



**Comments on the Addenda to the Environmental Impact Assessment (EIA) for the
Proposed Ara Macao Development, South Stann Creek, Belize**

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1. The Addenda fail to assess whether its proposed rate of groundwater withdrawal is sustainable

Aquifers are not stand-alone components of the environment, but interact with other components, such as rainfall patterns, surface water and surface activities, such as construction. In order to evaluate the potential impacts of proposed groundwater abstraction, the AM developers must consider a number of inter-relating factors. Among these factors is the recharge rate of the aquifer. According to a recent treatise on groundwater withdrawal and environmental sustainability:

“Estimating recharge is critical in any analysis of ground-water systems and the impacts of withdrawing native water from them. In water-resource investigations, ground-water models are often used to simulate the flow of water in aquifers, and, when calibrated, may be used to predict long-term behavior of an aquifer under various management schemes. Without a good estimate of recharge and its spatio-temporal distribution, these models become unreliable. Accurate estimates of recharge and recharge mechanisms also are necessary to assess the risk of ground-water contamination, particularly diffuse agricultural contamination (such as from nitrates and pesticides). Clearly, understanding recharge is critical to managing most ground-water systems.

“Under natural or virgin conditions and over long periods of time (before any development), ground-water recharge is balanced by ground-water discharge, i.e., $\text{Recharge} = \text{Discharge}$. Because ground water is nearly always moving, it will naturally flow from the recharge areas to the discharge areas. The discharge from the aquifers may occur in a variety of ways such as flow to streams, lakes, and springs; water use (transpiration) by phreatophytic vegetation that draws its water from the water table or its capillary fringe; evaporation from playas and areas of very shallow water table; leakage to adjacent aquifers; or flow to the sea.

“Pumping ground water constitutes an additional withdrawal from the system that was in a natural state of balance under virgin conditions. In order for the system to reach a new equilibrium (a state of sustainability), the pumping must either cause the recharge to increase, and/or it must cause the discharge to decrease. Ground-water pumping usually has little impact on the recharge, especially under arid and semiarid conditions with deep water tables, because recharge is determined mostly by climatic conditions, although in areas of intense irrigation, return flows to the underlying aquifer could be significant. Pumping, however, can decrease ground-water discharge by lowering shallow water tables, thus reducing ground-water evapotranspiration and seepage to streams, springs, lakes, or wetlands. In hydrogeologic terms, pumping can capture ground-water discharge. The position of the water table, which normally reflects the distribution of the recharge and discharge areas, as well as the geometry of the aquifer and its hydrogeologic properties, will change as the system adjusts to the change in discharge. Thus, declines in ground-water levels are not necessarily an indication that the sustainable yield of an aquifer is being exceeded, but simply that the water

balance has been altered (Cook et al., 2001), and may reflect a temporary decrease in aquifer storage that occurs before a new equilibrium is established.

“In order for a ground-water system to be sustainable, pumping must be balanced by an equal capture of discharge and/or recharge. If pumping exceeds the total amount of natural recharge or discharge from the system, ground-water mining occurs, and the system is no longer sustainable. However, even without regard to the environment, it is not always possible to extract all of the natural aquifer recharge or discharge. In some cases, wells will run dry before natural ground-water discharges are reduced to zero. The fraction of recharge that can theoretically be extracted from an aquifer under steady-state conditions will depend on the geometry of the aquifer system, and, in particular, on the location of the pumping wells relative to the natural recharge and discharge zones. Therefore, the sustainable yield of aquifers, and thus the environmental impact of ground-water extraction, depends not only upon the volume extracted, but also on the location of pumping wells relative to recharge and discharge areas, and sometimes also on the timing of the extraction. Prediction of environmental impacts of ground-water extraction always requires detailed investigation of natural ground-water recharge and discharge processes. ...”¹

The first section of the Addendum is titled: “Ara Macao Aquifer Pumping Tests.” This section of the Addendum reaches the following conclusions (on pages 14-15):

The Ara Macao wells 1A and 1B have the capacity to provide and suffice the entire project with the required 210 gal min⁻¹ and more.

Drawdown in the confined aquifer will not adversely affect other users with a 3 kilometer radius of the wells.

The production from well 1A can be increased without reducing the elevation of the potentiometric surface.

There are no hydrogeologic barriers within the radius of influence of well 1A. Pumping at the test rate will not adversely impact the excellent quality of the water.

There is limited or no recharge of the aquifer from overlying aquifers, aquicludes, streams or lagoon systems. Recharge is via the expose aquifer near the contact surface with the Maya Mountains.

These conclusions are made on the basis of data from a single pumping test performed in June 2006 that is deficient for the purpose of assessing whether the proposed abstraction 324,000 gallon per day is environmentally sustainable. That is, the data is insufficient to support the above conclusions.

