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EL TORITO - LOS VEGANOS

HYDROELECTRIC COMPLEX DEVELOPMENT PROJECT

ON UPPER YUNA RIVER

FEASIBILITY REPORT

VOL. III ANNEX

D. GEOLOGY

E. CONSTRUCTION MATERIALS

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JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX D

ANNEX - D

GEOLOGY

Table of Contents

List of Tables

List of Figures

D. GEOLOGY

D.1 INTRODUCTION

D.1.1 Scope of Study

The geologic investigations have been performed extensively and intensively in and around the study area of El Torito-Los Veganos hydroelectric complex.

Prior to this feasibility study, the project area was primarily mapped on geology by G. O. Bowin's academic research (1966), which covered the central part of the Dominican Republic. He established the stratigraphic sequence and described the rock facies of each stratum. (This feasibility will follow the criteria and nomenclature established by G. O. Bowin to mention the geology in the study area.) In 1980-81, CDE-ENEL executed a prefeasiblity study on the hydroelectric development in the Yuna river basin. In the study, the project area was geologically mapped out on the basis of 1/25,000 topographic map, and engineering geologic aspects were preliminarily studied upon several alternative plans.

A variety of alternative development plans have been conceived in the course of the feasibility study on El Torito-Los Veganos complex, and the geologic investigations covered an extensive area in the upper Yuna river basin. To cover the major alternative structure sites, focuses of the geologic investigations have been placed on the following sites:

El Torito:

- Alternative damsites: T1, T2, T3 (saddle dam) and T4 (weir site)
- Headrace tunnel route and its inlet
- No. 1 Surge tank, penstock and power house
- Intake weir
- Quarry site

Los Veganos:

Alternative damsites: V1, V2 and V3 (weir site)
Headrace tunnel route and its inlet
No. 2 Surge tank, penstock and power house
Intake weir
Quarry site

The geologic investigations have been principally executed through surface geologic mapping, geophysical exploration and core drilling. The surface geologic mapping in and around the study area has been perfomed on the basis of 1/5,000 scaled topographic map and 1/20,000 scaled aerial photographs. A total of about 27 km^2 have been mapped out. The reservoir area of each alternative damsite (T-1, T-2, T-4, V-1 and V-2) has also been investigated on the basis of 1/5,000 scaled topographic map. At the alternative damsites (T-1, T-2, V-1 and V-2), geologic mapping has been executed on the basis of 1/1,000 scaled topographic maps.

The geophysical exploration has also been executed at major structure sites for El Torito scheme and Los Veganos scheme, by means of seismic prospecting in refraction method. A total of 42 lines with a length 12,520 m have been explored and interpreted for El Torito-Los Veganos complex. (Refer to Table D-01)

Core drilling, including permeability test and standard penetration test, has been carried out at major structure sites by JICA drilling team and CDE subcontracted Geocivil team. A total of 1,441.05 m have been drilled at 37 holes. Permeability test and standard penetration test have been performed 143 times and 227 times, respectively. (Refer to Table D-02)

Further, Computerized Seismic Monitoring System (COSMOS) of CDE has been operating since December 1979, which is composed of one (1) central recording station and fifteen (15) remote stations. The central recording station is located near the Tavera Damsite and some of the network systems are involved in the study area. The data obtained until the end of March 1982 have been analyzed to determine earthquake acceleration for dam design of this project.

D.1.2 Investigation Tactics

(1) Geologic Mapping:

Ground surface investigation is made to observe outcrop and non-outcrop, as well as land form in the study area. Prior to field execution, aerial photos have been interpreted in terms of lineament, general trend of geologic structure and distribution, landslide and so forth. Observation of outcrop and non-outcrop involves the following:

Outcrop:

Rock facies:	- kind of rock - dip and strike, conformity or unconformity - fault and joint (direction, continuation, frequency and kind) - bedding plane and foliation (direction, stretch, exfoliation) - age of formation
Rock quality:	- weathering and deterioration - cracks - unusual phenomena (alteration, etc.)
Structural geology:	- fault (direction, continuation, disturbed zone, fault clay) - folding (sycline, anticline, microfolding, flexure)

Non-outcrop:

Overburden:	- kinds - origin - characters - distribution and thickness - vegetation

Thirty three (33) rock samples are petrographically checked under microscope to reveal detailed texture and component mineral of the rock. The results are described in Table D-03 to D-05.

