SUPPORTING INFORMATION REGARDING HEALTH AND WATER QUALITY CONSIDERATIONS

Introduction

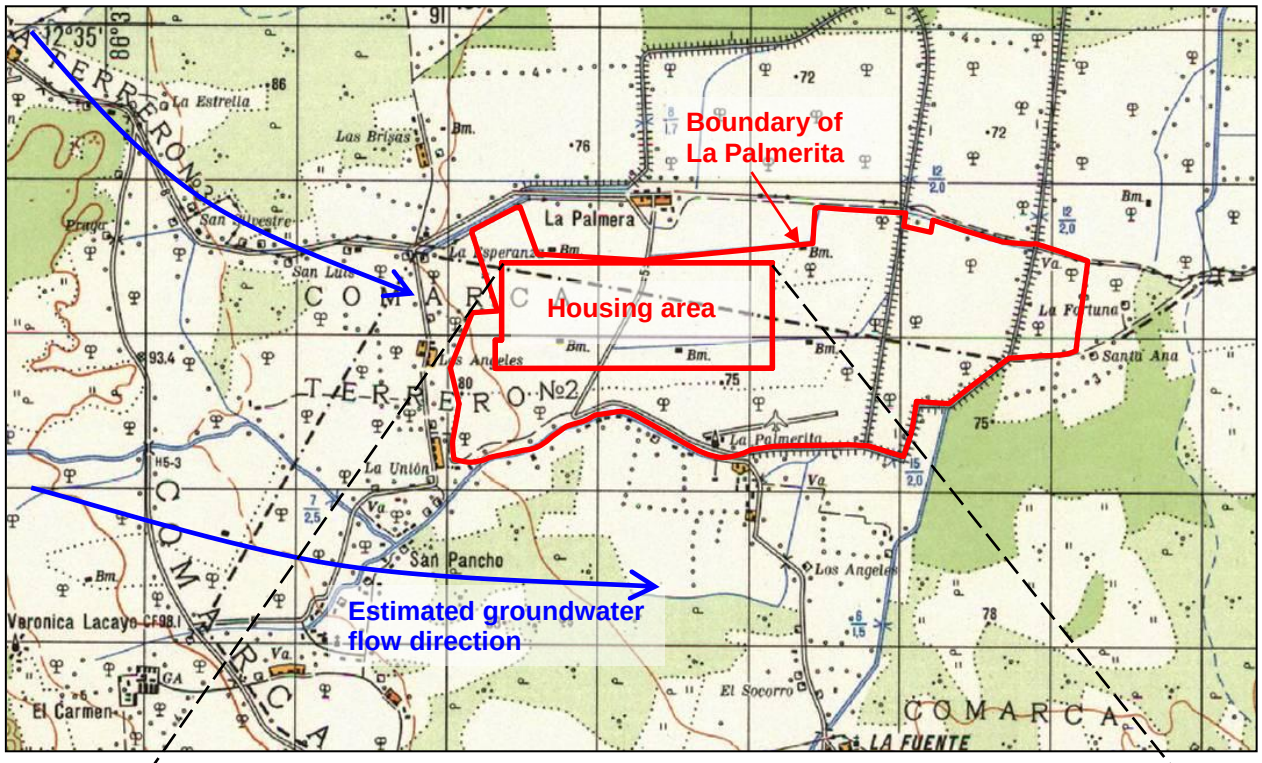
The proposed water supply project for La Palmerita was first designed in 2005. It was presented to CARE in 2006 by Nuevas Esperanzas and several revisions have been made subsequently to the project proposal. The proposal presented is for a borehole with electric submersible pump, water tower and piped distribution system with metered connections at each house. In support of the project as originally proposed, a hydrogeological study was prepared in November 2005. Although the concept of the original project has not changed, subsequent developments at the site such as the excavation of hand-dug wells for irrigation in most lots have affected the justification for the project. Whilst the socio-economic analysis of the project proposal clearly demonstrates the feasibility of the proposal in terms of both the capital investment and the operation and maintenance costs, some doubts have been expressed about the necessity for the project and the willingness of the beneficiaries to pay for a piped water supply now that each beneficiary family has their own well.

