ENVIRONMENTAL IMPACT STATEMENT

SUITABILITY OF A QUARRY NEAR AKUMAL AS A SITE FOR THE PROPOSED COMMUNITY CONSTRUCTED WETLAND AND MATERIALS RECOVERY CENTER

Introduction

It has been proposed by Centro Ecologico Akumal that a quarry located immediately west of Highway 307 near Akumal in the State of Quintana Roo be used as a site for a proposed community-scale constructed wetland and materials recovery center. A constructed wetland is a sewage treatment facility based on natural processes that will extract pathogens and nutrients from the sewage and prevent these from reaching the ground water table and contaminating the coastal bays. Such contamination can endanger human health and cause eutrophication of the coastal waters and death of fish, coral and other organisms that live there.

Wetlands consist of sealed concrete containers several meters or more in length and width. These are fitted with slotted pipe and filled with clean gravel. Plants are set into the gravel. Sewage from a settling tank, which removes large solids, flows through the pipes and into the gravel where bacteria destroy dangerous pathogens and plants take up over fifty percent of the liquid and extract phosphorous and nitrogen (Nelson, 1998). The effluent from the tank will have coliform, an indicator of sewage pollution, in the tens of millions in each 100 milliliters. The effluent passes to a second wetland stage where the process is repeated. The final discharge, based on experience at Akumal from wetlands built for homes and restaurants, has a reduced coliform count of 500 to 2000 coliform per 100 milliliters. When the reduced volume of effluent is taken into account, the reduction of total coliform is close to 99.99% (Nelson, 1998).

While the reduction in coliform levels is impressive, a spill or a leak in the seal of the wetland structure could result in serious contamination of groundwater flowing beneath the wetland site. It is important, therefore, that the site chosen is able to contain such a spill and that the rock strata beneath the wetland be of very low permeability to prevent downward leaching.

Because the proposed area is a quarry from which sascab has been mined, the forest cover has long since been removed and the local ecosystem once existing at the quarry site no longer exists. Thus, from the perspective of

protection of existing forest ecosystems, the quarry is preferable to opening a new site that would destroy additional forest.

This report focuses on the geological suitability of the site as a place where accidents, should they occur, will cause the least damage. The importance of protecting the ground water has been demonstrated recently in the area near the Ponderosa Cenote, north of Puerto Aventuras, where dark liquid has contaminated the saline water in the cenote. A coliform count of 200 was obtained from samples taken after most of the dark water had dissipated. While the contamination level was not huge, it does suggest the possibility of a leak from a sewage treatment facility.

Location and Dimensions

The quarry is located on the west side of Highway 307 approximately one kilometer north of the entrance to the Pueblo of Nuevo Akumal. It covers approximately 18.7 hectares and measures approximately 799.2 meters in a northeasterly direction by 234 meters in a westerly direction. The quarry is between four and six meters deep from rim to floor. Figure 1[1] is a map showing detailed dimensions. The CEA proposal would place a materials recovery center in the south portion of the quarry and the wetland in the central and northerly portions. Details of the proposal may be found in the paper by K. S. Robinhawk (1999).

Criteria

The proposed wetlands should be located in an area where the bedrock is low in porosity and permeability and is lacking in large fractures or cenotes. In the limestone terrain of the Yucatán Peninsula this means that it should be an area where dissolution of the bedrock is minimal.

General Geology of the Region

Over much of the peninsula, the land surface is pitted with circular depressions called sinkholes formed by collapse of the surface rock when supporting rock below the surface is dissolved away. The result is a highly porous surface and subsurface through which rainwater drains to the ocean without the development of streams and rivers. Where the sinkholes are deep enough to penetrate the water table, they are called cenotes.

The least dissolved limestones on the Yucatán Peninsula are mostly found close to the coast where the most recently deposited limestones occur

[1] Figures are available from Centro Ecologico Akumal

(Perry and others, 1989). It may be appreciated that the older strata that are found inland have had a longer period of time to dissolve and the most fully developed underground caves and channels through which ground water can drain is found in these older rocks. The most recently deposited limestones near the modern coast have had much less time to develop solution channels, although older, more dissolved limestones underlie the coastal rocks at depths of ten or twenty meters.