(2) Geophysical Exploration:

Seismic exploration is programmed to investigate engineering geology at damsite, tunnel route and penstock line. The exploration is executed by refraction method, using such instruments as geophones, transmitting cables,

amplifier, oscillograph recorder and electric blaster. These instruments are capable in the field to produce visual printed record of seismic waves received by geophones. The record has the time mark of 1/100 second and the shot-mark indicating the instant of explosion.

Exploration line is set straight. Pegs indicating the receiving point of seismic waves is placed on the ground at intervals of 5.0 m in horizon, and numbered continuously from the beginning to the end of the line. The elevation of each peg is measured by means of levelling or stadia survey to draw topographic profile along the lines on the scale of 1/500.

Shooting is carried out with the underground or underwater explosion, using dynamite and electric instantaneous detonator. In case of the underground explosion, hand-dug pit is excavated to the safe depth in accordance with the geological condition and with the quantity of explosives to be charged in the shot-point. The field execution to date shows that consuming rate per one (1) km of seismic exploration line is 12 kg of dynamite and 60 pieces of detonator.

Observation is made to obtain complete coverage over the line. The line is divided into the "spreads" of geophones, corresponding to 24 channels of amplifier. The beginning point of the spread overlaps with the end point of the spread previously observed, in order to obtain a continuous travel time curve covering the entire line. Each spread is covered by, at least, three pairs of orderly and reverse travel time curves of a pair of inset shootings and two pairs of in-line offset shooting. Interval of shot point for inset shooting is less than the length of a spread in case of the length being less than 60 m, and it is less than a half of the length of a spread in case of the length being more than 60 m. Intervals of shot points for in-line offset shooting is more than 120 m.

The travel time curve and the velocity layer profile along each exploration line, indicating the velocity of seismic wave and interface of the layers, are obtained. The scale of profile is 1/500. The ground surface line of the profile is drawn on the basis of the result of survey on receiving points. For interpretation of seismic record, the travel time calculation of the ray path in the fixed velocity layer model is indicated on the profile.

(3) Core Drilling:

To carry out the core drilling, a joint work has been programmed by CDE retained drilling team and JICA drilling team. The drill machines are two TDC-1G (TONE) by JICA and two Longyear 34 and one Craelius by CDE Team. Drilling of bore holes, associated with standard penetration test and permeability test, is made at major structure sites. Technical specifications for drilling of bore holes, standard penetration test and permeability test are briefly presented hereinafter.

Drilling of bore holes is executed with rotary drilling machines to obtain samples and cores. The initial diameter of bore holes is changed according to geologic condition but the final diameter of bit is 55 mm by JICA team and 69.9 mm (NQ) by CDE team. Core recovery is calculated in every one (1) meter of a drilled depth. Rock Quality Designation (RQD) is also calculated in every one (1) meter by applying the formula as follows:

$$RQD = l/L \times 100 \ (\%)$$

where, l = total length of cylindric cores longer than 10 cm
L = total core length

Standard Penetration Test (SPT) is carried out in the formation of overburden and weathered zone, at intervals of one (1) or 0.5 meter in depth or at each change of materials in soil layers. In the bedrock, permeability test is performed at intervals of five (5) meters in depth.

Standard penetration test (SPT) is done to verify "N-value" and to obtain representative disturbed samples of the soil layers. The N-value is used to outline subsurface conditions with respect to bearing capacity for foundation design. The N-value is expressed as the number of blows when a 63.5 kg hammer drops freely by 75 cm, until the sampler penetrates by 30 cm into the soil.

The drilled core is classified in accordance with the criteria for rock grade classification (Refer to Table D-06), which is based on hardness, weathering, crack spacing and other conditions of drilled core. In general, the rocks designated as CL and D grades are not durable enough for dam

foundation and the grade D is generally incompetent for basements of such structures as surge tank, penstock and power house, except for highly stiff decomposed zone. Therefore, rocks classified into such a grade should be excavated down to sound rock surface. Further, water table change is noted in drill logs, because it reflects the geohydrologic condition of subsurface rock. The geology, change of water table, core recovery, RQD, SPT and PT are to be described in the drill logs.

(4) Water Pressure Test:

Water pressure test is performed to get the Lugeon Unit and coefficient of permeability of strata. (In unhomogeneous rock formations, however, the coefficient of permeability is not determined.) The test is executed at intervals of five (5) meters in depth or less. The injection water is clean, without any fine materials.

