2.5 Características Fisiográficas

El desarrollo de la infraestructura es dinámico. El mismo evoluciona con el crecimiento y el desarrollo de la sociedad, el surgimiento de nuevas tecnologías y las exigencias de la reglamentación ambiental. La infraestructura es determinante en la actividad económica y la calidad de vida. A continuación se describe la situación de la infraestructura en el Municipio de Comerío, así como los proyectos planificados y en construcción para optimizar la misma. La información de los proyectos planificados y en construcción ha sido provista por las agencias pertinentes. Véase Figura 20, Infraestructura Principal del Municipio de Comerío.

- **Energía Eléctrica**

El Municipio de Comerío fue pionero en el establecimiento de la primera planta de energía hidroeléctrica en Puerto Rico. Esta se construyó en el año 1910 y llegó a suplir electricidad a 30 municipios en toda la Isla. La misma se encuentra localizada en el Barrio Cedrito a orillas del Río La Plata. En el año 1955, el servicio de riego pasó a formar parte de la Autoridad de Fuentes Fluviales (hoy Autoridad de Energía Eléctrica). Sin embargo, ante el precio más bajo del petróleo, se abandonó el sistema hidroeléctrico. Actualmente, la represa está en desuso y en proceso de remodelación.

Sobre Comerío cruza parte del sistema de transmisión del área Central-Este de la Isla. Entre las líneas que cruzan el municipio encontramos una línea de 115 KVA (kilovatios-Amper) y seis líneas de 38 KVA (Véase Figura 20, Infraestructura Principal del Municipio de Comerío). El circuito de 115 KVA está complementado por el sistema de sub-transmisión de 38 KVA, el cual alimenta las principales instalaciones de distribución del Municipio de Comerío. La línea 3,800 sale de la seccionadora de Comerío hacia el de centro de transmisión de Cayey. Las líneas 4,000 y 4,100 KVA salen del patio de interruptores de la Planta Comerío 2 hacia el Municipio de Bayamón para alimentar diversas estaciones del mismo. De igual forma, la línea 5,200 sale de Comerío hacia el centro de transmisión de Caguas.

Las líneas 6,500 y 7,700 KVA son líneas de transmisión que alimentan la sub-estación de distribución de Comerío. La primera proviene de Toro Negro en Villalba y la segunda sale de Comerío hasta la subestación #9703 siendo esta la línea primaria de servicio al municipio.
El Municipio de Comerío cuenta con la siguiente sub-estación de distribución:

- Sub-estación 9703 (SUB-9703) - Comerío
- Localización: en el Residencial Pasarell, Comerío
- Transformador de 38/8.32 KV
- Capacidad: 10500 KVA
- Tres alimentadores de distribución

Mediante carta del 8 de junio de 2004, la Autoridad de Energía Eléctrica (AEE) informó sobre la infraestructura existente en el Municipio de Comerío, así como el programa de mejoras capitales para los años fiscales 2004-2008. Ver Apéndice 2, Cartas de Agencias.

La capacidad de las líneas eléctricas de Comerío satisface a grandes rasgos la demanda actual de consumo. Sin embargo, para poder desarrollar en el municipio áreas industriales y nuevas áreas de crecimiento poblacional resulta necesario el establecimiento de nuevas sub-estaciones de potencia. Debemos recordar que la falta de infraestructura de energía eléctrica adecuada redundará en mayores costos a los desarrollos que se lleven a cabo.

CN 078-04479
REV. 11/05

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AUTORIDAD DE ENERGÍA ELÉCTRICA DE PUERTO RICO

SAN JUAN, PUERTO RICO

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APARTADO 364267
CORREO GENERAL
SAN JUAN, PUERTO RICO 00936-4267

15 de octubre de 2007

Sr. José M. Nieves
Director
Ordenamiento Territorial
Gobierno Municipal de Comerío
PO Box 1108
Comerío, PR 00782

Estimado señor Nieves:

RE: Declaración de Impacto Ambiental Estratégica (DIA-E)
Plan de Ordenación Territorial (POT)
Municipio de Comerío

Revisamos el documento ambiental de referencia. En el mismo se propone un Plan de Ordenación Territorial (POT) en el Municipio de Comerío (MC) para establecer la clasificación y calificación de los terrenos para dirigir el desarrollo social y económico del MC. No tenemos objeción al mismo siempre y cuando la acción se lleve a cabo según descrita en el POT.

