Economic Implications and Recommendations

Regarding Los Toros' Water Infrastructure

Assessment from January 2007 Visit

to Los Toros, Dominican Republic

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Los Toros Foundation Committee Meeting

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The January 2007 visit to Los Toros allowed for the collection of much needed data for the community water improvement project. While in the village two main types of data were collected. First, GPS enabled us to accurately map out the positions of the various parts of Los Toros' aqueduct. Coordinates and elevation estimates were recorded (see Appendix C), as well as the conditions surrounding key parts of the aqueduct. This data will be used to help determine why water pressure tends to drop off in the village. Additionally, knowledge of the magnitude of the system will help estimate the amount of financial help needed to repair the broken parts of the system. Photographs of vital parts of the aqueduct were also taken.

Secondly, testing for the presence of nitrates (NO_3) was done. Nitrates are often found in fertilizers. In high concentrations they can be dangerous to the health of humans. Fertilizers are used in the fields surrounding Los Toros, so the possibility of the presence of nitrates in the water supply was feasible.

Very few samples for nitrates were taken and no more than one sample was drawn per testing site. Samples were taken from a valve entering the primary storage tank (PST), the source at the head of the aqueduct, a Los Toros' resident's backyard tap, an irrigation channel near a farm field, and a spring on the eastern edge of Los Toros. All five tests turned up negative for the presence of nitrates. This does not mean that there are not nitrates in the water, or that they never will be in the water. Due to the small number of tests done in an uncontrolled environment, and without the addition of secondary and tertiary tests at each testing site, it is possible this is the reason nitrates were not detected.

Tests for the presence of total coliform completed during the June 2006 visit to Los Toros showed that coliform was present in various parts of the village's water supply. Total coliform tests are indicative of fecal coliform. This renders the water undrinkable due to the high

probability of illness-inducing bacteria in the water. Because of the incomplete and uncontrolled nature of these tests, it is recommended that further, more complete testing of Los Toros water supply be done in the future. It should be noted that while surveying the aqueduct, two large breaks in the pipes were encountered along the path leading to the source. The village plumber indicated that animals pass by at least one of these breaks. Animal waste is a potential source of coliform, so it is possible that the bacteria makes its way into the water system at this break.

Additional considerations concerning the tests: villagers reported that it had been rather dry in the region around the time of our visit. They indicated that heavy rains cause the water supply to become clouded with particulate matter. Presumably this is due to dissolved solids from agriculture being washed into the aqueduct at the source (and potentially at the various breaks in the aqueduct). Had it rained more prior to the nitrate tests, runoff from fields may have carried nitrates into the village water supply.

While in Los Toros, the cost of bottled water was discussed in terms of what the economic impact of having a free supply of clean, drinkable water would be. Not all families can afford to pay for bottled water. Those that have the resources to pay for clean water purchase five gallon containers from local *colmados* at a cost of RD$ 25 (25 Dominican pesos). The average family goes through one of these each day. The amount of water consumed per family may be more or less depending on the size of the family and if they use clean water for more than just consumption and cooking. Assuming the average family in Los Toros spends RD$25 per day for drinking water, in the course of a year they will spend RD$9,125 of their income on water alone. At the current exchange rate of RD$ 33.5 per US$ 1, that is roughly US$ 273 (in 2007 dollars). One estimate of the amount of income spent on consumption in the average Dominican household is

US$ 1,611 (in 1995 dollars). (Based on the Consumer Price Index, this figure is a little over US$ 2,000 in 2005 dollars).

According to this figure, families purchasing one five gallon container of water per day are spending nearly 13.6% of their yearly income on water *alone*. (*No one* in the United States would ever stand for having to put this much of their yearly disposable income toward *water*.) However, this percentage assumes that households in Los Toros have a disposable income of about US$ 2,000. Given the constricted nature of the village's economy (*colmados*, farming, and cottage industries), this figure is probably less for the people of Los Toros. This would mean that they are actually spending an even greater percentage of their yearly disposable income on water.