After setting the instruments, water is supplied for more than 10 minutes under the pressure of less than 1 kg/cm^2 at the hole mouth. Subsequently, measuring of water injection is started at the required pressure at 1, 3, 6, 8 and 10 kg/cm^2 and subsequently 10, 8, 6, 3 and 1 kg/cm^2 in order. Injection for each pressure is continued at least 10 minutes. Reading of water meter is made at every minute.

The Lugeon unit is decided by the "Pressure-Injection Quantity Diagram" or in accordance with the following formula:

a) When injection data at the injection head of 10 kg/cm^2 (pumping pressure plus static head) are available:

$$Lu = \frac{q}{L}$$

where: Lu = Lugeon unit (l/min/m/10 kg/cm^2)

q = constant injection quantity at injection head of 10 kg/cm^2 (l/min)

L = test length (m)

b) When injection data at the injection head of 10 kg/cm^2 are unavailable:

$$Lu = \frac{10\,Q}{HL}$$

where: Lu = Lugeon unit

Q = constant injection quantity (l/min)

L = test length (m)

H = injection head (kg/cm^2)

$H = p + (Hs + Hg) \times 0.1 - Hf$

where:

P = pressure gauge reading (kg/cm^2)
Hs = static head (m)
Hg = gauge height (m)
Hf = friction head loss of injection pipe (kg/cm^2)

The coefficient of permeability is calculated as follows:

$$k = \frac{Q}{2\pi LH} \ln \frac{L}{r} \qquad L \geqq 10\ r$$

$$k = \frac{Q}{2\pi LH} \sin h^{-1} \frac{L}{2r} \qquad 10\ r > L \geqq r$$

where: k = coefficient of permeability (cm/sec)

Q = constant injection quantity (cm^3/sec)

L = length of test section (cm)

r = radius of hole (cm)

H = differential water head (cm)

$H = p + Hs + Hg - Hf$

where

p = pressure gauge reading
Hs = static head
Hg = gauge height
Hf = friction head loss of injection pipe

D.2 REGIONAL GEOLOGY

D.2.1 Physiography

The project area occupies the eastern edge of the Cordillera Central mountaneous massif. The highest peak of the area rises up to 1,649 m above mean sea level, whereas the lowest land is approximately 350 m near the village of Boca de Tireo. The mountain ranges bordering the south of the project area show open hyperbolic curve, dividing La Vega Province to the north and Peravia Province to the south. Yuna river flows down, in general, from south to north, which seems to be well-matched with a consequent river. From upstream to downstream, the Yuna river is confluent from tributaries (arroyo), such as A. Blanco, A. Colorado, R. Tireo and A. Avispa. Sporadic terrace deposits are developed along the river course, which rise for about 10 m at maximum from the present river level. It is attributable to the phenomena that the river has been intensively incised during uplift movement in the Quaternary period, which is accompanied by intermittent stable duration of the land. The Yuna river shows its tortuous way at places, where fractured zone caused by fault is observable.

The mountain slopes in the range of 30° to 40° in the western half of the area where the Duarte Formation and the Tireo Formation are dominant. While in the eastern part where the Plutonic igneous rocks prevail, the mountain shows gentle appearance of slope.

Aerial photo interpretation indicates that lineaments with north-south direction are predominant,which are followed by east-westward lineaments. The former matches the general trend of strike of fault or bedding and schistosity of the Duarte Formation and the Tireo Formation.

Landeslide and surface erosion occur particularly in the area where the Duarte Formation is distributed. It is anticipated that exfoliation structure caused by fault and schistosity of the formation is responsible for the massif movement. Consequently, fan detritus is sporadically discernible at the mouth of tributaries.

Old river terrace and its surrounding mountainslope are used mostly

for coffee cultivation, where several small villages are scattered. The forest of mountain flank is widely cleared away for reasons of shifting cultivation. It is inferred that this land reform may pull a trigger on surface erosion, followed by subsequent debris feeding, which are seen at places in the study area.

D.2.2 Stratigraphy

The geology in the study area is divided into the Duarte Formation, the Tireo Formation, the Plutonic igneous rocks, Terrace deposit, Debris and River bed, in an ascending order. The geologic age of the Duarte Formation is uncertain, according to the previous studies, but it is considered to be Pre-Middle Albian (uppermost of Lower Cretaceous) after G. O. Bowin (1966). The Tireo Formation is identified to be upper Cretaceous sediments by fossils. The Plutonic igneous rocks are not positioned in geologic age, but are inferred to be successive phase of the Duarte Formation or to be slightly younger. The stratigraphic sequence is shown on Table D-07.