El Programa de Mejoras Capitales (PMC) de la Autoridad de Energía Eléctrica (AEE), según está contemplado en el Contrato de Fideicomiso de 1974, requiere que se provea capacidad generatriz adicional al sistema eléctrico y las extensiones necesarias a las líneas de transmisión y distribución del sistema. La Junta de Gobierno de la AEE revisa y aprueba anualmente este Programa. El mismo está sujeto a cambios de acuerdo con las necesidades del sistema eléctrico y la capacidad financiera de la AEE. Por lo tanto, la AEE se reserva el derecho de reprogramar los proyectos, modificar el alcance de los mismos y eliminarlos del PMC en caso de que su ejecución ya no sea justificada. Incluimos copia de nuestro PMC para los años fiscales 2008 al 2012 para el MC.

Este proyecto no se ha sometido para la evaluación eléctrica correspondiente. De surgir cambios en la DIA-E que puedan afectar nuestra infraestructura, deberá comunicarse con el ingeniero Raúl Burgos Santiago, Superintendente, Departamento

de Ingeniería de Distribución de la Región de Caguas, por el (787) 745-7912. Dicho funcionario lo asesorará sobre los documentos necesarios para completar dicho proceso.

De necesitar más información al respecto, puede comunicarse con el ingeniero Jaime A. Plaza, Jefe, División de Protección Ambiental y Confiabilidad de Calidad, por el (787) 289-4959.

Cordialmente,

Por:
Juan F. Alicea Flores, Director
Planificación y Protección Ambiental

Anejo

AUTORIDAD DE ENERGÍA ELÉCTRICA
PROGRAMA DE MEJORAS CAPITALES
AÑOS FISCALES 2008 AL 2012*
($ EN MILES)

MUNICIPIO DE COMERÍO ***AÑO FISCAL***

LOCALIZACIÓN	*NÚM.*	*PROYECTO*	*2008*	*2009*	*2010*	*2011*	*2012*	*TOTAL*
BARRIO PUEBLO	12642	AUMENTO DE CAPACIDAD DEL ALIMENTADOR 9703-	0	0	169	183	200	552
BARRIO PUEBLO	16198	RECONSTRUCCIÓN DE LA LÍNEA 400	0	0	0	3,015	3,000	6,015
BARRIO RIO HONDO	16615	MEJORAS DEL ALIMENTADOR 9703-1	0	170	0	0	0	170
		TOTAL	$0	$170	$169	$3,198	$3,200	$6,737

* El año fiscal 2008 comienza el 1 de julio de 2007 y termina el 30 de junio de 2008.

25 de Junio de 2007

Gilbert Heriberto G.

HON. JOSE A. SANTIAGO RIVERA
ALCALDE
MUNICIPIO DE COMERÍO
PO BOX 1108 COMERÍO, P. R.
00782

REF. COMENTARIOS DECLARACIÓN DE IMPACTO AMBIENTAL ESTRATÉGICO DEL PLAN DE ORDENAMIENTO TERRITORIAL DE COMERÍO

La Oficina para Salud Ambiental, región de Bayamón, evaluó el documento de referencia y tiene los siguientes comentarios:

- ✓ Para los proyectos de construcción tales como viviendas, parques de bombas, cementerios y escuelas, deberán someter los planos por individual a la oficina de Ingeniería Sanitaria para su facturación y endoso.

Relacionado al contenido adicional del documento, no tenemos comentarios adicionales.