By way of comparison, the median family income for a household in the village of Grafton in 2000 was $65, 825. In Grafton, residents pay fixed quarterly water charges of US$ 14.25 (US$ 57 annually), and US$ 2.17 per 1,000 gallons of clean, drinkable water (up to the first 30,000 gallons; the next 470,000 gallons cost US$1.87 per 1,000 gallons). Based on usage of five gallons of clean drinking water per household per day in Los Toros, annual usage is 1,825 gallons. Were Los Toros residents to pay for the same amount of water in the village of Grafton, they would only have to pay US$ *3.96* per year for water. (Again this does not take into account fixed service charges because there is no water utility in Los Toros to charge for services.) If residents of the village of Grafton were to be allotted only five gallons per household per day of clean drinking water, the median household would spend only *0.006 %* of their annual income on drinking water. Even if you factor in service charges of US$ 57 per year, and bump annual usage up to 71,000 gallons for a standard household of three (about 65 gallons per person per day

for a year), the median Grafton household still only spends *0.3 %* of their annual income (or US$ 198.77) on reliably clean drinking water.

If this figure seems lower than the average water and sewage bill in the village of Grafton, it probably is. That is because sewage costs (quarterly sewage charges and cost of treatment) were not factored into this estimate, nor was an annual fire protection charge of US$ 11.80. This is not an issue in Los Toros because there is no public sanitary sewer system, nor are there any fire suppression services. It should also be noted that even with quarterly water utility service charges and household water usage 38.9 times greater (71,000 gallons [US] /1,825 gallons [RD]) than is reported in Los Toros, the annual costs for water *alone* in the village of Grafton are still *less* (US$ 198.77 in the village of Grafton compared to US$ 273 in Los Toros) than in the Dominican Republic. Usage of 71,000 gallons per year in the village of Grafton might even be a conservative estimate.

Even if an exorbitant amount of water, say 500,000 gallons, was consumed by one village of Grafton household per year, at the current rates, including service charges, the percentage of the median household's income spent on water would still only be *1.52%*. (See *http://www.village.grafton.wi.us/d-water.htm* for the rates used to compute these figures.) Even with this estimate (Los Toros household drinking water usage constant at five gallons per day, and village of Grafton household water consumption at 500,000 gallons annually) residents of Los Toros are spending *almost nine times* more of their income (13.6 %/1.52 %) on water than village of Grafton residents. It should be noted that the five gallon *per family* per day figure is only *drinking* water. The amount of clean water necessary *for each person* per day for cooking and bathing should be at least twice this amount. All 71,000 gallons of water a household of

three in the village of Grafton would use is purified—this means in addition to having pure water to drink, they have pure water for bathing, washing, cleaning, doing laundry, and for sanitation.

Undoubtedly, in Los Toros there are families that have a yearly income significantly less than the estimate given earlier. While these families are not saving any money by having a free source of clean water (because they probably didn't have the means to purchase water in the first place), the overall improvement in health they would experience from a free source of clean water would have numerous drastic benefits. Three specific improvements would be: an increase in overall health, an increase in educational attainment, and an increase in economic productivity.

Many water-borne pathogens lead to parasitic infections in Los Toros. The main consequence of this is diarrhea—which leads to further dehydration of the infected person. Theoretically, if a resident had no source of clean water, and tried to combat the diarrhea via re-hydration with unclean water (i.e. the only source of water available to an impoverished family), the symptoms would continue. Perhaps the family might scrape together enough money for some purified water, but the cost of the water might force the family (if extremely impoverished) to sacrifice part of their food budget—furthering the denigration of their overall health. With a source of clean water, the overall health of families would dramatically improve and they would be able to spend less time trying to purify their water with chlorine and other rudimentary methods. These benefits feed into the next two advantages of a clean water source for the residents of Los Toros.