(1) Duarte Formation:

The Duarte Formation is composed of three rock facies: a) gneiss, b) amphibolite, foliated diorite and peridotite and c) green schist.

According to the detailed petrographic studies, the Duarte Formation shows a systematic pattern of metamorphism which was probably caused by the anatexis (a high temperature metamorphic process by which the plutonic rock in the deeper levels of the crust is dissolved and regenerated as a magma) in the regional metamorphism. High grade metamorphic rocks of diorite, gneiss and amphibolite occupying the eastern part of the Duarte Formation are in intrusion contact (?) with the Plutonic igneous batholith. On the amphibolite of immediate surrounding of the contact, however, no contact metamorphism is petrographically discernible under microscope. In other words, the biotite mineral originated from thermal metamorphism is not observable. Further, the geologic outcrop shows an ambiguous contact between the Duarte Formation and the Plutonic igneous rocks. Consequently, the relation may be attributable to the transitional change. On the other hand, low grade metamorphic rocks formed of several kinds of schists are distributed in the western part.

The Duarte Formation is in thrust fault contact with the Tireo Formation in the northern part of the study area, and is accompanied by a fractured zone of approximately 15 meters in thickness at maximum. To the south, however, the fractured zone gradually pinches out and eventually the Duarte Formation have upturned the Tireo Formation near the village of Los Veganos.

a) Gneiss shows the highest metamorphism grade of the Duarte Formation and crops out in the vicinity of Pino de Yuna and T-1 damsite. Gneiss has extremely foliated texture and is composed of coarse grained constituent minerals of hornblende, chlorite, epidote, mica, plagioclase and quartz. Residual soil is found on the surface of weathered gneiss. Gneiss and amphibolite are in fault contact with green schist. Fractured zone is estimated to reach approximately 30 meters in thickness at maximum.

b) Amphibolite, associated with subordinate foliated diorite and peridotite are distributed in the uppermost part of the Yuna river basin and in the surroundings of El Torito. The rock is cut by several faults trending north to south. Two kinds of textures with microcrystalline and foliated are recognized in amphibolite, which is accompanied by altered zone at places especially in T-2 damsite. The foliation trends NE to SW.

c) Green schist is distributed throughout the study area from El Torito to Piedra Gorda, having a general trend of schistosity of N to S in the downstream and NW to SE in the upstream. The rock is intensively schistosed and exfoliated near Piedra Gorda, but rather massive facies are dominant in other area except for some sporadic spot.

(2) Plutonic Igneous Rocks (quartz diorite):

Judging from the fact that the quartz diorite shows concordant texture at the contact with amphibolite, it appears that the quartz diorite was emplaced in the geologic age similar to the period when the Duarte Formation was formed. This implies that the quartz diorite was re-melted and re-consolidated in deep subsurface by the regional metamorphism. The quartz diorite is easily distinguishable from amphibolite in field appearance. Therefore, the both rocks are separated in the geologic map.

The plutonic igreous rocks were originally described as nolite by G. O. Bowin. Since the rock includes the different facies with non-banded and banded texture, however, nomenclature of quartz hornblende diorite is given in the report. The rock is generally coarse-grained holocrystalline and leucocratic.

The rock occupies the eastern part of the study area, where the watershed range with gentle slope runs approximately in the north to south direction. Further, the rock is widely decomposed into red clay in the adjoining area of Los Pejes village. The residual red clay is appropriate for borrow area of earth material of the dam.

(3) Tireo Formation:

The Tireo Formation crops out in the downstream part of the study area extending from Los Veganos to Piedra Gorda. The rock is made up mostly of pyroclastic and volcanic rocks such as tuff, tuff breccia, lapilli tuff and dacite, with subsidiary well-bedded sediments of limestone, slate, conglomerate, chert and sandstone. The Tireo Formation is believed to be late Cretaceous in age due to key foraminifera fossil found in the limestone. The Tireo Formation is inferred to be thrust over by the older Duarte Formation along the Bonao Fault which is traceable from Piedra Gorda as far as Los Veganos. The bedding plane shows a trend of NNW-SSE strike and dips 30° to 55° eastward. On the other hand, the Tireo Formation along the Tireo river trends NE and dips 20° to 30° southward. This difference is probably due to block movement broken by fault activity taking places mostly in parallel to the Bonao fault.