Director Regional
Salud Ambiental, Bayamón

C/c Sr. Alfredo Casta Vélez
Secretario Auxiliar para Salud Ambiental

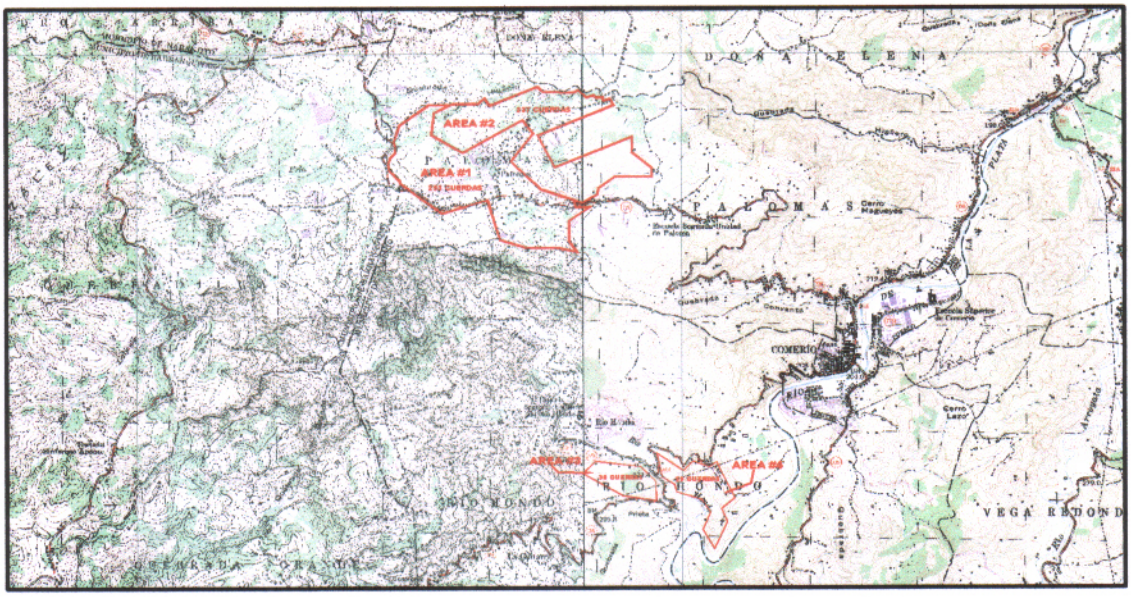
OFICINA DEL ALCALDE
JUL 10 2007
RECIBIDO

Apéndice 3:

Evaluación Hidrológica

MUNICIPALITY OF COMERIO
COMERIO, PUERTO RICO

EVALUATION OF THE IMPACT TO THE HYDROLOGY FROM THE DEVELOPMENT OF FOUR AREAS COMERIO, PUERTO RICO



June, 2006

CA Engineering

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Website: http//:www.ca-eng.com
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MUNICIPALITY OF COMERIO
EVALUATION OF THE IMPACT TO THE HYDROLOGY FROM THE DEVELOPMENT OF FOUR AREAS

Casiano Ancalle, P.E.

May, 2006

I. INTRODUCTION

Municipality of Comerio wants to know the impact to the hydrologic conditions of Río La Plata watershed from the areas the Municipality of Comerio zoned as for urban development. Figure 1 shows the location of these areas.

Comerio is located in the valley along the course of Rio de La Plata. The valley formed by this river is characterized by being constrained by an abrupt topography, which makes expansion of the urban area difficult. The neighboring terrains are not much different. Hills with steep slopes are predominant in all areas of possible urban expansion. Even though some areas have been selected for development and have been zoned as programmed urban soil and non-programmed urban soil. Besides, the Municipality of Comerio is an important souce of water supply, as three reservoirs are located downstream. The combination of the necessity of land for development and the need to keep water quality and quantity at high standards makes necessary a hydrologic assessment that would give clues of the impact to the water bodies from the development. On this perspective, several topics related to the hydrology of these areas are focus of this assesment: The water bodies, the storm watercourses, groundwater, floodability, and sediment transport .