If families with clean, drinkable water are healthier, the children in these families will be able to do better in school. They will undoubtedly have less sick days and will be able to concentrate more on their studies when they are healthy. Children from families unable to afford

bottled water will have a better shot at completing primary and secondary school with better grades. This will allow them to be more competitive for scholarships. If they are able to get scholarships to attend a university, they will likely end up with skills that will make them competitive in the job market and set them up to attain higher incomes than their parents. Children from families able to afford bottled water will be able to spend their money on things other than water. One possibility is that these families will choose to send another one of their children to school with the money they save. (The only cost to send a child to school in Los Toros is the cost of a uniform.) With more children attending school, the overall human capital of the village will improve as literacy rates increase and more children are able attain higher levels of education. Students with solid primary and secondary educations will be better prepared for college courses and will be more competitive at the university level. The attainment of higher education leads into the third (but certainly not final) benefit of a clean source of drinking water for the residents of Los Toros.

Clean, drinkable water in Los Toros will lead to increased economic productivity. The health benefits of having clean water will lead to less sick days and more productive work days. In theory, this would allow for the possibility that these families could increase their yearly income simply because they would be working more. Another possibility for healthier farmers is that they could invest more time in learning more productive agricultural techniques. More productive varieties of seeds and efficient ways of farming would lead to increased harvests without increasing the amount of land that would need to be worked. (This is definitely possible—even without better seed varieties. While in Los Toros, I was astonished to see how far apart corn was planted in the fields.) If fewer days were lost due to illness, the potential increased income could be invested in these more productive techniques. Sharing these

techniques with poorer farmers could lead to increased incomes. This could help to bring the neediest families out of extreme poverty.

Increased educational attainment will also stimulate Los Toros' economy. Greater education inevitably leads to innovation due to the increase in human capital that accompanies education. Those with degrees in agriculture could advise farmers on how to increase efficiency. Those with medical degrees will be able to improve the health of the village. Engineers would be able to improve Los Toros infrastructure. Even those who get degrees and do not return to Los Toros will be able to make money elsewhere to send back to their families in the village. This overall increase in income could eventually produce a surplus of capital that could be invested in other community resources like an ambulance, tractors, communication infrastructure, and cooperative businesses. Increased incomes will also qualify more residents for loans, which can be used to further stimulate the economy. The possibilities stemming from a clean source of drinking water are innumerable and endless.

There is one argument that I have neglected to make thus far: *Clean, drinkable water is a basic human right*. If there is one thing that should be done for the people of Los Toros, it should be ensuring their human rights. St. Joseph's Congregation has already done this in numerous ways—encouraging the right to literacy through a community library, supporting educational endeavors, and facilitating the healthcare of Los Toros' residents. Part of the Los Toros Foundation's mission is to enable the people of Los Toros to solve their community's problems. The most effective way that we can defend their human rights and enable the people of Los Toros to better their community is by ensuring that they have a clean source of drinking water. This *must* be a priority.

How can this be accomplished? This is a huge task and completion of this project will not happen overnight. Multiple steps must be taken and great efforts must be made to achieve this goal. Starting at the household level is the best way to ensure there is clean drinking water for as many residents as possible as soon as possible. Until the recent folding of a company that manufactured household water filters that met the demand for a family's drinking water at an affordable price, the Diocese of San Juan was able to furnish these units to families in Los Toros. During the January visit, we were able to acquire one of these bucket filters to take back to the United States. There are plans to do empirical laboratory tests to determine if these filters are indeed effective. If they are effective and maintenance recommendations can be created that will keep the filters in working order for years, a solution for getting these filters to all villagers must be found. A survey done by Los Toros youth after the June 2006 visit, determined an overwhelming majority of a sample of villagers would like household filters. Alternatives to the filters made by the recently defunct manufacturer could consist of building similar filters from the component parts of this company's bucket filters or finding a supplier of cost-effective ceramic filters. Procedures for effective use of these filters must also be determined to complete this short-term solution.

