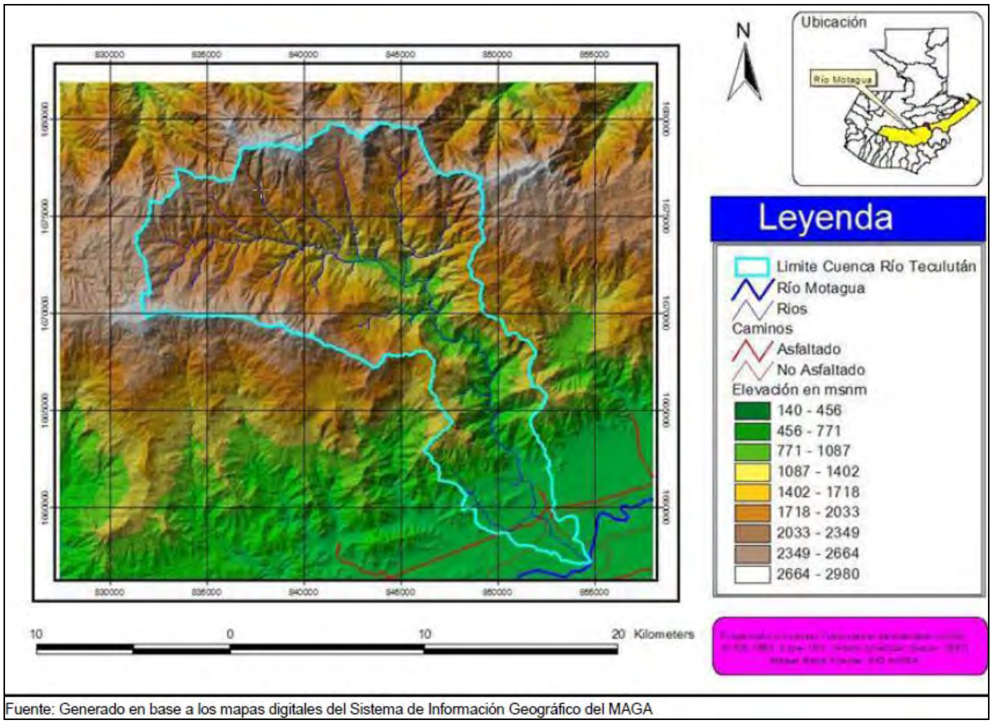
OBJECTIVES

- Convert from flood irrigation to drip irrigation to decrease quantity of water withdrawals from surface waters and improve crop yields

BACKGROUND & DESCRIPTION OF ACTIVITY:

The Teculutan sub-watershed has an area of 216 km^2, drains via the Teculutan River, and discharges into the Montagua River, which flows to the Caribbean Sea (WWF 2008). The Teculutan River provides water originating from the Sierra de las Minas Biosphere Reserve that supports the livelihoods of the rural communities within its borders. The water in the general region of the Sierra de las Minas Biosphere Reserve is used for irrigation of subsistence crops and small scale cattle pastures, processing of coffee and fruit for exports, and the production of hydroelectric energy. However, inappropriate agricultural and cattle ranching practices are degrading the land, causing deforestation that has resulted in reducing the water supply, especially during the dry season (Goldberg 2007).

This project was conducted as part of the Program of Compensation by Hydrologic Services (facilitated by WWF-CA and CARE-Guatemala) to reduce the amount of water used and increase crop yields in the project area by implementing drip irrigation practices where, previously, flood irrigation had been the standard practice. The project will also prevent the expansion of the agricultural frontier in the middle-upper part of the river basin. The project area is 8.8 hectares in size and supports 6.0 hectares of okra and 2.8 of corn production. In addition, management practices were implemented to reduce the amounts of fertilizers, herbicides and pesticides used, to use more environmentally friendly products, and to clean application equipment in the fields rather than directly in the river.



Map of the Teculutan River Watershed (Figure 1, WWF 2008)

ACTIVITY TIMELINE:

- Start Date: December 2008
- End Date: July 2009

COCA-COLA CONTRIBUTION: 30%

- Total Cost of Project: US$89,000
- Coca-Cola's Cost Share: US$27,000

WATERSHED RESTORATION BENEFITS CALCULATED:

DECREASE IN SURFACE/GROUND WATER USAGE

<u>Approach & Results</u>

The water quantity benefit was estimated as the water savings resulting from conversion from flood to drip irrigation. Irrigation water usage was provided in the survey response. The water savings were computed as the difference between pre-project water usage and post-project usage at the project cropland location.

<u>Site-specific characteristics</u>:

- Surface area: 8.8 hectares (okra – 6.0 ha, corn – 2.8 ha)

Project Conditions:

- Pre-project water use (flood irrigation): 8,575 m^3/ha/cycle
- Post-project water use (drip irrigation): 3,000 m^3/ha/cycle
- Change in water use = 5,575 m^3/ha/cycle

Quantification Results:

- [*Water Savings*] = [5,575 m^3/ha/cycle] * [8.8 ha] * [2 cycles/yr] = 98,120 m^3/yr
- **Estimated water quantity benefit is 98 ML/yr**

Data Sources:

- Water usage data were provided in survey responses.

Assumptions

- Two full irrigation cycles are conducted per year.
- Assumed no depreciation in savings over 5 years (system continues to function as in 2009).

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Reduction in nutrient/chemical runoff to streams (no monitoring data provided)

NOTES

- None

REFERENCES

Goldberg 2007. Economic Valuation of Watershed Systems: A Tool for Improved Water Resource Management. Jeffrey Goldberg, Organization of American States, Department of Sustainable Development. Background Note for the VI Inter-American Dialogue on Water Resource Management, Guatemala City, Guatemala; August 15, 2007. Page 7.

WWF 2008. Estudio Hidrológico de la Cuenca del Río Teculután. Preparando por Carlos Roberto Cobos, Hidroinformática Ambiental, S.A., Mayo 2008.

PROJECT NAME: Go Green! Go for the Real Thing!
PROJECT ID #: 77

DESCRIPTION OF ACTIVITY: Reforestation - Tree planting to help alleviate the denudation of mountains, forests, mangroves, and watershed areas

LOCATION: 30 sites across the Philippines

PRIMARY CONTACT:
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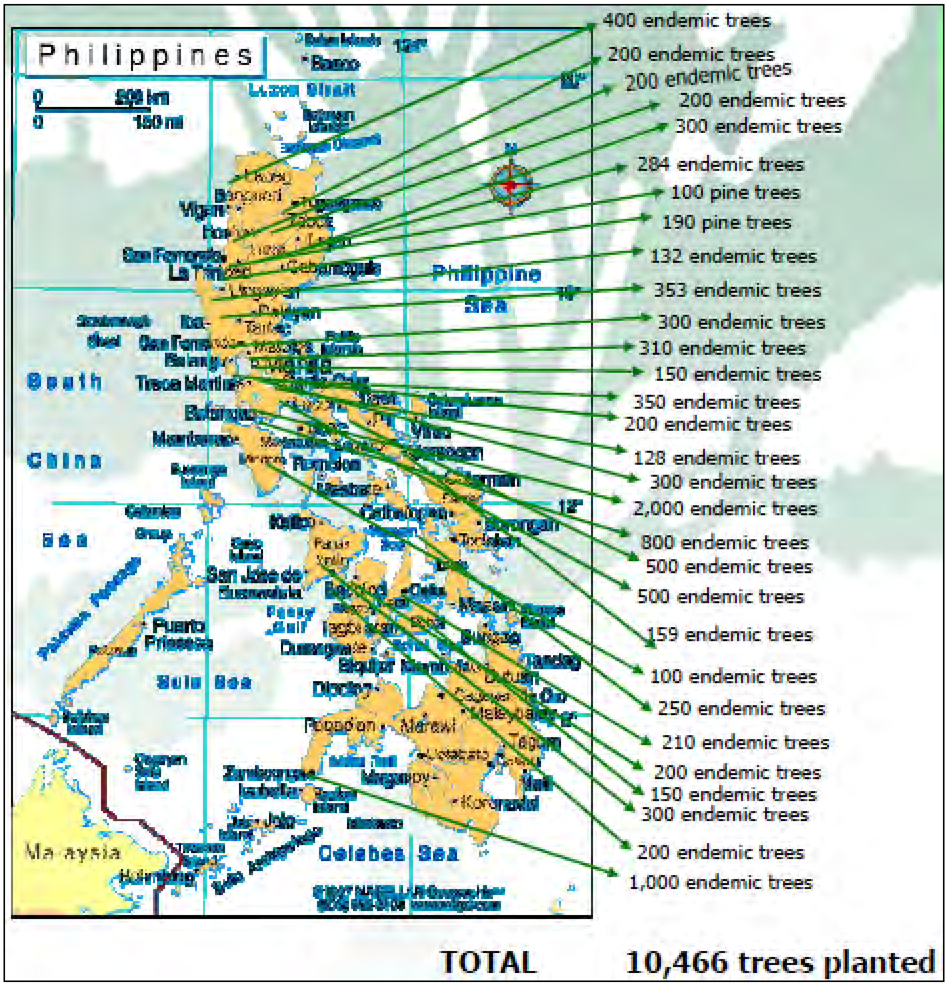
OBJECTIVES