1.1 Authorization

The elaboration of this report has been authorized by Ms. Iana Martinez on behalf of the

owner; under an agreement signed with Mr. Casiano Ancalle, Principal of CA Engineering.

II. PROJECT DESCRIPTION

2.1 Areas Planned for Development

Comerio has a mountainous topography with abundant steep slope terrains, unsuitable for urban development due to the difficulties of access, cost of earth stabilization, cost of foundations, and wastewater disposal. This factors combined with environmental considerations leave few areas for urban expansion. The Municipality of Comerio identified four areas for development, three of them as “Suelo Urbanizable Programado” and one as “Suelo Urbanizable No Programado”. Areas #1 and #2 are located at state road PR-779 at Palomas, at the northwest of the Municipality of Comerio. Areas 3 and 4 are located at State road PR-156, at Rio Hondo, southwest of Comerio. Figure 2 shows the location of all these areas and the following Table 1 shows their characteristics.

Table 1
Characteristics

	AREA	CLASSIFICATION
	Cuerdas	
Area 1	293	Programado
Area 2	237	No Programado
Area 3	38	Programado
Area 4	59	Programado

2.2 Topography

Areas #1 and #2 slope from southwest to northeast, and they are located between elevations of 600 and 500 meters above mean sea level. Area #3 is at the top of a hill, slopes to the southwest, and is located between elevations 320 to 250. And Area #4 slopes from northeast

to southeast, and it is located between elevations 300 and 250 meters.

III. HYDROLOGY

3.1 General

The areas of future urban development will affect two waterbodies: Quebrada Higuero and Río Hondo, both tributaries of Río La Plata. Surface runoff form Areas #1 and #2 drain to Quebrada Higüero; and runoff from Areas #3 and #4 to Rio Hondo. Figure 3 shows the areas of development in relation to the waterbodies to which they drain.

3.1.1 Rainfall

There is no a single rain gages at the area of the project. Precipitation data from NOAA's Station Toa Baja 1 SSW, Located at Latitude 18º26' and Longitude 66º16' in Toa Baja, Puerto Rico is included herein for reference. The monthly precipitation data during the period of 1990 to 1994 show its lowest in august 1993 with 1.09 inches; and its highest in October 1990 with and as much as 12.33 inches. The annual average for 1990 and 1991 are 71.7 and 48.9 inches respectively, there area no averages for 1992-1994. Appendix A includes this data obtained from NOAA.

The portion of the isohyetal map for Puerto Rico covering this watershed is shown in Figure 4 (Black & Veatch, 1970). Based on the isohyetal map the mean annual rainfall in the area of the project is about 75 inches/year.

Rainfall depths as a function of rainfall duration and frequency of occurrence were obtained from the Technical Paper No. 42 (TP-42) [National Weather Service. The rainfall events of 2 through 100-years frequency for different durations for the area of the project are shown in Table 2.

Table 2
Rainfall Depths (Inches)

Duration (hours)	**Frequency**				
	2-Year	*10-year*	*25-year*	*50-year*	*100 Years*
1	2.3	3.3	3.8	4.3	4.75
2	2.78	4.25	4.8	5.5	6.2
3	3.2	4.7	5.5	6.3	7.0
6	3.7	5.7	6.8	7.8	8.8
12	4.25	7.1	8.25	9.25	10.5
24	5.25	8.25	9.8	11.2	12.2

3.1.2 Runoff

The project area is located in Río La Plata Basin, but no rainfall gages are found in the immediate neighborhood. The USGS has a streamflow gage and sediment station in the Rio La Plata (gage 50043800). This gage is located on Latitude 18º13’23” longitude 66º13’30”, 0.6 kilometers southwest of Comerio High School and 0.3 kilometers northeast of Plaza de Comerio, at bridge 15 meters off state road PR-167. This location is indicated in Figures 5. Mean annual runoff at this gage averages 85,240 Acre-ft/year, equivalent to an average of 14.73 inches of annual rainfall between 1989-1996. According to the USGS Water Resources Data Puerto Rico and the Virgin Islands annual reports, the drainage area of this gage is 109 square miles.