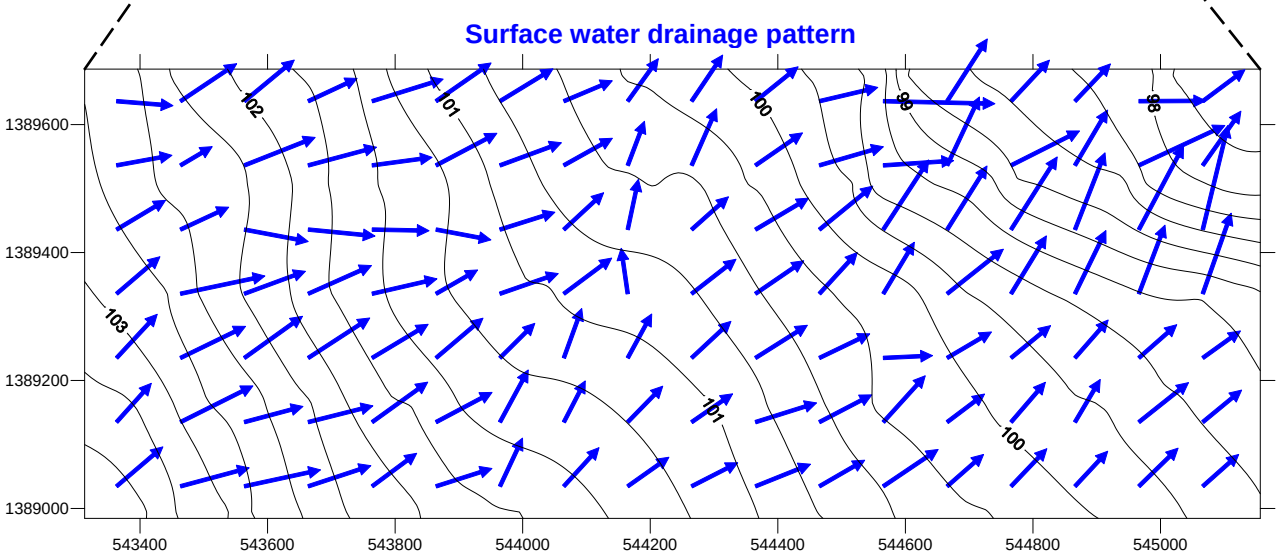
This document presents a further justification for the project based on health and water quality considerations. This document supplements the information provided in the hydrogeological study of November 2005, including subsequent bacteriological data and health statistics. Information provided in the original study on pesticides, arsenic and physico-chemical parameters is still valid.

Hydrogeological context

La Palmerita is underlain by an unconfined aquifer comprised of unconsolidated and semi-consolidated Quaternary alluvium including some re-worked pyroclastic sediments, conglomerates, pumice and ash. This aquifer generally has high porosity and permeability. Groundwater contours on the published map (*Estudios Hidrogeológicos e Hidroquímicos de la Región del Pacífico de Nicaragua* by Krasny & Hecht, INETER, 1998) indicate that the groundwater level is between 70 and 80 m.a.s.l. and that it is between 3 m and 20 m below ground level. Wells on and close to the site record depths to water of between 7 m and 12 m. The high permeability of the aquifer, coupled with the shallow depth of the water table indicates that this aquifer has high vulnerability. As the unsaturated zone is both thin and highly permeable, attenuation of faecal contamination from superficial sources (livestock and open field defecation by humans) and shallow buried sources (latrines) will be limited. It is possible that faecal contamination will pass relatively quickly to the saturated zone where it would spread according to patterns of groundwater flow.

As indicated on the map below, groundwater flow is generally towards the east where it discharges into the influent lower reaches of the Rio Sinecapa, but as the site lies close to an inferred groundwater divide it is possible that local patterns of groundwater flow may be different. A study of superficial drainage patterns within the housing area (shown below) indicates that surface water will flow in a similar direction to that of groundwater. This means that both groundwater and surface water will transport contaminants in an easterly direction.





Existing groundwater abstractions

At the time of the previous hydrogeological assessment there were three large diameter irrigation wells at La Palmerita itself, drilled around 30 years ago by Riegos de Nicaragua, two 6 inch irrigation wells drilled in November 2002 by Mercy Ships Nicaragua and around six hand-dug wells. No details are available for the large irrigation wells, but the two wells drilled by Mercy Ships Nicaragua were to depths of 70 and 120 ft respectively. The old irrigation wells were previously fitted with rotary pumps but the pumps were removed by the community and the wells are no longer in use. One of the wells drilled in 2002 has a windpump but the other is not currently in use. The hand dug wells excavated before 2005 have either rope pumps or buckets and some are covered.

In 2006, around 100 wells were constructed at La Palmerita, financed by Medico Internacional. These wells were intended for irrigation and, as such, were not constructed with sanitary linings or seals. Most wells now have concrete covers and are equipped with rope pumps. Some of the wells are located away from the houses at the back of the lots, providing easy access for irrigation, but others were constructed adjacent to the houses and close to existing and future latrines. In the absence of progress on the piped water supply project, the community uses these wells for household supply, including drinking and cooking.

Water Quality

A review of data relating to water quality was given in the previous hydrogeological assessment. The information given here relates only to bacteriological contamination, which has been monitored at the site since 2002.

Microbiological analyses of samples from hand-dug wells from July 2002 until September 2003 using the Oxfam-DelAgua field testing kit showed levels of *Escherichia coli* of between 16/100 ml and 570/100 ml with lower levels recorded in the months after well rehabilitation work had been undertaken. Analysis of water abstracted by the windpump installed on an irrigation borehole in September 2003, showed very high levels of faecal contamination with 1100 *E. coli* /100 ml. By contrast, the other 6 inch irrigation well drilled in 2002 was unused and sealed and this showed 1 *E. coli*/100 ml.