- Decrease sediment erosion and surface water runoff

BACKGROUND & DESCRIPTION OF ACTIVITY:
This tree planting project was initiated by the Boy Scouts of the Philippines in partnership with Coca-Cola and will help alleviate the denudation of mountains, forests, mangroves, and watershed areas throughout the Philippines. The trees planted included hardwood and fruit-bearing varieties endemic to each locality. After establishing a nursery and a seedling bank (funded by Coca-Cola), more than 6,000 Scouts and other volunteers conducted tree planting activities over a two day period at 30 locations throughout the country with a total of 10,466 trees planted. This included 381 volunteers from Coca-Cola Bottlers Philippines, Inc. (CCBPI) who participated in planting 5,640 trees at 13 sites in Bacolod, Calasiao, Carlatan, Cebu, Ilagan, Iloilo, Maycauayan, Naga, Sta. Rosa, Tacloban, Tagbilaran, and Zamboanga.


Zamboanga Tree planting site


Tagbilaran Mangrove planting site



Go Green, Go for the Real Thing – Quezon City, National Capital Region

CCBPI Participation Results

Location	Latitude, Longtitude	Watershed	Pre-Project Land Cover	Qty. Trees Planted (5,640)	Post-Project Land Cover
Brgy. Alangilan, Bacolod City	10.618768, 123.135452	Mandalagan	Bare or grassland	150	Narra
Lanantin HS, Urdaneta	15.991695, 120.568085	Bued, San Fabian, San Roque	Bare or grassland	140	Mahogany, Gmelina, Nehm, Chico
Majors Park, Rosario, La Union	16.244837, 120.482855	Bued, San Fabian, San Roque	Bare or grassland	100	Mango, Guyabano, Avocado
Camp Polikit, Capitol Hills, Lahug, Cebu City	10.332821, 123.893917	Mananga & Kotkot-Lusaran	Bare or grassland	200	100 Narra, 50 Auricacia, 50 Jackfruit
July 18 - Ilagan Sanctuary Brgy. Sta Victoria	17.125206, 122.126684	Abuan	Bare or grassland	500	500 Narra
Don Jose Armada Locsin Scout Camp, Sitio Tangaw, Cabanu, San Lorenzo, Guimaras	10.578609, 122.685699	San Lorenzo / Buenavista	Bare or grassland	200	White lauan
Inang Pilipinas Shrine, Pandi, Bulacan	14.866819, 120.958958	Angat	Bare or grassland	300	100 Mahogany 200 Narra
BSP Pili, Camarines Sur	13.542205, 123.273468	Mt. Isarog	Bare or grassland	150	Molave, Yakal
San Francisco HS, QC	14.657250, 121.028250	La Mesa	Bare or grassland	100	Narra
PUP Subdivision Tagapo, Sta. Rosa	14.319029, 121.104805	Santa Rosa	Bare or grassland	300	Narra, Kamagong, Ipil
Brgy. Salvacion, Tacloban	11.233886, 125.012913	Palo River	Bare or grassland	200	Mahogany
Santa Fe, Albur, Bohol	9.629184, 124.111862	Bohol	Bare or grassland	3000	Mangrove
Brgy. Abong-Abong, Zamboanga City	6.953691, 122.075272	Pasonanca	Bare or grassland	300	300 Narra

ACTIVITY TIMELINE:

- Start Date: June 2009
- End Date: July 2009

COCA-COLA CONTRIBUTION: 44%

- Total Cost of Project: $5,387.06 USD
- Coca-Cola Foundation $2,362.06 USD

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in runoff
2. Decrease in sediment erosion/runoff

---

1. DECREASE IN RUNOFF

Approach & Results

The Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model (Neitsch et al. 2005) was used to estimate the decrease in runoff for the conversion of open, unforested land to forested land. Water quantity calculations were focused on estimating the change in runoff volume because 1) runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and reductions in sediment erosion/yield; and 2) predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Curve numbers for the pre-project condition and the post-project condition were estimated based on information provided in the TR-55 document (USDA-NRCS, 1986):

- Pre-project:
  - Hydrologic soil group (HSG) "D"
  - Grassland in "fair to poor" condition (CN = 87)
- Post-project:
  - Hydrologic soil group (HSG) "D"
  - Woods/grass mixture in "fair" condition (CN = 82)

Daily precipitation and air temperature data were obtained from the TuTiempo.net website for the Calapan station (http://www.tutiempo.net/en/Climate/Calapan/984310.htm) during the 2000-05 time period. The Hamon method was used to estimate daily potential evapotranspiration (PET) for this year based on daily average air temperature and latitude (Hamon, 1963).

Processed meteorological data were used to estimate daily runoff for the pre- and post-project cases. Total annual runoff volumes and the resulting water quantity benefit were estimated as follows:

- Pre-project (open space) runoff volume: 345.3 ML/yr
- Post-project (agro-forest land) runoff volume: 330.8 ML/yr
- **Benefit (runoff reduction): 14.5 ML/yr**

Data Sources/Site-specific characteristics:

- Land condition pre-project: bare or grassland (assumed 50% of each)
- Land condition post-project: various native trees planted (Mahogany, Narra, Jackfruit, etc.)
- Slope: mostly "flat" (assume 5% slope)
- Soil type: primarily clay (assume HSG type "D")
- Daily precipitation and air temperature data were obtained from TuTimpo.net for the Calapan station (ID: 984310).

Assumptions:

- Surface area is approximately 30 ha (10,466 trees planted) based on 30 locations and a surface area of approximately 1 hectare per location.
- Assumed pre-project land condition was 50% grassland and 50% bare land
- Used approximate average slope of 5%.
- Precipitation data for the Calapan station (2000-05) are representative of precipitation conditions for the agro-forested areas. (Average annual precipitation for these 6 years at this station was 2,254 mm.)
- SWAT model parameter "CNCOEF" was set to 0.5 (used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- Soil erodibility factor (K) was assumed to be 0.24 for both pre- and post-project conditions.

2. DECREASE IN SEDIMENT EROSION/RUNOFF

Approach & Results:

The Modified Universal Soil Loss Equation (MUSLE) method (Williams, 1975) as implemented in the Soil & Water Assessment (SWAT) model was used to compute the change in sediment erosion and washoff that would occur as a result of converting open, unforested land to forested land. The meteorological and physical datasets described above for the runoff calculation were used to support application of the MUSLE equation. Estimates of runoff volume were based on the Curve Number method described in the previous section, and daily maximum hourly rainfall intensities were estimated for years 2000-05.

The Cover/Management Factors (C_{usle}) used in the MUSLE were estimated as follows based on Haith (1992):

- Pre-project: 60-80% cover as grass/weeds mixture (C_{usle} = 0.02)
- Post-project: 40-75% tree canopy cover (C_{usle} = 0.003)

Total annual sediment yields for the pre- and post-project conditions were estimated as follows:

- Pre-project (unforested) sediment yield: 454 MT/yr
- Post-project (forested) sediment yield: 65 MT/yr
- **Benefit (sediment yield reduction): 389 MT/yr**

Data Sources:

- See previous runoff section for a description of supporting meteorological and physical datasets and sources.