The amount of sediments reported in the USGS record is 803,575 tons per the year starting on October 1995 and ending in September 1996.

3.1.3 Soils

The classification of the soil of the site is included in the Soil Survey of the San Juan Area of Puerto Rico. This study was made for the Soil Conservation Service in cooperation with the University of Puerto Rico in 1972. According to this study, the soils found in the areas were identified as Daguey Clay, Humatas Clay, Urban Land Vega Alta complex, Aibonito Clay and Maricao Clay. The most predominant type found was Humatas Clay with more of the 50 percent of the total area. A more detailed classification is shown in Table 2, Table 3, Table 4 and Table 5. Figure 6 shows the site in a partial copy of the map of the Soil Survey of San Juan Area of Puerto Rico.

Table 3: Soils Classification of Area #1

Name	Description	Area (cdas)	%
DaC	Daguey Clay 2 to 12% slopes	.98	.003
DaD	Daguey Clay 12 to 20% slopes	86.62	30
HtE	Humatas Clay 20 to 40% slopes	113.55	38
HtF	Humatas Clay 40 to 60% slopes	49.18	17
MxE	Mucara Clay 20 to 40% slopes	8.62	3
Uv	Urban Land Vega Alta complex	34.05	12

Table 4: Soils Classification of Area #2

Name	Description	Area (cdas)	%
MxD	Mucara Clay 12 to 20% slopes	8.13	21
MxF	Mucara Clay 40 to 60% slopes	29.87	79

Table 5: Soils Classification of Area #3

Name	Description	Area (cdas)	%
CaF	Caguabo Clay Loam 40 to 60% slopes	38.88	66
MxE	Mucara Clay 20 to 40% slopes	12.01	20
MxF	Mucara Clay 40 to 60% slopes	8.11	14

Table 6: **Soils**

Name	Description	Area (cdas)	%
AbD	Aibonito Clay 12 to 20% slopes	3.02	1
DaC	Daguey Clay 2 to 12% slopes	0.97	.004
DaD	Daguey Clay 12 to 20% slopes	32.02	14
HtE	Humatas Clay 20 to 40% slopes	126.81	54
HtF	Humatas Clay 40 to 60% slopes	32.53	14
MoF	Maricao Clay 20 to 60% slopes	4.67	2
MxE	Mucara Clay 20 to 40% slopes	7.93	3
MxF	Mucara Clay 40 to 60% slopes	29.05	12

Classification of Area #4

3.1.4 Annual Runoff

Mean annual precipitation is about 65 inches/year as gotten from Figure 4.The relation runoff to precipitation at this area was set at 0.65 as corresponding to the area's curve number of 75. Then, the amount of surface runoff produced by the drainage area in annual basis will be 716,300 gallons a day. Mean discharge was estimated for the purpose of showing the magnitude of the water course. The relationship used was developed by U.S. Army Corps of Engineers and is expressed by the following formula:

$$Q_a = 0.73*A^{0.760}*S^{-0.250}*(\text{Index}-75)^{1.07}$$

where: A = Watershed area, mi^2
S = Main channel slope, m/m
Index = Climatic index
Q_a = Mean annual discharge, cfs.

Climate index taken from the climate index map for PR is 100. Therefore, mean discharge using this formula yields 3.3 cfs..

Computations are included in Appendix B

3.1.5 Water Quality

There are no water quality records at the watercourses neighboring the development sites. The nearest USGS water quality station in located one, Gage 0440, upstream Comerio reservoir; and other, Gage 0430 way upstream of the sites in consideration. Quality records are included in Appendix B

3.1.6 Flooding

All of the areas are not classified as floodable by the FEMA's Flood Insurance Rate Map, sheet 1160, 1180, 1205 April 2005, as shown in Figure 7.