Long-term solutions to improving the water quality in Los Toros will take much more time, effort, and funding. The solutions range from convincing the Dominican government to repair the aqueduct to building a new chlorination unit that would purify water for the entire village. The government's water utility, INAPA, could potentially be persuaded to take responsibility for fixing the breaks in the aqueduct and begin chlorinating the water again. The village plumber reported that INAPA has not chlorinated the aqueduct for over five years. The primary storage tank has a chlorination room attached to it and could probably be easily

reactivated. Repair and chlorination would go a long way toward improving water quality. A similar solution to this would be to get a non-governmental organization (NGO) to take the same actions. Local college chapters of Engineers Without Borders at Marquette University or the University of Wisconsin-Madison might be able to design and implement a new aqueduct and filtration program or repair the current system.

Another long-term solution would involve only repairing the current breaks in the aqueduct and building a separate chlorination unit on the edge of the village. These units, known locally as *casitas*, would disinfect the water from the aqueduct before it was distributed throughout the village via the current pipe infrastructure. Unfortunately, much of this infrastructure is in serious disrepair and would either need to be completely overhauled or bypassed. To avoid complete overhaul, a more practical solution might involve laying a new pipe line that would have multiple community taps. This would ensure that the chlorinated water remained clean without requiring an entirely new pipe infrastructure to be laid out, while still delivering water to within a short walking distance of most homes. These solutions will take at least five years to implement in addition to a great deal of coordination with local officials and agencies funding this solution.

An additional source of water is situated on the eastern edge of Los Toros. There is a natural spring (see MANGO FUEN in Appendix C) that currently supplies water to those living nearby for household chores. It is possible that this unprotected source is used for drinking water as well. It is unlikely this water is clean enough to drink safely, especially because there is a farm field less than fifty feet away. Runoff during heavy rains certainly pollutes this source. Were this source encased by a protective concrete structure, the water could be retained, treated, and made available to residents to use for drinking, cooking, and cleaning.

There is still much information to be collected before a long-term solution to Los Toros' water problems can be solved. While the GPS data collected in January will be useful for rough calculations for improving water pressure within the village, an accurate topographic map is needed to determine accurate difference in elevation between the coordinate-marked positions of various parts of the aqueduct. More investigation into the agricultural practices (redirecting water for irrigation and what is being done to curb runoff from fields) needs to be done to determine how this affects Los Toros' water. A timeline of the steps that need to be taken to improve the quality of water in Los Toros should be a priority of the Los Toros Foundation, just as having access to clean drinkable water is a priority of the residents of Los Toros.

Appendix A

This appendix is a collection of miscellaneous data regarding the state of the water project in Los Toros. This data was collected during the January 2007 visit and consists of information collected at the water committee meeting, and from a survey of the aqueduct. Some of this data was incorporated into the official report.

Aqueduct Survey

Source Data & Observations

Coordinates: N 18° 35' 34.6" W 70° 51' 59.3"

Elevation: 1,311' NO_3 levels: 0.0 mg/l

- Stagnant water in tank compartment No. 2 (See Appendix B)
- Water entering tank in compartment No. 1 appeared clear (no rains to produce runoff full of sediments though)
- A few animals nearby, no farms in sight (thought coffee fields were nearby), no fertilizer reported used nearby
- Locks not present on doors into compartments; doors questionable
- Pipe width from source to Primary Storage Tank (PST): 16" *

PST Data & Observations

Coordinates: N 18° 35' 3.9" W 70° 52' 33.8"

Elevation: 922' NO_3 levels: 0.0 mg/l

- No electricity nearby
- Fence around PST broken in many places, no locks; some pipes broken as well
- Hatch on top of PST has no cover
- Capacity: 600 m^3 (listed on side of PST—about 158,500 gallons)
- Pipe width into PST: 16" *
- Pipe width out of PST: 8" *
- Three reported breaks along aqueduct between source and PST; two confirmed