Assumptions:

- The Cover/Management Factor (C_{usle}) was assumed to remain constant through time (both seasonally and across years).
- The soil erodibility factor (K) was assumed to be 0.24 for use in MUSLE equation.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

- None

REFERENCES

Haith, D.A., R. Mandel, and R.S. Wu. 1992. "Generalized Watershed Loading Functions – Version 2.0 User's Manual." December. Cornell University. Ithaca, NY.

Hamon, W.R., 1963. "Computation of Direct Runoff Amounts From Storm Rainfall." Int. Assoc. Sci, Hydrol. Pub. 63:52-62.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

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Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

PROJECT NAME: Coca-Cola Lexington Rain Garden
PROJECT ID #: 78

DESCRIPTION OF ACTIVITY: Construction of a rain garden

LOCATION: Bluegrass Coca-Cola Bottling, 2275 Leestown Road, Lexington, Fayette County, KY (38° 4'33.48"N, 84°32'17.87"W)

PRIMARY CONTACT:

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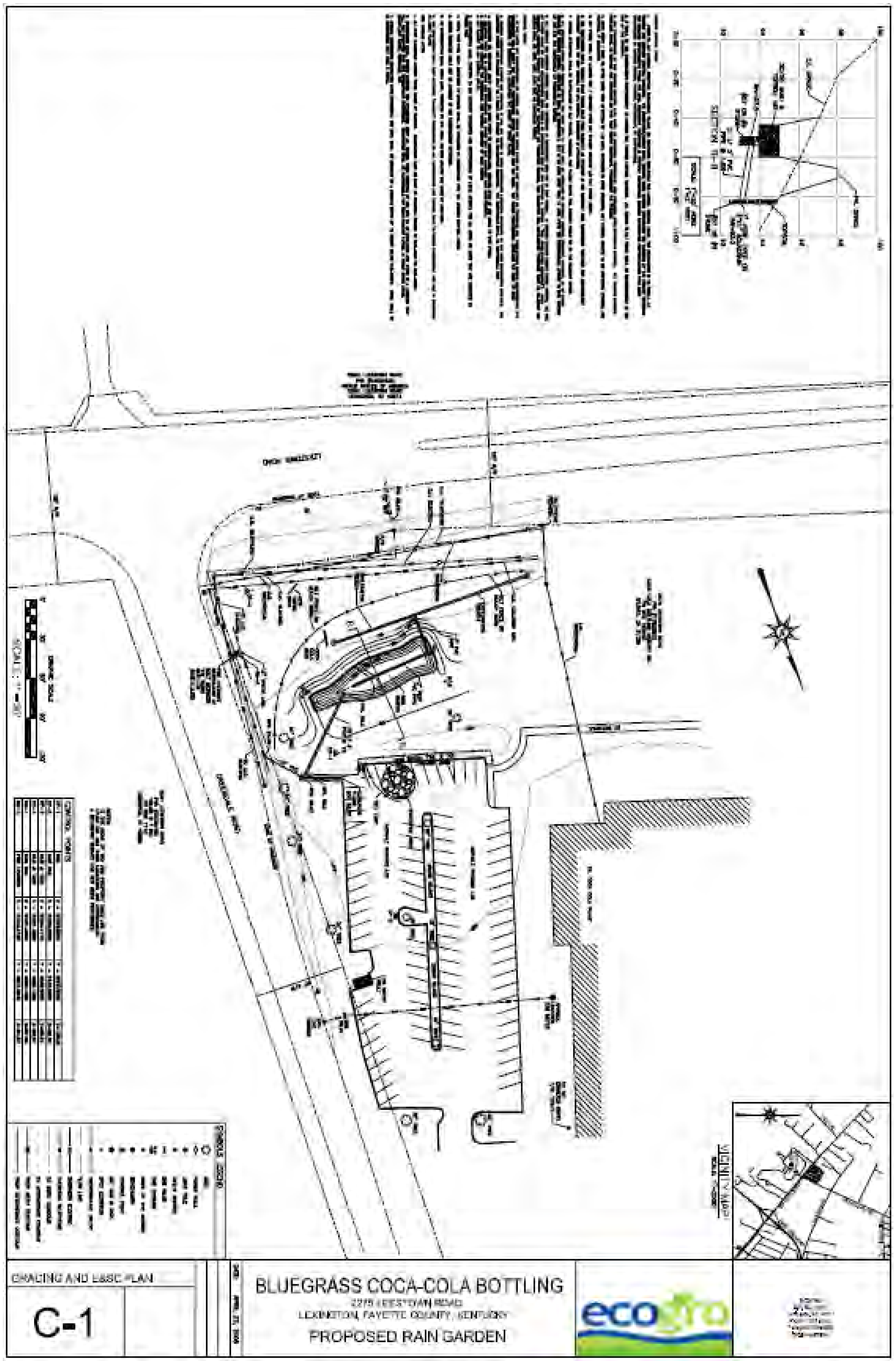
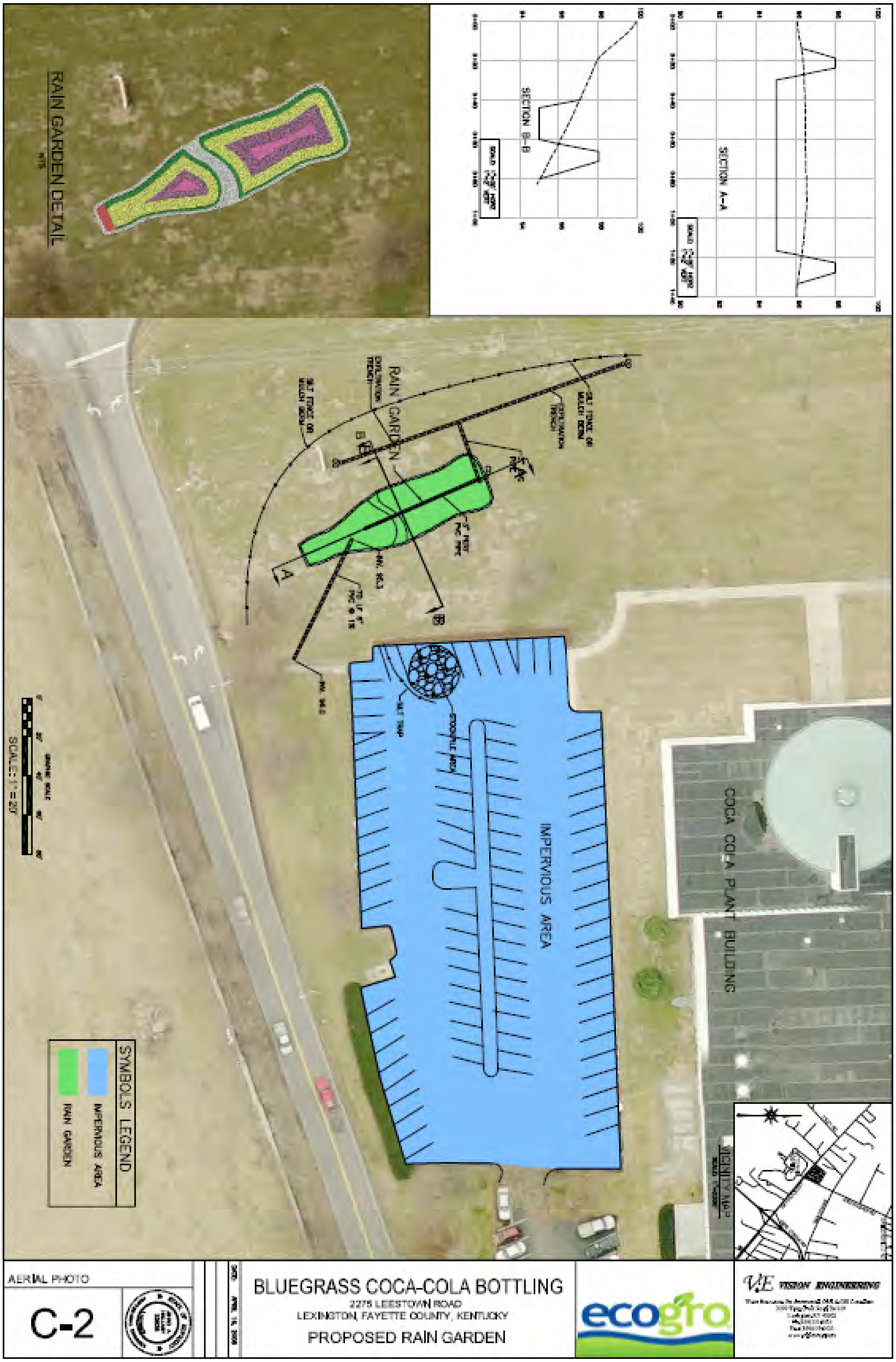
OBJECTIVES:

- Reduction of sediment and other pollutant run-off
- Improved stormwater infiltration

BACKGROUND & ACTIVITY DESCRIPTION: A Coke bottle-shaped rain garden was constructed at the Bluegrass Coca-Cola Bottling plant to collect stormwater runoff from a parking lot. This helped reduce the volume of offsite runoff during small, frequent storm events. Runoff previously drained off the site to Greendale Road storm sewers and, ultimately, to South Elk Horn Creek. The rain garden was designed to capture storm water runoff from a 0.75-acre parking lot during a 1-inch rain event. The pollutants targeted are sediments, grease, oils, fuels and other potential discharges from vehicles in the parking lot. Aside from visual surveys of the rain garden during rain events, no data has been collected. The use of Kentucky native wildflower and grass species in the rain garden provides food for numerous pollinators and birds. The rain garden was constructed using 85% recycled materials. The rain garden is a joint effort by Lexmark, EcoGro, Bluegrass Rain Garden Alliance, University of Kentucky School of Agriculture and Lexington Fayette Urban County. Construction diagrams from the Bluegrass Rain Garden Alliance website follow.


GRADING AND E&SC PLAN
C-1
BLUEGRASS COCA-COLA BOTTLING
2275 LEESTOWN ROAD
LEXINGTON, FAYETTE COUNTY, KENTUCKY
PROPOSED RAIN GARDEN
ecogro
VICINITY MAP
LEESTOWN ROAD


RAIN GARDEN DETAIL
SECTION B-B
SECTION A-A
RAIN GARDEN
IMPERVIOUS AREA
COCA COLA PLANT BUILDING
SYMBOLS LEGEND
IMPERVIOUS AREA
RAIN GARDEN
SCALE: 1" = 20'
VICINITY MAP
AERIAL PHOTO
C-2
BLUEGRASS COCA-COLA BOTTLING
2275 LEESTOWN ROAD
LEXINGTON, FAYETTE COUNTY, KENTUCKY
PROPOSED RAIN GARDEN
ecogro
VISION ENGINEERING

ACTIVITY TIMELINE:

- Activity completed during the month of August 2008
- Percent complete as of December 31, 2008: 100%

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola ($22,000)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. Decrease in stormwater runoff into sewers and streams

---

1. DECREASE IN STORMWATER SEDIMENT LOADING TO SEWERS/STREAMS

Approach & Results:

- Average annual rainfall captured by rain garden (rainfall up to a 1"/hour storm): 44.5 inches/year = 1.13 meters
- Drainage area: 0.75 acre = 3,035 square meters
- Volume of runoff captured by rain garden: 1.13 meters rainfall * 3,035 square meters area = 3,429 cubic meters stormwater = 3.43 million liters stormwater/year
- **Benefit (reduced runoff): 3.4 ML/year**

Data Sources:

From LTI CWP Survey:

- Total drainage collection area: 0.75 acre parking lot
- Area of rain garden: 3,000 ft2 (30' x 100')
- Slope of land surface: 25:1
- Predominant soil type(s) in the project area: Maury silt loam
- Daily average rainfall is always <= 1 inch (NOAA weather normals for Lexington, KY)

Assumptions:

OTHER BENEFITS NOT QUANTIFIED

- Decreased pollutant loading to sewers/streams.

NOTES

REFERENCES

Bluegrass Rain Garden Alliance website: http://www.bluegrassraingardenalliance.org/?q=node/16

Ecogro website: http://www.advancedmulching.com/EcoGro/ecogro_coca_cola.htm

Stormwater Solutions website: http://www.estormwater.com/Corporate-Rain-Garden-Makes-Its-Mark-article9897

APPENDIX F

Fact Sheets for Activities Investigated but not Quantified

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Appendix F Table of Contents

PROJECT NAME: Etowah River Watershed Conservation Partnership
PROJECT ID #: 04

DESCRIPTION OF ACTIVITY: Removal of a run-of-the-river dam on an unnamed tributary to Raccoon Creek.

LOCATION: Etowah River watershed

PRIMARY CONTACT:

Katie Owens	Rena Stricker	Jon Radtke
Upper Coosa River Program Director, The Nature Conservancy, P.O. Box 737, Amuchee, GA 30105-0737	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
706-767-0497	404-723-2433	404-676-9112
kowens@tnc.org	rstricker@na.ko.com	jradtke@na.ko.com

OBJECTIVES:
- Restore stream reach connectivity to improve habitat and range for darter spawning.

BACKGROUND & ACTIVITY DESCRIPTION: A small man-made dam (length: 8', height: 2.5') on an unnamed tributary to Raccoon Creek (which is a tributary to the Etowah River) was removed to restore access to upstream spawning habitat for darters. The removal of the dam is not expected to significantly affect flow rates in the stream. Water quality improvements are also expected to be small, but some reduction in streambank erosion in the vicinity of the dam may be realized. No monitoring of flow rates or water quality is planned for this activity.

ACTIVITY TIMELINE:
- Dam removal occurred in November 2008.

COCA-COLA CONTRIBUTION: 100%
- Project is fully funded by Coca-Cola

WATERSHED RESTORATION BENEFITS CALCULATED: (None)

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED
- Habitat quality improvements, including fish passage.
- Reduction in instream erosion in the vicinity of the former dam structure.

NOTES
- As noted above, removal of this small run-of-the-river dam is not expected to significantly affect either local flow conditions or water quality.
- Quantification of reductions in instream bank erosion would require monitoring of total suspended solids concentrations downstream of the dam location, both prior to and following removal of the structure.

PROJECT NAME: Etowah River Watershed Conservation Partnership
PROJECT ID #: 04

DESCRIPTION OF ACTIVITY: Implementation of the Etowah Habitat Conservation Plan (EHCP) to promote habitat conservation

LOCATION: Etowah River watershed

PRIMARY CONTACT:

Katie Owens	Rena Stricker	Jon Radtke
Upper Coosa River Program Director, The Nature Conservancy, P.O. Box 737, Amuchee, GA 30105-0737	Ecologist for Coca-Cola North America, Delta Consultants	Water Resources Manager, Coca-Cola North America
706-767-0497	404-723-2433	404-676-9112
kowens@tnc.org	rstricker@na.ko.com	jradtke@na.ko.com

OBJECTIVES:

- Habitat conservation
- Reduction of stormwater impacts on runoff quantity and water quality

BACKGROUND & ACTIVITY DESCRIPTION: The Nature Conservancy is partnering with USFWS, the University of Georgia, and the Upper Etowah River Alliance to support the Etowah Habitat Conservation Plan, the largest aquatic HCP ever written in North America. The HCP is currently under regional review by USFWS. Once the review is complete the HCP will go through a public comment period before being formally adopted by cities and counties in the Upper Etowah Watershed. The goal of the Etowah HCP is to protect listed species, while at the same allowing sustainable development. The HCP does this by enacting specific ordinances related to stormwater runoff, buffers, etc.

ACTIVITY TIMELINE:

- Activity is still in the planning phase, and, once adopted, the EHCP and related ordinances will be implemented gradually in future years.
-

COCA-COLA CONTRIBUTION: 50% *[per email from Katie Owens, 5/18/09]*

- TNC is working closely with USFWS, UGA, and the Upper Etowah River Alliance on all HCP outreach efforts, and there are also several private grants involved.

WATERSHED RESTORATION BENEFITS CALCULATED: (None – too early to quantify)

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Various future improvements in stormwater runoff reduction and water quality due to implementation of ordinances associated with the EHCP.