As in the case of the Duarte Formation, aerial photo interpretation shows that many lineaments are recognizable and most of them are explicable as the results of faulting. In addition to these prominent phenomena, a large number of landslides are distinguishable throughout the area of the Tireo Formation. It is uncertain, at this stage, if these faults and landslides will present serious problems to the project.

The Tireo Formation distributed near Los Veganos is characterized by the alternation of limestone and green pyroclastic rocks. Specially

corroded open crack is recognizable in bedded-limestone outcrop, showing high permeability on the basis of water pressure test in drill hole.

(4) Young Terrace Deposit:

It is composed of the terrace deposit, debris and present river deposit. The characteristics of the young terrace deposit are briefly summarized hereunder.

a) The terrace deposit is distributed mostly along the main stream of the Yuna river and is made up of uncemented loose mixture of sand, silt and gravel. The terrace deposit is divided into lower, middle and upper deposit, but the criteria of those are ambiguous. They are classified on the basis of the gap in elevation, where the terrace deposit exists. The highest terrace, which shows a biggest elevation gap above present river level, is observable on both riversides of the Yuna river near Piedra Gorda. The elevation gap reaches 60 m, which indicates the terrace was deposited in relatively older age than the middle and lower terraces. While, in the case of middle and lower terrace, the gap ranges in elevation from 5 to 30 m above present river leve. The terrace deposit offers power station site because of its flat topography and is assessable as aggregate materials of a dam.

b) Debris consists of loose and unconsolidated deposit of rock and soil, which is distributed in the toes of landslide massif and in the gentle slope fan caused by flood pour. In the geologic map, the debris with a relatively great extent is mapped. Some of the debris, which are distributed near damsites, are acceptable for earth materials of a dam.

c) Present river deposit forms the present river course, where most of the deposit underlies the water level. The deposit is made up of uncemented loose mixture of sand, silt and gravel. Consequently, the deposit can be evaluated as aggregate materials.

D.2.3 Tectonic Structure

The geology of the study area is characterized by faults, some of which are recognizable not only by air photo interpretation but also by field geologic survey. It is anticipated that major faults will have an engineering geologic effect on the project in terms of dam construction and tunnel excavation.

The major faults in the study area trend approximately north to south and dip at high angle in a range of 60° to 90°. The Bonao Fault, which is one of the principal fault or tectonic line in the Dominican Republic, extends north-southward through the study area. It is clearly recognizable that a conspicuous escarpment with a gap of approximately 300 m in elevation runs along the Bonao Fault in the left abutment near Los Quemados. The Fault is inferred to bevel the Yuna river at Piedra Gorda and stretch to the right abutment. Further, it is vertified by the outcrop that the Bonao Fault crosses Arroyo Avispa, approximately 1 km upstream from the confluence with the Yuna river. It is presumed that the Fault extends up to the vicinity of Los Veganos, bordering the Duarte Formation and the Tireo Formation.

The fractured zone of the Bonao Fault reaches about 12 m in thickness, judging from the inclined drilling executed at the Piedra Gorda damsite. However, the fractured zone gradually pinches out in the direction to the south, and it is inferred to be around 5 m in thickness near Los Veganos and eventually dies out. It is inferred that the fractured zone is reconsolidated after it was crushed, since the low velocity zone corresponding to the fractured zone demonstrates 2.4 to 3.0 km/sec and the drill core shows moderately hard rock regardless of its exfoliation texture.

Actually, the fractured zone accompanied by the Bonao Fault exists in the schist of the Duarte Formation, not in the very contact with the Tireo Formation. This is probably attributable to the difference of durabilities of the rocks against shear failure caused by compression stress.

The Bonao Fault is conceived to be reverse fault at its high angle area, while it is thrust at low angle area. It is anticipated that the

Bonao Fault was formed under the condition where horizontal compression dominated, which is consistent with subduction movement of the Atlantic plate against the Caribbean plate.

The second major fault (called El Torito Fault hereinafter) in the study area runs in parallel with the Yuna river in its upstream reach and probably extends as far as Arroyo Avispa. The fault dips nearly vertically, and it is accompanied by the fractured zone of approximately 30 meters in width at maximum. The exposute appearance and the elastic velocity value presented by low velocity zone reveal that the fractured zone may be re-consolidated after it was crashed. The river course is sporadically crooked because of the different durabilities of the rock affected by the faults.

D.3 ENGINEERING GEOLOGY

The engineering geologic conditions at the possible alternative structure sites are studied on the basis of the results of geologic investigations. The geologic map in the study area has been prepared as shown on Fig. D-01. The results of investigations are also presented as referred to in each paragraph.