3.1.7 Ground water

Ground water is a significant abstraction to precipitation. The amount of ground water depends on the permeability of the soil. The water that permeates the subsoil usually accumulates and forms a water table, which is the ground water piezometric line. The slope of the water table indicates the direction of the groundwater movement. Ground water surfaces the ground when the ground elevation intersects the water table.

There are no records of water table at the areas of development. However, there are no registered water wells at the project site.

3.2 Water Bodies

Thought the surface runoff from the areas of development is related to water bodies, few water bodies exist within the limits of the sites of development. Areas 1 and 2 contain two water bodies born on the site. Runoff on the areas of development is mostly spread along the surface, as sheet flow, concentrating only at the points of discharge.

There are several storm watercourses to which the development areas will discharge. However two are the main. Runoff from Areas 1 & 2 discharge to Quebrada Higuero and runoff from areas 3 & 4 to Río Hondo; Quebrada Higuero as well as Río Hondo are tributaries to Rio La Plata. Figure 3 includes the location of these water bodies.

3.2.1 Quebrada Higüero

Quebrada Higuero runs from west to east to discharge at Río La Plata. Its nascents area located west of its 3.58 square miles drainage area. The topography of the drainage area is uneven in which steep slopes are abundant, and storm watercourses are numerous. Most of

the area is undeveloped. The area planned for development, Areas 1&2, are located to the southwest of the drainage area. Figure 8 shows the drainage area belonging to Quebrada Higuero.

3.2.2 Rio Hondo

Rio Hondo is a main tributary to Rio La Plata. Its drainage area covers a 10.65 square miles terrain characterized for being hilly with steep slopes, heavy vegetation, and numerous storm watercourses that spread disorderly in the mountainous topography. Watercourses run from west to east as well as from east to west; and from north to south as well as from south to north. But the general direction of Rio Hondo is from west to east. Areas of development 3&4 are located within the watershed of Río Hondo. Figure 8 pictures the flow patterns of Río Hondo as well as its drainage area.

3.2.3. Rio La Plata

Rio La Plata is the main water body in the Municipality of Comerio. Its drainage area starts at the water divide south of Lago Carite and ends at the Atlantic Ocean. In addition to Lago Carite, which has been diverted to Lago Toa Vaca in Villalba, Rio La Plata has three areas of impoundment: Two small dams at Comerio, and a major one at Lago La Plata.
The drainage area at PR-2, at Station 50046000 is 208 square miles, at damsite (Lago La Plata), Station 50045000, 181 square miles, and at Comerio, Sta 50043800, 109 square miles.
Rio La Plata is one of the main water supply for the metropolitan area of San Juan.

IV. POSSIBLE IMPACTS

The development of the areas indicated in Chapter 2 will change the surface characteristics of the natural topography and so will introduce changes in the local hydrology of the site, which will rebound in changes in the overall hydrology of the receiving water bodies and ultimately in the hydrology of Río La Plata.

Apart of the environmental significance of the waters related to the areas of development, these waters use is mainly for water supply for domestic use. The existing of three reservoirs is indicative of this use. Then quality and quantity of water are of concern.

4.1 The Area of Development in Relation to the Concerned Watersheds

Considering that the drainage area for Quebrada Higuero is 2,290 acres and the areas of development 1&2 are 515 acres, and considering a linear relation between drainage area and discharge, only in a 22.5 per cent the waters being conveyed by Quebrada Higuero will be impacted. Similarily, the waters of Rio Hondo will be impacted by the development of Areas 3&4. The drainage area for Rio Hondo is 6,814 acres and the areas of development 3&4 are 94.17 acres, then 1.38 percent of Río Hondo will be impacted by the development. A larger view of the impact can be obtained in relation the whole Río La Plata watershed. The four areas planned for development total about 646 acres. Taking into consideration that the drainage area of Rio La Plata is 69,759.72 acres, and considering that the hydrologic loads are proportional to the drainage areas, only 0.93 percent of the waters running Río La Plata system will be impacted by the proposed areas of development. Assuming that all urban waters area fully loaded with organic and inorganic contaminants, with concentrations similar to that in industrial wastewater, dilution would reduce the impact to traceable levels that would not be harmful when used for human consumption.