NOTES

- Additional details on the EHCP are available at: http://www.etowahhcp.org

PROJECT NAME: Mulanje Mountain Community Watershed Management (Malawi)
PROJECT ID #: 09

DESCRIPTION OF ACTIVITY: Cropland management using contour marker ridges, tree plantings, and vetiver grass strips on contours.

LOCATION: Malawi

PRIMARY CONTACT:
James Dyett
Project Director
Global Environment & Technology Foundation (GETF)
2900 So. Quincy St., Suite 410
Arlington, VA, 22206
(703) 379-2713
james.dyett@getf.org

OBJECTIVES

- Reduce sediment runoff from smallholder farms

BACKGROUND & DESCRIPTION OF ACTIVITY:

Smallholder farms involve hand cultivation with a hoe for moderately productive croplands (forests, plantations, tea estates, maize gardens, irrigated vegetable gardens, and small fruit orchards). Cropland slopes range from 0% to 40%.

The Ministry of Agriculture has an ongoing program of soil and water conservation, supported in this area by the Mulanje Mountain Conservation Trust (MMCT). Approximately 8,000 hectares are under improved water resource, watershed, or basin resource management (number of hectares derived from mapped area within boundary of Mulanje Forest Reserve and Traditional Authority Laston Njema). Conservation farming, use of organic fertilizers, agroforestry and contour farming are the primary technologies being promoted. Approximately 200,000 tea seedlings were distributed to farmers. 60,000 tree seedlings were planted along exposed river banks in 2006-2007 (55,000 are reported to have survived).

ACTIVITY TIMELINE: (based on survey response)

- Project duration: January 2007 to January 2008
- Project is 100% complete

COCA-COLA CONTRIBUTION: 100%

- Project would not have occurred without TCCC funding (per Denise Knight)

WATERSHED RESTORATION BENEFITS CALCULATED:

1. None

NOTES: Data deficiencies include physical characteristics for project areas (i.e., surface area of land affected, soil type/organic content) and details on cropland management practices

REFERENCES

Development Alternatives, Inc. 2009. Mount Mulanje Community Watershed Partnership Program, WADA Malawi Close-Out Report.

GETF. 2007. Trip Report, Mulanje Mountain CWPP Site Visit, 29 January – 3 February 2007. Franklin Broadhurst, Consultant.

PROJECT NAME: Friends of Alum Creek and Tributaries – Coca-Cola Wetland (US OH)
PROJECT ID #: 17

DESCRIPTION OF ACTIVITY: Removal of invasive species

LOCATION: Alum Creek in Columbus, Ohio (39°54'12.11"N, 82°56'8.95"W)

PRIMARY CONTACT:

Rena Stricker
Watershed Coordination for Coca-Cola North America
Delta Consultants
404-723-2433 (cell)
rstricker@deltaenv.com

Nick Martin
Senior Project Manager
Delta Consultants
804-332-6401
nmartin@deltaenv.com

OBJECTIVES:

- Restore habitat/wildlife diversity
- Improve water infiltration

BACKGROUND & ACTIVITY DESCRIPTION: The purpose of the project is to restore a wetland being taken over with invasive grass species. The lack of buffer around the wetland and the surrounding development has impacted the wetland in terms of biodiversity of herbaceous and woody plant species, and most likely animal species; it has been documented that amphibian diversity is dependent on buffer width.

The primary benefit of this project will be to restore habitat diversity and, as a result, wildlife diversity. At the same time, native plants typically have more substantial root system and can provide more infiltration. Instead of mowing the area around the wetland, the buffer of trees and shrubs with their deeper root systems will allow more water to infiltrate and therefore the wetland will have a better capacity to act as a sponge. There are few wetlands within Alum Creek watershed, therefore increasing the function of this wetland would be beneficial overall.

During 2008, 150 trees were planted in the 1.81 acre area (see Figure of project area, below) that was outside the wetland zone; however, a number of these trees were destroyed during area mowing activities. During Spring 2009, FACT hoped to plant herbaceous species in the wetland. During Fall 2009, FACT hopes to return to plant more tree and shrub species in the 1.17 acre north of the wetland and some supplemental plantings in the 1.81 acre zone. Native species to be planted include: American Highbush Cranberry (Viburnum trilobum), Witch Hazel (Hamamelis virginiana), Winterberry (Ilex verticillata), Silky Dogwood (Cornus amomum), Eastern Redbud (Cercis canadensis), Paw Paw (Asimina triloba), Red Maple (Acer rubrum).

FACT
2820 Watkins Rd
Columbus, OH 43207
(614)409-0511
www.friendsofalumcreek.org

MAD Scientist & Associates LLC
Specialists in Ecological & Wetland Consulting
(614) 818-9156
www.madscientistassociates.net

Coca Cola Wetland Project 2008-2009

Green Dots = 1.81 acres of buffer planted with native trees
Orange hash mark= 1.17 are that can be targeted with supplemental wetland plantings
Green hash mark= 1.13 acres of existing forested wetland area. Limited wetland plantings
Blue hash mark=1.05 wooded area that has invasive honeysuckle that can be removed.

MAD Scientist and Associates, LLC provided graphics, conceptual plan and assisted with planting. The mission of Friends of Alum Creek and Tributaries (FACT) is to preserve and protect the quality and beauty of Alum Creek watershed and promote environmentally responsible recreation, educational opportunities, and citizen participation at many levels.

ACTIVITY TIMELINE:

- There is no reported timeline for invasive species removal
- April 2008: Project implementation
- September 2009: Projected project completion
- Percent complete as of December 31, 2008: 30%

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola.

WATERSHED RESTORATION BENEFITS CALCULATED: None

- Primary focus is on habitat improvements.
- Increased infiltration quantity would require an understanding of the uptake rate of the invasive honeysuckle and the native plants – currently not available.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved wetland plant species diversity (i.e., promotion of native species via removal of invasive species).

NOTES

REFERENCES

PROJECT NAME: Friends of Alum Creek and Tributaries – Coca-Cola Wetland (US OH)
PROJECT ID #: 17

DESCRIPTION OF ACTIVITY: Installation of a riparian buffer

LOCATION: Approximately one mile from Alum Creek in Columbus, Ohio (39°54'12.11"N, 82°56'8.95"W)

PRIMARY CONTACT:

Rena Stricker
Watershed Coordination for Coca-Cola North America
Delta Consultants
404-723-2433 (cell)
rstricker@deltaenv.com

Kimberly L. Williams
Watershed Coordinator/Executive Director
Friends of Alum Creek and Tributaries
2820 Watkins Road
Columbus, OH 43207
614-409-0511
kwilliams@friendsofalumcreek.org

OBJECTIVES:

- Restoration of wetland habitat and native plant diversity

BACKGROUND & ACTIVITY DESCRIPTION: The purpose of the project is to restore an isolated wetland being taken over with invasive grass species. The wetland is a mile away from Alum creek, separated by a road and buildings. The lack of buffer around the wetland and the surrounding development has impacted the wetland in terms of biodiversity of herbaceous and woody plant species, and most likely animal species; it has been documented that amphibian diversity is dependent on buffer width.

The primary benefit of this project will be to restore habitat diversity and, as a result, wildlife diversity. At the same time, native plants typically have more substantial root system and can provide more infiltration. Instead of mowing the area around the wetland, the buffer of trees and shrubs with their deeper root systems will allow more water to infiltrate and therefore the wetland will have a better capacity to act as a sponge. There are few wetlands within Alum Creek watershed, therefore increasing the function of this wetland would be beneficial overall.

During 2008, 150 trees were planted in the 1.81 acre area (see Figure of project area, below) that was outside the wetland zone; however, a number of these trees were destroyed during area mowing activities. During Spring 2009, FACT hoped to plant herbaceous species in the wetland. During Fall 2009, FACT hopes to return to plant more tree and shrub species in the 1.17 acre north of the wetland and some supplemental plantings in the 1.81 acre zone. Native species to be planted include: American Highbush Cranberry (Viburnum trilobum), Witch Hazel (Hamamelis virginiana), Winterberry (Ilex verticillata), Silky Dogwood (Cornus amomum), Eastern Redbud (Cercis canadensis), Paw Paw (Asimina triloba), Red Maple (Acer rubrum).