Limestone in the Akumal Quarry

For the purposes of this report, the limestones in the Akumal quarry may be divided into three parts from the top of the quarry to the bottom. The uppermost limestone in the quarry consists of one meter of very hard, well-cemented, cream-colored limestone that contains few fossils and, where undisturbed, contains few fractures and even fewer openings formed by dissolution. One small cavern less than a meter in diameter may be seen near the top of the east wall of the quarry.

Below the hard cap lies five meters, more or less, of soft limestone composed mostly of crushed and whole fossil shell material. The sediments are well sorted to poorly sorted and coarse to fine in grain size, depending on location within the quarry. Figure 2 is a topographic map showing the quarry and the surrounding area. It can be seen that the quarry lies within a large triangular hill that protrudes eastward toward the coast from a persistent ridge line that may be followed unbroken from Puerto Aventuras to just south of Xel Ha, after which, though present, is much less prominent. The triangular hill is one of several that occur in the coastal area and almost all of the quarries in the area are within these sedimentary features (Shaw, 1997).

The third unit underlies the quarry floor and is a second hard caprock, much like the one forming the topmost unit. Like the upper cap, the lower one is hard, well cemented, has few fractures and only one known cenote, a small opening one-half meter in diameter which penetrated the water table less than a meter below the quarry floor.

The Quarry Floor

The floor of the quarry presently is covered with a thin layer of sascab left from recent quarry operations during the construction of the new highway in 1998 and 1999. The quarry was first opened in the late 1970s when the original highway was built between Cancun and Chetumal. Before the quarry was reopened for the present highway the floor was clear of debris and was clearly exposed. Observations made before 1998 showed a

very hard, well cemented surface with no observable fractures. One small cenote was present, as noted above. For two years measurements were made of ground water levels in that cenote as part of a study carried out by Centro Ecologico Akumal. Water levels fluctuated by around 20 centimeters over that period and never rose above the quarry floor.

Rainfall onto the quarry floor accumulated in large and small ponds a few centimeters deep and remained so until the water evaporated. There was no suggestion that ponded water was able to drain through the quarry floor. All evidence indicates the quarry floor is very tight and would make an excellent seal should contaminated water ever breach a wetland or a tank leak into the quarry floor.

Ground Penetrating Radar

To further check on the thickness and continuity of the quarry floor, a series of profiles were made using ground penetrating radar through the generosity of Dr. Larry Brown of Cornell University. Figure 3 shows the results from three parallel lines, each about 100 meters in length and separated by one meter. This configuration gives a three-dimensional sample of the continuity of the caprock in the midpart of the quarry. The continuous red and blue lines along the top of the profiles indicate continuous reflection of energy from the hard cap and that the cap is continuous and perhaps a meter or so thick. Deeper reflections may be seen indicating deeper layers, but many of these curve downward after a short distance, a phenomenon typical of a layer that terminates abruptly, such as one cut off by a cave, a small channel or a sudden change in the degree of cementation. With more refined computer processing, Dr. Brown thinks it might be possible to distinguish caves from other features.

Despite uncertainties of interpretation below the cap rock, it can be confidently inferred that the caprock in the quarry floor is continuous over the area of the survey and that significant fractures are absent. This is in agreement with observation of the top of the floor.

Recommendations

On the basis of field observations and ground penetrating radar data, it is concluded that:

1. The quarry is an almost ideal site for the proposed wetlands and that accidents, should they occur, are unlikely to penetrate the quarry floor owing to the thick, well-cemented limestone that underlies it. A similar condition is

probable in other quarries in the immediate area based on similar hard caprock observed in their floors.

2. It is strongly recommended that landfills or other facilities with the potential of releasing contaminated liquids into the water table be located west of the coastal ridge only after the most careful consideration. West of the ridge older strata are exposed at the surface and even casual inspection on the ground or on aerial photographs shows widespread dissolution features that may be expected to connect directly to the underground drainage system.

3. There is no forest ecosystem in the quarries to be damaged.

4. A materials recovery center, developed as in the CEA proposal (Robinhawk, 1999) with only clean dry waste, can offer no threat to the groundwater, even if the ground below it were porous.

5. Compost as described in the proposal should be protected so that leachate cannot escape to the quarry floor, as for example when rainfall soaks in to the compost. Although the sealed floor will prevent fluids from draining downward, contamination of the quarry floor should be avoided.

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