*Reported by village plumber, not confirmed

Secondary Storage Tank (SST) Data & Observations

Coordinates: N 18° 33' 28.8" W 70° 53' 14.9"

Elevation: 867' NO_3 levels: N/A (SST not online)

- SST reported to not be functioning during January 2007 visit, however water was present in the tank and seemed to be flowing
- Aqueduct reported to be bypassing SST; SST supposed to come online in future
- Fertilizer likely used on farms near SST
- Lock purchased in June 2006 not used to secure SST hatch
- Pipe width from PST to SST: 8" *
- Pipe width from SST to highway: 8" *
- Pipe width from highway to village: 6" *
- Dimensions: Roughly 34' x 34' Depth: 6' *
- Capacity: about 51, 900 gallons (based on above dimensions)

Edge of Village Data & Observations

Coordinates: N 18° 32' 56.5" W 70° 53' 48.4"

Elevation: 772'

- Aqueduct point of entry into village along middle road
- Pipe width into village: 6" *
- Distance between SST and village edge: 0.85 miles
- Break near entry point

Other Data & Observations

- Agricultural diversions were reported * along the road and potentially at point IR2 (see Appendix C), though this point seemed to be offline
- Pipes reported to be buried * at a depth of 60 cm between the source and the PST
- Pipes reported to be buried * at a depth of about 1 meter between SST and Los Toros
- Straight-distance between source and Los Toros is 3.61 miles
- See Appendix C for complete aqueduct coordinate data