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Coca Cola Wetland Project 2008-2009

Green Dots = 1.81 acres of buffer planted with native trees
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Blue hash mark=1.05 wooded area that has invasive honeysuckle that can be removed.

MAD Scientist and Associates, LLC provided graphics, conceptual plan and assisted with planting. The mission of Friends of Alum Creek and Tributaries (FACT) is to preserve and protect the quality and beauty of Alum Creek watershed and promote environmentally responsible recreation, educational opportunities, and citizen participation at many levels.

ACTIVITY TIMELINE:

- April 2008: Project implementation
- 2008: 150 trees were planted in the 1.81 acre area
- Spring 2009: plant herbaceous species in the wetland
- Fall 2009: plant more tree and shrub species in the 1.17 acre north of the wetland and some supplemental plantings in the 1.81 acre zone
- September 2009: Projected project completion
- Percent complete as of December 31, 2008: 30%

COCA-COLA CONTRIBUTION: 100%

- Project is fully funded by Coca-Cola.
- $344.00 for plants. Other materials cost is unknown. Octavia Arthur's records should be consulted at Coca Cola.

WATERSHED RESTORATION BENEFITS CALCULATED:

- None – project is not directed at runoff reduction.

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improvement in wetland/riparian habitat

NOTES:

REFERENCES

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2005. "Soil and Water Assessment Tool Theoretical Documentation: Version 2005." January.

USDA-NRCS. 1986. "Urban Hydrology for Small Watersheds – Technical Release 55 (TR-55)." 2nd Edition.

Williams J.R. 1975. "Sediment yield prediction with USLE using runoff energy factor." In: *ARS-S-40.* Agr. Res. Serv., USDA. Washington DC. pp. 244-252.

Wischmeier W.H. and Smith D. 1978. "Predicting rainfall erosion losses: a guide to conservation planning." USDA-ARS Agriculture Handbook No. 537, Washington DC.

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Land protection and improved land management

LOCATION: Mexico: Pegüis Canyon (Río Conchos lowlands)

PRIMARY CONTACT:
Mauricio De La Maza Benignos
Director Programa Desierto Chihuahuense
WWF Programa México
Tel. +52 (614) 4157526, 4157413 ext. 102
www.wwf.org.mx
mmaza@wwfmex.org

OBJECTIVES:

- Protect wildlife & biodiversity
- Reduce erosion
- Improve livelihoods of local communities

BACKGROUND & ACTIVITY DESCRIPTION: Pegüis Canyon is home to mule deer and bighorn sheep. It is in exceptional condition due to its remote location. WWF efforts have been primarily focused on protection measures for a 55,000 Ha area, including the lands of two neighboring ejidos: el Agrillal and Cañon de la Barrera. The main threat is poor grazing practices and limited economic alternatives. A management plan was recently completed. WWF is working with the State and Federal governments toward protection status. *[Based on information provided by M. De La Maza Benignos*]

Pegüis Canyon and Río Conchos at ejido El Agrillal. Photo provided by WWF Mexico Program

ACTIVITY TIMELINE:

- Habitat assessments & socioeconomic studies completed in 2008 (WWF, 2008)
- Management plan completed in 2008 (WWF, 2008)
- Land use plan completed in 2009 (CONANP, 2009)

COKE CONTRIBUTION: 46%

- Total cost: ($1,421,000 pesos)
- Coca-Cola contribution: $651,000 pesos

WATERSHED RESTORATION BENEFITS CALCULATED:

1. None (would be premature to quantify benefits from land protection measures)

WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Habitat improvements benefiting terrestrial wildlife
- Reduced erosion and sedimentation due to improved grazing and land management practices.

NOTES

- None

REFERENCES

WWF 2008 Estudio socioeconómico de las comunidades rurales y el entorno institucional que inciden en la región del Cañón y Sierra del Pegüis, Chihuahua, by Gerardo Jimpénez, Biodesert A.C. Prepared for World Wildlife Fund.

WWF, 2008 Caracterización del hábitat para Borrego Cimarrón y Venado Bura en los ejidos El Agrillal y Cañón de la Barrera, by Carreón-Hernández, E., P.A. Calderón-Domínguez, J.C. Guzmán-Aranda and A. Valerio, Profauna A.C.. Prepared for World Wildlife Fund.

WWF, 2008 Propuesta de Programa de Manejo y Conservación de los Ejidos El Agrillal y Cañón de la Barrera, Chihuahua, México. By Guzmán-Aranda, J.C., E. Carreón-Hernández y P.A. Calderón-Domínguez y A. Lafón-Terrazas. 2009. Prepared for World Wildlife Fund.

WWF. 2009. WWF-TCCC Partnership Quarterly Report: Chihuahuan Desert Ecoregion. February 16.

PROJECT NAME: TCCC-WWF Partnership: Rio Grande/Rio Bravo Basin
PROJECT ID #: 21

DESCRIPTION OF ACTIVITY: Check dam installation & terracing

LOCATION: Mexico: Río Conchos Headwaters (Ejido Panalachi, Sierra Tarahumara); Upper portion of Ureyna micro-basin and Resonachi micro-basin of Panalachi

PRIMARY CONTACT:
Mauricio De La Maza Benignos
Director Programa Desierto Chihuahuense
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OBJECTIVES
- Create micro-habitats for Aparique trout
- Control erosion and associated sedimentation
- Demonstration project to illustrate sound resource management based upon community involvement

BACKGROUND & DESCRIPTION OF ACTIVITY: The last refuge of the endemic Aparique trout is 7 Km of the arroyo Ureyna. Flash flooding, exacerbated by poor land practices and forest fires in the headwaters basin have impaired fish habitat, and caused gullying and deposition of sediment on flooded lands.

Biological studies were conducted to assess needs, and 550 check dams were built in 426 hectares as part of WWF micro-basin restoration. The dams are made of stones and branches and designed to slow water flow, retain soil, and maximize water infiltration.

Aparique trout individuals collected in July 2008 for husbandry studies at the Guachochi Aquaculture Center. (Photo from WWF, 2009 © WWF/José Luis Montes)

ACTIVITY TIMELINE:

- All activities were conducted in 2008.

COKE CONTRIBUTION: 32%

- Total cost: $2,626,000 pesos
- Coca-Cola contribution: $838,000 pesos

WATERSHED RESTORATION BENEFITS CALCULATED:

- None (Data to estimate reduced sediment load are not available; primary focus is on creation of micro-habitats)

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved fishery due to creation of micro-habitats (WWF, 2007)
- Improvement of livelihoods of local communities (WWF, 2007)

NOTES

- Improvements due to check dams have not yet been quantified by WWF. Data will be collected during the July-August 2009 rainy season, the first year after construction. The metric used to measure improvement is the Index of Biological Integrity (IBI).
- This is a demonstration pilot project established to illustrate sound resource management based upon community involvement. May be replicated by government agencies in future.

REFERENCES

WWF. 2007. Restoring a Desert Jewel – The Chihuahuan Desert's Big Bend and the WWF/Coca Cola Partnership. August.

WWF, 2008. TCCC Partnership Quarterly Reporting Form. November 12, 2008.

WWF. 2009. WWF-TCCC Partnership Quarterly Report: Chihuahuan Desert Ecoregion. February 16.

PROJECT NAME: Watershed Protection and Regeneration Program - Landcare
PROJECT ID #: 47

DESCRIPTION OF ACTIVITY: Removal of invasive species near waterways

LOCATION: Australia

PRIMARY CONTACT:
Michelle Allen
Public Affairs and Communications Manager
Environment and Internal Communication
Coca-Cola South Pacific
Telephone: +61 (0)2 9291 3427
miallen@apac.ko.com

OBJECTIVES:
- Reintroduce native vegetation
- Minimize sedimentation and pollutant loading into waterways

BACKGROUND & ACTIVITY DESCRIPTION: The Australian government and local businesses are collaborating through the Landcare partnership and applying innovative environmental management practices to watershed communities to ensure the cleanup, protection, and regeneration of many valuable and threatened waterways. Over 30 invasive species are targeted for removal and replacement by up to 76 native species. The majority of the invasive species are terrestrial weeds that do not directly impact water quantity or quality; however, they engulf the invaded areas, reducing or eliminating native species. Some reduce the growth of native ground cover species that are critical for filtration of eroded sediments, biomass, contaminants and nutrients, minimizing entry of these substances into waterways. Ten Landcare groups have positively impacted 27 hectares with invasive species removal and over 22,000 plantings. The project requirements did not include quantitative estimates of post-project water quantity or quality improvements based on invasive plant control. It is currently too early post-project to see any reportable improvements in water quality and many project locations have seen drought conditions and are thereby unable to assess any associated runoff into waterways.