D.3.1 Alternative Damsites in El Torito Area

(Reference)

Geologic map: Fig. D-02 and D-03

El Torito area is occupied by the Duarte Formation and the Plutonic igneous rocks. The former is composed of gneiss, amphibolite and green schist, whereas the latter comprises quartz diorite. Out of these rocks, amphibolite dominates on all the structure sites. The El Torito Fault extends in the north-south direction to the west of the area. Several landslides, accompanied by debris sediments, are observed. The river terrace deposits are distributed in the course of the Yuna river, with steps in different elevations.

(1) T-1 Damsite:

(Reference)

Geologic map:	Fig. D-02 and Fig. D-03
Profile:	Fig. D-04
Seismic profile:	Fig. D-14 and Fig. D-15
Drill log:	Log sheet DL-01 to DL-04
Water pressure test:	Table D-08 to Table D-11 Fig. D-31 to Fig. D-34

Four (4) drillings and five (5) geophysical interpretations reveal the engineering conditions of the damsite. The riverside and the both abutments are occupied by foliated and microcrystalline amphibolite, which strike ENE to WSW and dip 30° south in general trend of foliated plane. Joint is developed in parallel with foliated plane as well as in beveled direction of NW to SE. Joint is slightly open at exposures, but is estimated to be tight

in the intact rock, judging from the water pressure test.

Debris and overburden soil are approximately 5 m in depth from the ground surface in the left abutment, while they are less in the right abutment. Judging from the rock grade of the drilled core and the refraction interface by the geophysical exploration, it appears possible to construct a concrete gravity dam with a height of 60 to 70 meters. However, a rock fill dam is considered as more recommendable from the viewpoint of material availability and the associated economic cost.

For the construction of a rock fill-type dam, the core material is required to be embanked with great care so that differential settlement of core material is avoided after it is placed on the relatively steep abutments. Excavation depth of dam axis for a rock fill dam is approximately 15 m in the left abutment and 5 m in the right abutment.

Permeability is generally small, since the Lugeon unit ranges from 21 to 22.3 and water tables rise in elevation toward both abutment intact rocks. Further, the rock is groutable for waterstop.

(2) T-2 Damsite:

(Reference)

Geologic map:	Fig. D-02 and Fig. D-03
Profile:	Fig. D-05
Seismic profile:	Fig. D-16 to Fig. D-18
Drill log:	Log sheet DL-05 to DL-08
Water pressure test:	Table D-12 to Table D-15 Fig. D-35 to Fig. D-38

The site is geologically clarified by four (4) drillings and four (4) seismic line interpretation. A primary concern with the site is to ensure the extent and effect on the foundation rock (foliated and microcrystaline amphibolite) of the damsite affected by the El Torito Fault extending in the left abutment with a north-south strike.

A major fault of about 20 m in width is discernible not only by geology but also by seismic exploration at the higher portion of the left abutment. It is considered, however, that this fault has no serious effect on the surrounding rock near the damsite. On the basis of the results obtained by drilling and seismic exploration, a rock fill type dam is possible to be constructed within a limited height of 50 m to 60 m to specially avoid foundation excavation of the surrounding rock of the El Torito Fault.

However, drilling core indicated the fact that the amphibolite is altered and become cracky, being associated with some altered clay at places (e.g. TP-B3). Since Lugeon units by water pressure test are in a range of 2.4 to over 100, permeability is high as a whole, probably affected by frequent joint and alteration. Besides, critical pressure is observable at some stages of water pressure test, such as 5 kg/cm^2 in the 24 m to 30 m section in depth of drill hole T2-B2 and 9 to 10 kg/cm^2 in the 21 m to 40 m section of T2-B4. A critical pressure should be carefully checked in specifying grouting plan to stop seepage water of the basement rock.

The rock is more deeply decomposed and weathered if compared with T-1 damsite. Therefore, the basement rock should be excavated down to approximately 17 meters at maximum.

Water tables in drill holes of T2-B1 and T2-B3 are slightly higher than the river water level in elevation. Further, water level of T2-B2 is approximately 3 m high above the ground, showing a confined groundwater head. Therefore, a great care should be paid on curtain grouting treatment for water stop of the dam axis.

The landslide probably affected by the El Torito Fault exists immediately downstream from the dam axis. The excavation works of T-2 dam should not be extended to the toe of the landslide massif. This is another constraint to limit the height of T-2 dam. Further, landslides seen in the reservoir area should receive attention on mass movement by impounded water and sediment storage.