¹ Sophocleous, M.A. (2004) “Introduction to ground-water recharge, discharge, and sustainability.” <http://www.kgs.ku.edu/Hydro/Publications/2004/Bull249/contents.html>

1.1. The EIA contains no information about the recharge rate of the aquifer

As noted above, comparing the proposed withdrawal rate with the recharge rate of the aquifer is an essential component of an analysis to determine whether the proposed abstraction 324,000 gallon per day is environmentally sustainable. There are methods for the estimating the recharge rate of an aquifer.² It is not possible to determine a water budget for an aquifer without information about its recharge rate.

A 24-hour pump test is not a method for estimating the recharge rate of an aquifer. It is only a method for measuring the amount of drawdown the withdrawal will cause at a specific point in time (the day of the test), but does not answer whether the proposed withdrawal is sustainable in the *long-term* (several years or decades).

Understanding the recharge rate of the aquifer the Ara Macao project would rely upon is particularly important given the fact that the aquifer is confined. Little, if any, of the water abstracted for the Ara Macao project would return to replenish the aquifer.

1.2. The EIA contains no information about how the proposed withdrawal would impact the water table after an extensive drought

Aquifer recharge rates vary over time: lower during dry season and higher during rainy season. When assessing the sustainability of a proposed withdrawal of groundwater, it is essential to assess what will happen during an extensive drought.

In the United States, projects involving a proposal to abstract groundwater are the subject of state regulations that require a groundwater withdrawal permit. For example, in the State of New Hampshire, any person proposing a large groundwater withdrawal (a withdrawal of 57,600 gallons per day)³ must obtain a permit to do so. A rule adopted by the State of New Hampshire in 2001 describes the hydrogeologic analysis a person applying for a large groundwater withdrawal permit must submit:

(c) To obtain and maintain a permit to develop a new withdrawal, the applicant shall complete the following process: ...

(2) Develop a conceptual hydrologic model of the withdrawal in accordance with Env-Ws 388.06;⁴

The conceptual hydrologic model for the proposed groundwater abstraction must meet the following requirements:

² Sophocleous, M.A. (2004) "Introduction to ground-water recharge, discharge, and sustainability. Appendix A: Physical Methods for Recharge Estimation."
<http://www.kgs.ku.edu/Hydro/Publications/2004/Bull249/appendixa.html>

³ The AM developer proposed to abstract 324,000 gallons of water per day.

⁴ Env-Ws 388 Rule for Major Groundwater Withdrawal at Env-Ws 388.04 Requirements for Major Withdrawals. http://www.des.state.nh.us/Rules/adopt_388.pdf

(i) The conceptual hydrologic model shall include: ...

(3) Delineated extents of the study area, with *the assumption of a conceptual hydrologic model condition of 180 days of continuous pumping at maximum volumes without recharge from rainfall or snowmelt, including all of the following items*: a. The maximum extent of the cone of depression created by the withdrawal; b. The maximum extent of the recharge area for the withdrawal; and c. The downgradient area of the withdrawal. ...

(1) A description of the hydrologic cycle and a water budget calculation for the study area shall be prepared that describes: (1) *The amounts and timing of precipitation, runoff, storage, recharge, and discharge*; (2) The distribution and availability of water necessary to maintain natural resources, existing water uses, and the proposed withdrawal; and (3) The location and amounts of natural and artificial loss of water, consumption, discharge, and recharge of water to and from the study area.⁵

The analysis provided by the AM developers falls far short of what would be required to obtain a groundwater use permit in the United States. There is no assessment of conditions during an extensive drought (*180 days of continuous pumping at maximum volumes without recharge from rainfall*).

For example, the single, 24-hour pump test that the AM developers conducted from June 5-6 is during one of the wettest periods of the year in Belize. The consultants might well have found a very different drawdown had they conducted the pump test in early April, immediately after the dry months of February and March.

2. The Addenda fail to assess the extent of beach erosion on properties south of the proposed development

There are computer models the developers could use to predict the change in beach morphology that would result from construction of the marina and jetties. One of the models most commonly used in EIAs for shoreline projects is the GENESIS (GENERALized Model for SIMulating Shoreline Change) model developed by the U.S. Army Corps of Engineers. Using site-specific information, such as bathymetric data, sand quality data, wave heights, etc., the GENESIS model “simulates the long-term platform evolution of the beach in response to imposed wave conditions, *coastal structures*, and other engineering activity (e.g., beach nourishment).” The U.S. Army Corps of Engineers has a website from which the developers could download the GENESIS model and receive documentation and support about how to use the model to predict the shoreline response of building a marina and jetties at the proposed Ara Macao resort in Placencia.

⁵ Env-Ws 388 Rule for Major Groundwater Withdrawal . http://www.des.state.nh.us/Rules/adopt_388.pdf

In my view, the prospective developers must use the GENESIS computer model now, as part of this EIA process, to provide adjacent property owners and government decision-makers, adequate information about how the shoreline would respond to the proposed construction of the marina and jetties.

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