ACTIVITY TIMELINE:
-

COCA-COLA CONTRIBUTION:
-

WATERSHED RESTORATION BENEFITS CALCULATED: None – primary purpose is to re-establish native species

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED: None

NOTES:

REFERENCES:

PROJECT NAME: Green Kalinga - Philippines
PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Water resource management activities

LOCATION: 11 villages in the provinces of Laguna, Pangasinan, National Capital Region, Negros Oriental, Davao, Compostela Valley, Sulu, and Zamboanga, Philippines

PRIMARY CONTACT:
Josh Cayabyab
Gawad Kalinga
(632) 718-1738
Josh.ong.cayabyab@gmail.com

OBJECTIVES
- Wastewater treatment plant construction
- Other unspecified water resource management activities

BACKGROUND & DESCRIPTION OF ACTIVITY:
This project will promote water resource management by identifying communities in the most need of clean water and constructing water treatment systems, including rainwater catchments, anaerobic baffled reactors (ABR), reed bed wetlands and/or bio-digesters. Monitoring of water treatment systems will be conducted by the external project partner, Gawad Kalinga. The project is expected to benefit 780 families in 11 priority villages in various locations nationwide.

Several of the priority sites have little or no access to water. The project will provide ABR and reedbed technology to areas where there are currently no sanitation facilities, or will be installed as additional facilities in areas where septic tanks are already in use. Reedbed systems will be added to several villages in order to increase effectivity of waste water treatments after these have initially passed through the septic tank systems. Receiving waters are projected to include rivers (Davao, Negros Oriental, Mindanao, Zamboanga, QC, Compostela), lakes (Laguna), and coastal areas (Alaminos, Sulu). Future plans include reusing approximately 30% of treated wastewater effluent at certain sites for farming/agricultural purposes.

ACTIVITY TIMELINE: Project has not yet launched
- Start Date: To be determined
- End Date: To be determined

COCA-COLA CONTRIBUTION: 65.8%*
- Total Cost of Project: $151,975 USD
- Coca-Cola Foundation (*$100,000 USD Grant Amount applied for to CCF-USA - Actual Grant Amount still unspecified)

WATERSHED RESTORATION BENEFITS CALCULATED:

- **Project has not yet begun**

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

- None

REFERENCES

- None

PROJECT NAME: Santa Rosa River Basin Protection/Laguna Lake Watersheds - Philippines
PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Watershed management activities

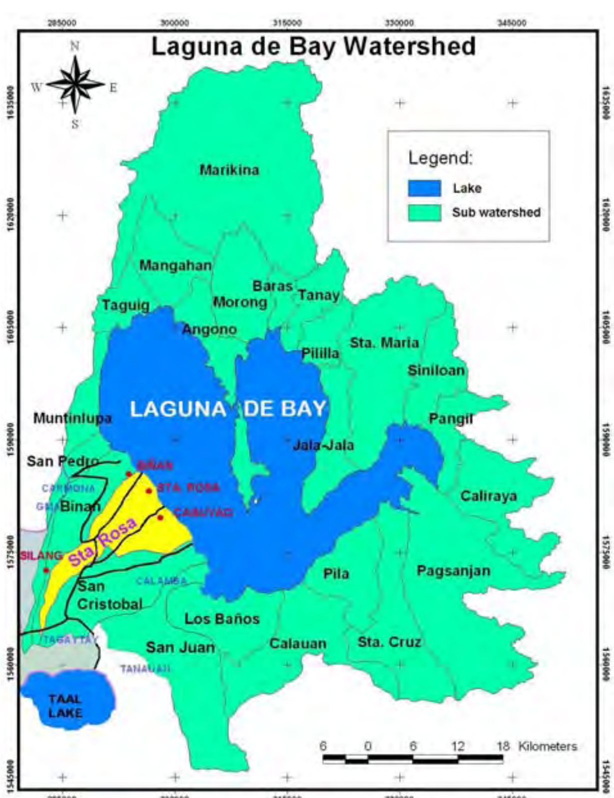
LOCATION: Santa Rosa watershed, City of Santa Rosa, Municipalities of Binan and Cabuyao, Laguna Province, Philippines (14.33 N, 120.98 E)

PRIMARY CONTACT:
Edgardo Tongson
World Wildlife Fund – Philippines
etongson@wwf.org.ph

OBJECTIVES

- Stormwater management to reduce runoff, associated sedimentation, and flooding
- Reforestation/revegetation and conservation of existing land cover to protect drinking water supply
- Dam removal or changes in dam operations to restore natural flow regime
- Wastewater treatment plant construction to reduce human health risks from pathogen exposure

BACKGROUND & DESCRIPTION OF ACTIVITY:
The Santa Rosa River Basin is one of 24 basins surrounding the Laguna de Bay (Laguna Lake). The basin has an area of about 120 km2 (11,500 ha) comprising 4.1% of the Laguna Lake Basin. The basin covers practically the whole City of Santa Rosa and Cabuyao municipality, the southern part of Biñan and several eastern barangays of the municipality of Silang, Cavite. The dominant land use categories are commercial-residential lands (25%), grasslands (25%), rice lands (17%), industries (9%), forests (8%), mixed crops (8%) and coconut plantations (7%). The downstream part of the watershed consists of heavy users of groundwater including beverage companies, semiconductors, distilleries, chemical companies and car manufacturers.



The flood zone and coastal plains of the watershed have slopes 0-3%. The terrain is undulating and gently sloping. The western section is marked by an escarpment traversed by the Western Marikina Fault line and dissected slopes leading to the plateau in Silang.

The annual rainfall varies from about 3000 mm in the headwaters to about 1800 mm on the lake shore, with a mean annual rainfall of 2436 mm. An average monthly rainfall of less than 40 mm is experienced during the dry months from January to April. The wet season peaks in July and August with about 430 mm rainfall per month. Extreme monthly rainfall of more than 1000 mm has occurred several times most probably due to the intense southwest monsoons. Recent flooding during typhoons triggered national attention to prioritize watersheds and averting future natural disasters.

The project is engaging private sector companies in initiating and sharing best practices in water management and efficiency. The project will reduce damages due to flooding in the lower areas of Santa Rosa (municipalities of Binan and Cabuyao). These floods occur during heavy rains due to lack of a formal drainage system. The project will introduce the concept of a combined sewerage and drainage system, and will assist the local government in designing a formal drainage system in Santa Rosa using the natural floodway provided by the Santa Rosa River. The sewerage system will provide treatment of wastewater from unserved houses, institutions and establishments before discharge to the lake.

The uptown municipality of Silang provides for the infiltration of rainwater that replenishes the downstream aquifers depended on by half a million residents of Santa Rosa. Infiltration is still conducive to the land use of Silang which is predominantly agricultural with 10,163 hectares (or 73% of total land area). The project will help formulate an environmental code in Silang to provide penalties and incentives for land developers and land owners to maintain lands conducive to watershed functioning (infiltration, detention ponds, swales, green belts, reforestation, etc.)

The Santa Rosa River Basin Protection project is the first part of the Laguna Lake Watersheds project. The best practices and lessons learned from the Santa Rosa project will be used to develop a broader Integrated Watershed Resources Management (IWRM) program throughout the 25 sub-watersheds of the Laguna Lake basin.

ACTIVITY TIMELINE:

- Start Date: February 2008
- End Date: February 2013

COCA-COLA CONTRIBUTION: 54%

- Total Cost of Project: $1,110,204.00 USD
- Coca-Cola Foundation $600,000 USD
- From tcccgws.com

WATERSHED RESTORATION BENEFITS CALCULATED:

Overview:

- Activity #1:
    - Develop formal drainage system for Santa Rosa watershed, including introducing the concept of a combined sewerage and drainage system which can be factored in when preparing the drainage engineering plans. This will treat the wastewater of unserved houses, institutions and establishments before these are disposed to Laguna Lake.