(3) T-3 Saddle Damsite:

(Reference)

Geologic map:	Fig. D-02 and Fig. D-03
Seismic profile:	Fig. D-18 and Fig. D-19
Drill log:	Log sheet DL-09

This site is checked by two (2) geophysical explorations, one (1) drilling and three (3) test pittings. Another drilling for material survey (TQ-B2) is also referred to. The results indicate that fractured zone is inferred at each abutment and that decomposed zone is as deep as about 25 m from the ground surface at each abutment. The weathered cracky rock is exposed at the col near the road. N-values are in a range of 5 to 45 until about 10 m in depth from the ground surface.

The result of survey demonstrates that construction of a low fill type dam is possible at this site. In case this site is used as an open channel connecting the reservoirs impounded by T-1 and T-2 dams, the decomposed zone is easy to be excavated, and the excavated debris may be used as impervious materials for dam embankment.

(4) T-4 Weir Site:

(Reference)

Geologic map:	Fig. D-02
Profile:	Fig. D-06
Seismic profile:	Fig. D-19 and Fig. D-20
Drill log:	Log sheet DL-10 and DL-11
Water pressure test:	Table D-16 and Table D-17 Fig. D-39

T-4 weir site is located approximately 0.8 km downstream from the confluence of the Yuna river and Arroyo Blanco. The riverbed is narrow, or 15 m in width. The right abutment shows a steep cliff of 40° dip, while the left abutment demonstrates a thin and a slightly gentle slope of 30° to 35° dip. The two transverse profiles with a 300 m spread each are geophysically explored and the two drillings are performed by CDE.

The site is geologically composed of gneiss, showing a remarkable foliation dipping to the right abutment. The gneiss crops out with fresh appearance in the riverside, as well as in the right abutment. However, in the left abutment where the decomposed zone is deep, residual red soil covers the slope surface. The drilling reveals that the thickness of the decomposed zone is approximately 6 m from the ground surface and the alluvial river gravel is 4.5 m in depth. On the basis of the geologic mapping of the adjacent area, the El Torito Fault with about 20 m in width is inferred to exist in the higher portion of the left abutment. Judging from the drilled core, though some portions show a very poor core recovery, several subordinate faults to the major fault are recognizable in gneiss of the riverside and the left abutment drillings.

It is concluded that the topographic and geologic conditions permit to construct a concrete weir with a height of 20 to 25 m at maximum.

D.3.2 Other Structure Sites for El Torito Scheme

Waterway works for El Torito scheme consist of a diversion tunnel from Arroyo Blanco to T-1 dam, an intake tunnel inlets and a headrace tunnel to Los Veganos. The former two structures are planned in amphibolite area of the Duarte Formation, while the latter is designed to pass not only amphibolite and green schist of the Duarte Formation but also the Tireo Formation.

Some portions of the diversion tunnel and the intake tunnel outlet will be affected by fractured zone, because they are close to the El Torito Fault. The headrace tunnel bevels the schistosity plane of green schist with a low angle.

(1) Diversion Tunnel from Arroyo Blanco:

(Reference)

Geologic map: Fig. D-02
Seismic profile: Fig. D-21

The diversion tunnel was proposed under the ENEL pre-feasibility to connect the intake on Arroyo Blanco with T-1 dam.

On the basis of geophysical interpretation (line TD-A), a wide low velocity zone (about 70 m in width) probably matching with fractured zone by the El Torito Fault is recognizable.

(2) Intake Tunnel Inlet:

(Reference)

Geologic map: Fig. D-02
Seismic profile: Fig. D-20 and Fig. D-21

This site is located in the left abutment, approximately 400 m upstream of T-3 dam axis. Weathered amphibolite crops out in a small stream near the site. Several faults accompanied by the fractured zone are inferred in a NE to SW direction, as observed through geologic survey. Geophysical exploration (TU- A and TU-B lines) reveal an extent of such fractured zone. The weathered or decomposed zone is as deep as 30 m from the ground surface through the route, but nothing to constrain a construction of a inlet is found, though the fractured zone is carefully excavated and treated by lining and steel support.

(3) Headrace Tunnel from El Torito to Los Veganos:

Based on the surface geologic investigation, there is no serious constraint to excavate a tunnel (approximately 5.3 km in length and 2 m in diameter). However, since the green schist of the Duarte Formation develops exfoliation in parallel with schistosity at places, thick concrete lining work supported by steel is required at the fractured zone, well-schistosed zone and the zone where overburden intact rock is relatively thin.