4.2 Rerouting Storm Water Courses

The development will require the original courses to be rerouted except for the watercourses that qualify as water bodies. Earth movement necessary for laying out the development are expected to affect the original storm water courses, and new storm water courses will be necessary. These water courses will be piped by storm collectors located in the streets, in such a way that open spaces over the pipes are provided for emergency overflow. Rerouting of the storm watercourses will be done in accordance with Puerto Rico Planning Regulation No. 13. Water surface levels, at the immediate upstream property, will not increased by the rerouting structures.

4.3 Runoff Increase Mitigation

The development will increase the peak discharge. The original pervious soil will be substituted by impervious roofs and, walkways and streets resulting in an increment of the runoff-rainfall ratio, thus in the peak discharge. The effect of the increment of the peak discharge can produce adverse effects on the downstream. The Puerto Rico Planning Board Regulation No. 3 calls for mitigation of this increment. Therefore, the development of the site will include runoff increment mitigation structures in conformance with said state regulation.

4.4 Sediment Transport

Two stages of sediment transport are considered: Transport during the erection of the development and after the project construction activities are completed.

During construction, a great amount of material is loosened. This material is mainly composed of suspended and settleable solids. Any rainfall event has the potential to transport material to the downstream. To counter act this possibility, the areas of construction will be provided with appropriate solids capture structures: Sedimentation ponds, hen pack barriers, etc. On the permitting aspect, a CES plan conforming the requirements of the Puerto Rico Environmental Quality Board will be prepared, as well as a Storm Pollution Prevention Plan conforming EPA's requirements. The solids control structures will have dimensions and hydraulic characteristics to guarantee good solids capture rate.

After the construction activities are completed, the topographic contexture of the site will be in such a way that the whole area will be formed by stable terrains, few grassed slopes, concrete roofs and paved streets. Thus, the potential of erosion will be diminished: The horizontal terrains will produce low runoff velocities and no loose material will be exposed to the dynamic action of the running storm water.

4.5. Water Quality

In consideration of the typical activities given at developed areas, it is inferred that the water does not get contaminated to the point that it useless for drinking water. The activities found in the catchment basin are mostly domestic. Organic contaminants can be expected from failing septic tanks. Traces of agricultural chemical products may also exist. But outside of them, no significant polluting industrial activity is found.

Solids capture normally goes on as the water gets in contact with the soil. In any natural system, the rainfall runoff migrating to the ocean picks up dissolved solids (DS), suspended

solids (SS). Since rainfall is the product of condensation of evaporated water, when it reaches the earth crush, it is essentially distilled water, with no solids. Distilled water is chemically active. This property plus the erosive forces generated by the water movement ere responsible for solids capture. A certain amounts of dissolved solids are necessary for buffering the chemical capacity of the rainfall water. As runoff progresses within the project site, it is expected DS capture, for water stabilization.

4.6 Groundwater

The amount of water, with or without the development, will be the same because waters are not being withdrawn from the watersheds, nor waters are being added into. The impact of the development will then be local, in the way these waters recharge the aquifers, and on the quality these water posses after being in contact with the activities common to urbanized areas.

The development will produce more runoff than that of the natural condition. Rainfall waters that are naturally entering into the subsoil to recharge ground water will be forced to run over the surface as surface runoff. Then, the ratio ground water to surface runoff will be lowered as a consequent effect of the development. Without extensive field studies, it is difficult to estimate the degree of change in this relation. But approximate estimations can be done starting from the soil characteristics and its capability to capture water when subject to rainfall.

The effect of the development in the groundwater will be local, at the development site. The amount of groundwater will recover on the downstream of the areas of development.