- Activity #2:
    - Assist in formulate an environmental code in Silang to provide penalties and incentives for land developers and land owners to maintain lands conducive to watershed functioning (infiltration, detention ponds, swales, green belts, reforestation, etc.)

Location:

- City of Santa Rosa, Municipality of Binan and Cabuyao
- Laguna Lake
- Coordinates: 14.33 N, 120.98 E

Site-specific characteristics:

- Surface area: 120 km^2 (12,000 ha) is the total affected area
- Slope: typically 0-3% (mostly coastal plains)
- Soils: sand/silt/clay, pyroclastic
- Precip: basin mean annual rainfall = 2,436 mm

Quantification Approach:

- **Too early to quantify; project appears to be in the planning stages.**

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

- None

REFERENCES

WWF 2009. Santa Rosa Watershed Hydrology and Hydrogeology Report 2009. Santa Rosa Watershed Management Project, WWF-Philippines.

PROJECT NAME: Haribon Foundation Native Tree Nursery - Philippines
PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Reforestation

LOCATION: Caliraya watershed, city of Cavinti, province of Laguna, Philippines (14° 18' 18" N, 121° 29' 19" E)

PRIMARY CONTACT:
TBD

OBJECTIVES

- Reforestation

BACKGROUND & DESCRIPTION OF ACTIVITY:
Supporting water quality, this project will establish a nursery of native tree species suitable for planting within the Caliraya watershed, and will educate and initiate active participation of various stakeholders (communities and local NGOs) in forest restoration. The project is part of a larger campaign, Haribon's ROAD to 2020.

ACTIVITY TIMELINE: Project has not yet launched

- Start Date: April 2010
- End Date: December 2011

COCA-COLA CONTRIBUTION: 100%*

- Total Cost of Project: $44,000 USD
- Coca-Cola Foundation (*$44,000 USD Grant Amount applied for to CCF-USA - Actual Grant Amount still unspecified)

WATERSHED RESTORATION BENEFITS CALCULATED:

- **Project has not yet begun**

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- None

NOTES

- None

REFERENCES

- None

PROJECT NAME: Monkey Cheeks Project (part of the larger Village that Learns and Earns project)
PROJECT ID #: n/a

DESCRIPTION OF ACTIVITY: Water supply for community use/agriculture

LOCATION: Thailand

- Monkey cheeks in Buriram (northeastern Thailand), Nakhon Sawan (central Thailand) and Lumpang
- Check dams in Chiangmai and Tak (northern Thailand) and Songkla (southern Thailand)
- Natural Treatment: Constructed Wetland in Songkla

PRIMARY CONTACT:
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OBJECTIVES

- Capture and store water for community and agricultural irrigation use
- Mitigate flood and drought impacts
- Maintain groundwater levels

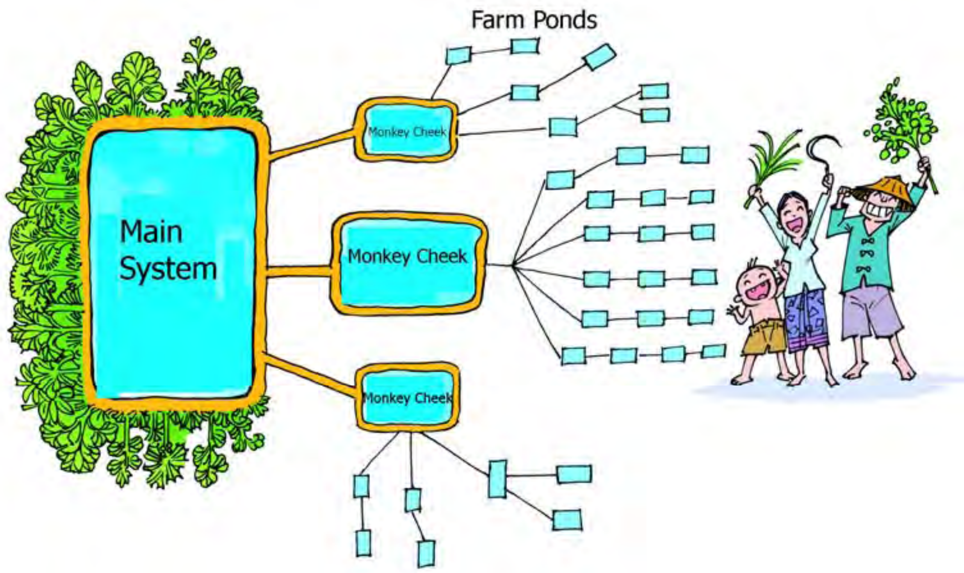
BACKGROUND & DESCRIPTION OF ACTIVITY:
Water resource management practices applied for this project are typically divided into three major areas: Head watershed areas, Water scarcity areas and Excessive water areas.

Check dams (small water dikes) are built in the areas of Chiangmai and Tak in the North and Songkla in the South of Thailand to slow down the speed of water flow in head watershed areas. This results in higher soil moisture content and enhanced biological systems.

Monkey Cheeks are a water retention concept championed by King Bhumibol Adulyadej to store water for the community. The Monkey Cheeks Project involves the construction of new water storage facilities (water retention ponds or Monkey Cheeks), water filtration treatment facilities, piping systems, and distribution canals in the provinces of Buriram in northeastern Thailand and Nakhon Sawan in central Thailand. The term Monkey Cheeks comes from a monkey's eating behavior whereby it collects food in both cheeks. The constructed water retention units store water and are connected to an existing main water canal and will fill, primarily, by capturing rainwater during the rainy season.

The project has two major benefits: 1) during periods of water shortage, the collected water will be used for agricultural purposes to increase crop production, especially in water scarcity areas (northeast region of Thailand) and 2) during the rainy season, the water retention units will help prevent flooding on farmlands. In addition, the check dams and retention ponds will provide potential additional sources of soil moisture and groundwater recharge.

The project also includes the planting of vertiver grass and trees along the banks of the newly constructed retention ponds and irrigation channels to prevent soil erosion, as well as the development of a satellite image mapping system that enables villages to manage their water resources more effectively.



Concept of Monkey Cheeks Reservoir Network

ACTIVITY TIMELINE:

- Project initiation: June 2006
- Anticipated project completion: October 2010

June 2006-May 2007
- Ban Pa Sak Ngam, Chiangmai – plan to build 100 additional check dams every year in Ban Pa Sak Ngam, Chiangmai province
- Ban Limthong, Burirum – existing ponds

June 2007-May 2008
- Ban Bang Keaw, Nakorn Sawan – 2 ponds (26,700 m3)
- Ban Limthong, Burirum – 7 ponds (51,696 m3) – refilled by rainfall (except filled by canal water diversion in Phase 1, June 2006-May 2007)

June 2008-May 2009
- Ban Limthong, Burirum – enlarge ponds to store 121,000 m3 in rainy season and 72,600 m3 in summer
- Ban Nong Thong Lim, Burirum – 8 ponds (83,882 m3) – water refilled by rainfall

June 2009-May 2010
- Ban Khao Pra, Songkla (beneficiaries: 300 households, ~1000 people) – build 5 check dams, build 400 liter/day
- Ban Don Hua Wang, Lumpang – pond capacity extended to 20,000 m3 through canal renovation

November 2009-October 2010
- Ban Nong Thong Lim, Nongbode Subdistrict, Buri Ram Province – waterways (1.5 m width X 1.5 m depth X ~4,000 m total length) to link all water storages (total capacity 56,000 m3)
- Ban Non Kwang, Buri Ram Province - 10 ponds (14,000 m3)

COCA-COLA CONTRIBUTION: 95%

WATERSHED RESTORATION BENEFITS CALCULATED:

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1. **RAINWATER HARVESTING FOR STORAGE IN MONKEY CHEEKS PONDS**
2. **FLOOD MITIGATION**
3. **GROUNDWATER RECHARGE**

OTHER WATERSHED RESTORATION BENEFITS NOT QUANTIFIED

- Improved ecosystem health

NOTES

REFERENCES