*Reported by village plumber, not confirmed

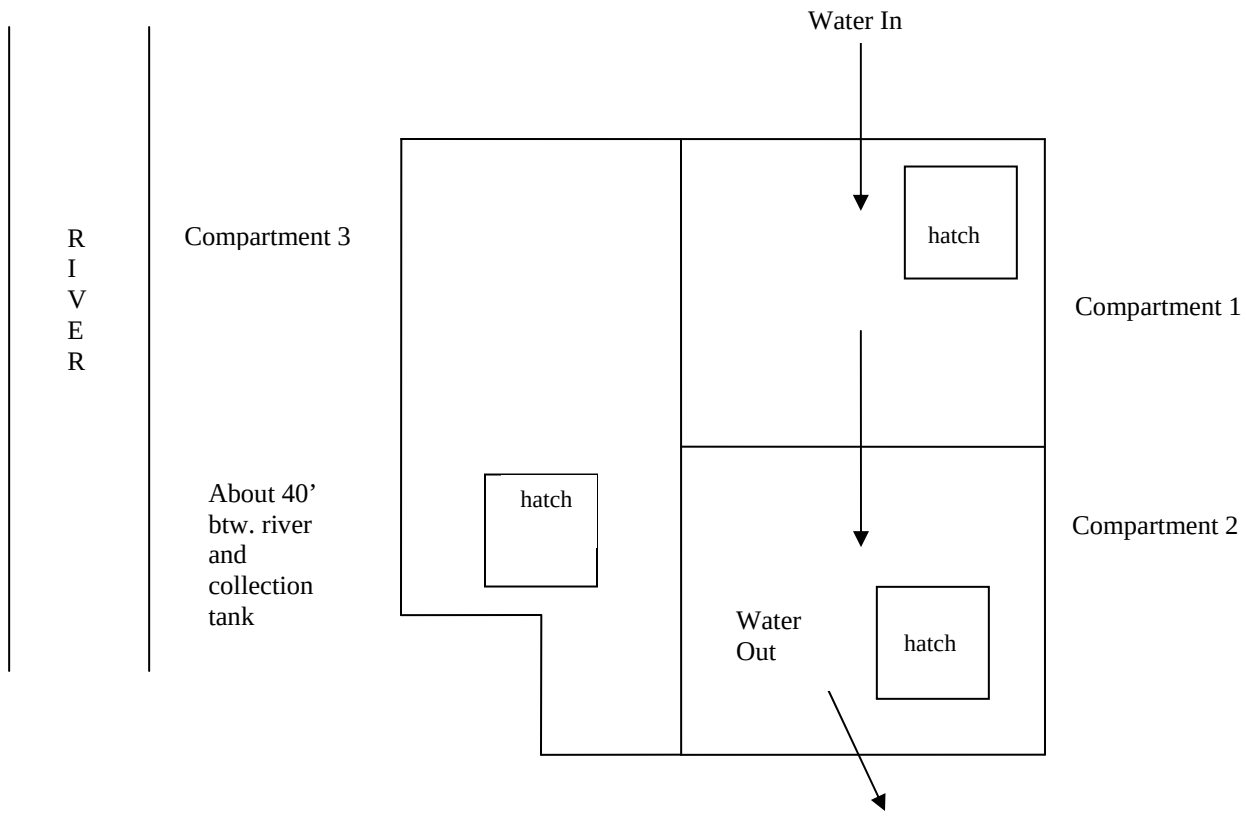
Water Committee Meeting Notes

- Santiago provided us with a bucket filter (cost of RD$ 360) to take back to the United States. It was recently reassembled and will be tested for effectiveness. The filter consists of string element that filters out sediments and particulate matter and a carbon filter element that removes the taste of the chlorine used to disinfect the water. Both elements are replaceable. It appears to take about two and a half hours to filter about five gallons of water.
- Water cannot be filtered when the rains are heavy because of the large amount of sediment in the water. The water must sit so the sediments can settle before the water can be filtered.
- It was recommended that the string filter be replaced every eight months if there is heavy usage; every twelve months for light usage.
- It was recommended that the carbon filter be replaced every year. (The water will taste like dirt if the element is bad.) The carbon can be changed out of the element for about RD$ 20.
- There is a laboratory in Azua that may be able to test water, but it would be expensive. Training somebody in the village to do testing may be an option.
- Ajax chlorine is the disinfectant of choice in Los Toros. The concentration of Sodium Hypochlorite (NaOCl is 5.25%). It is recommended that five drops (from a baby dropper) be added to each gallon of water before it goes through the bucket filter. 25 drops should be used for each full bucket of water to be purified.
- While in Los Toros, it was reported that the week after the meeting, the village would be receiving 50 filters from the Diocese of San Juan. The shipment never arrived. It was later found out the company that manufactures the filters is no longer in business. Another source of filters needs to be found now that this option is no longer viable.
- The Los Toros Water Committee reported that the water has been clean recently, but not bacteria free.

- It was reported that farms and the village use the same water, but it can be diverted to the fields for agricultural use. This does not occur daily. This may play into why the water pressure drops off in Los Toros. Another reason may be that there is simply not enough water in the PST to supply the village. It is also unknown whether or not water in the aqueduct is diverted to Tabara Arriba (a village north of Los Toros along the aqueduct). It was reported that water pressure is good when it rains.
- It was decided that Isidora Antonia De Leon Feliz (Nuris) is now the chair of the Los Toros Water Committee. Contact needs to be made with her.

Appendix B

*Schematic of source collection tank**



- Water enters into Compartment 1 through a 12"-16" hole in the side of the compartment wall. This water is presumably collected from the river via a network of pipes underneath the riverbed. The water is then diverted into this compartment.
- It was reported (unconfirmed) that the water in Compartment 1 enters into a pipe that is buried below Compartment 2 and begins its trip to the PST.
- The purposes of Compartments 2 & 3 are undetermined, though Compartment 3 has pipes and valves at the bottom.
- Width = 16' 8"
- Length (long side) = 16'
- Length (short side) = 12' 5"
- Depth (estimate) = 10'

*Not to scale