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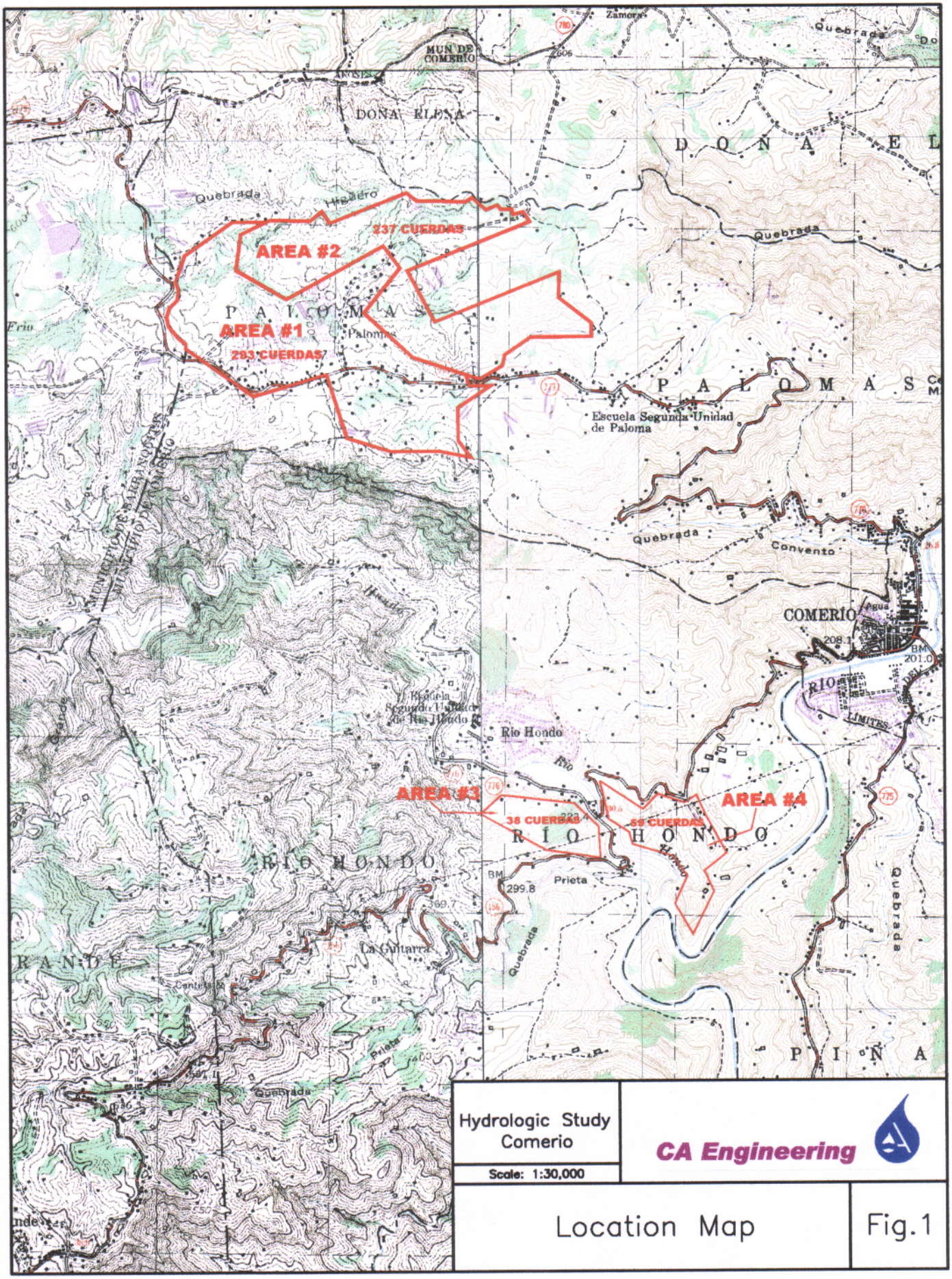
FIGURES



Hydrologic Study Comerio	CA Engineering
Scale: 1:30,000	
Location Map	Fig.1