Analyses of water samples from hand-dug wells in June 2006 showed levels of contamination considerably worse than those previously recorded. Six wells were sampled and one additional sample was taken from one of the large diameter irrigation wells which was being used for drinking water. Three of the wells were covered and sealed with a concrete slab and the other three had only temporary corrugated iron covers. Levels of contamination ranged from 6 *E. coli*/100 ml to 2500 *E. coli*/100 ml, with an average of over 1000 *E. coli*/100 ml for both covered and uncovered wells. The most contaminated well was one which was protected with a concrete slab and appeared to be well kept. The drilled irrigation well contained 500 *E. coli*/100 ml.

A further analysis was undertaken in August 2007 of 12 wells at La Palmerita. 11 of the 12 wells sampled were equipped with hand pumps, financed by Medico Internacional. These included wells constructed 2-4 months before samples were taken and also wells constructed 2 years earlier. One well was open with a bucket used to collect water. Levels of contamination ranged from <10 *E. coli*/100 ml to 830 *E. coli*/100 ml (the open well with bucket). Three wells had <10 *E. coli*/100 ml, four wells had 10-100 *E. coli*/100 ml and five wells had >100 *E. coli*/100 ml. Although this represents a significant improvement on the wells sampled in 2006, faecal coliform counts still indicate relatively high levels of contamination in most wells.

Faecal contamination, as evidenced by the presence of *Escherichia coli*, may be caused by direct contamination of wells through handling of pumps and buckets, or it may come from sources of groundwater contamination such as latrines or open field defecation. In the previous hydrogeological assessment it was stated that the analysis suggested that contamination was most likely to have come from direct sources. In general, this conclusion is supported by the more recent data, although the fact that protected wells with concrete covers have had faecal coliform counts of up to 2500 *E. coli*/100 ml may indicate that the groundwater itself within the housing area is also contaminated.

Since groundwater flow is towards the east, the only part of the site which can be regarded as at low risk from faecal contamination is the small piece of land between the western boundary of the site and the housing area. This is the location of the proposed borehole. There are no houses or latrines within the site to the west of this location and outside the boundary of La Palmerita, housing is much more dispersed.

Health considerations

Baesline information and health statistics specific to La Palmerita are not available from MINSA. However, monthly clinics are held by MINSA at the site and anecdotal information was provided by the visiting doctor (Dra Iris Rosales) and the health team. The most prevalent diseases were considered to be:

1. Respiratory infections
2. Diarrhoeal diseases
3. Skin infections
4. Parasitic infections (especially *Giardia* and *Ascaris lumbricoides*)

Despite the proliferation of mosquito larvae observed in water containers at the site, neither dengue fever nor malaria is considered a particular problem.

It is likely that inadequate water and sanitation is a major factor contributing to the prevalence of both diarrhoeal diseases and parasites. *Giardia* is a faecal-oral protozoan disease transmitted through contaminated water supplies and poor hygiene; *Ascaris lumbricoides* is a soil transmitted helminth and its prevalence at La Palmerita is most likely to be related to inadequate sanitation.

It should be noted that *Giardia* is resistant to chlorination and thus disinfection of the existing wells is unlikely to be effective.

Conclusions and recommendations

The relatively shallow depth to water at La Palmerita and the high permeability of the aquifer means that the aquifer should be regarded as highly vulnerable. Existing wells contain unacceptably high levels of faecal coliforms, even those with reasonable protection. Faecal-oral diseases such as *Giardia* and diarrhoea are prevalent at La Palmerita. Protection of the water source is considered more feasible than remediation measures to improve the quality of the existing sources and it is recommended that a communal source is developed in a protected area away from latrines and other sources of contamination. Groundwater flow and surface water drainage are from west to east and therefore the area to the west of the housing is at lowest risk from faecal contamination caused by latrines within the site.

The proposed borehole, water tower and distribution system should be considered the most cost effective means of providing potable water to the community, given the vulnerability of the aquifer to contamination. The existing wells are not adequate to meet the INAA standard of 0 *E. coli*/100 ml (Normas Técnicas para el Diseño de Abastecimiento y Potabilización del Agua, NTON 09003-99) and are unlikely to meet the more relaxed operational target of 10 *E. coli*/100 ml for untreated rural water supplies in the long term. The health risk of the existing water supply is considerable and it should be noted that diseases such as cholera and typhoid could spread rapidly were anyone from the community to become infected.

It is recommended that the borehole be sited to the west of the housing development, up-gradient of latrines and other sources of contamination. It is also recommended that a protected area around the borehole be established and protected with barbed wire. Finally, it is recommended that a means of chlorination be included in the design for the system. At pH 7.3-8.3, groundwater at La Palmerita falls within limits for effective chlorination.

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