(4) Intake Weir on Arroyo Colorado:

The site is located approximately 775 m in elevation. Both abutments consist of hard and fresh dacite and show a small cliff in topography. Riverside of 50 m in width is underlain by boulder sized gravels and sand, which is estimated to be approximately 5 m in thickness. Permeability is inferred to be in a range of 1×10^{-2} cm/sec.

The diversion tunnel from the Intake to No. 1 headrace tunnel (about 1.6 km long) is to be excavated in such rocks of the Tireo Formation

as dacite, andesite, chert and limestone. Except the small valley located at immediate downstream from the Intake weir, where the detritus derived from mass movement is accumulated, the rock is as a whole very sound.

(5) Outlet Works and Power House Sites:

Two alternative sites (the upstream site and downstream site) are investigated to locate surge tank, penstock and power house for El Torito scheme. The upstream site along the TP-A seismic exploration line is located immediately upstream of the village of Los Veganos. This site is selected in case a dam and reservoir is planned at V-1 damsite. The downstream site is located immediately downstream from V-1 damsite, and the site is selected if and when V-1 dam is not planned to be constructed.

a) Upstream Site:

(Reference)

Geologic map: Fig. D-08
Seismic profile: Fig. D-22 and Fig. D-23
Drill log: Log sheet DL-12 to DL-15

A mountain flank of the site dips 30° to 35° and shows stable slope where green rock belonging to the Duarte Formation is distributed but widely covered by talus deposit and residual soil made up of green rock fragment and red clay. Three (3) lines of geophysical exploration and four (4) drillings clarify the depth of the talus deposit and the weathered green rock.

The rock is durable for surge tank and penstock anchor block foundation, after it is carefully excavated down to weathered rock surface of about 7 to 12 m in depth from the ground level.

Power house site is situated on a narrow flat land which is higher than the riverbed by 10 to 15 m in elevation. It is composed of an old river terrace gravel deposit of 8 to 10 m in thickness. An underlying bed is a slightly weathered green rock. This site offers a sound foundation for power house, although excavation of gravel deposit is required to some extent.

b) Downstream Site:

(Reference)

Geologic map:	Fig. D-08
Profile:	Fig. D-07
Drill log:	Log sheet DL-16 to DL-18
Water pressure test:	Table D-25 Fig. D-40

This site is located on the higher portion of the left abutment of V-1 damsite. A water head for power generation is approximately 200 meters. The three (3) points are drilled along the Penstock line to mainly clarify the depth of weathered zone. The lower section of the Penstock slope is composed chiefly of limestone and overburden debris is less than 4 m in thickness.

Therefore, the limestone mass should be extensively excavated for providing an open power house and an open switchyard foundation areas (approximately 3,000 to 4,000 m^2). To save excavation cost of hard rock by blasting, appropriate measures are required; e.g., bench-cut method is recommendable. Toward the higher section of the slope, however, the thickness of the residual soil reaches 7 m and the weathered zone is getting thick down to 13 m from the ground surface. However, the site offers a sound foundation for surge tank and penstock anchor block, after the site is excavated down to the top of the weathered limestone.

D.3.3 Alternative Damsites in Los Veganos Area

(Reference)

Geologic map: Fig. D-08

The area is mostly underlain by the Tireo Formation, though the V-1 damsite and the surroundings of the headrace tunnel inlet are occupied by the green schist of the Duarte Formation. The both formations are in fault contact, accompanying fractured zone of approximately 5 to 8 m in width. However, as mentioned in the section of tectonic structure (Chapter D.2.3), fractured zone gradually pinches to the south and eventually dies out near Los Veganos. The problems revealed by the geologic investigations are such

a fractured zone and permeability in the limestone.

(1) V-1 Damsite:

(Reference)

Geologic map:	Fig. D-08 and Fig. D-09
Profile:	Fig. D-11
Seismic profile:	Fig. D-23 to Fig. D-26
Drill log:	Log sheet DL-19 to DL-23
Water pressure test:	Table D-19 to Table D-22 Fig. D-41 to Fig. D-45

The site shows V-shaped valley in topography, sloping 30° in the left abutment and 40° in the right abutment. The riverbed is approximately 25 m in width.

The site consists geologically of green rock and well-bedded limestone (partly muddy or tuffaceous). The former forms the right abutment, while the latter occupies the left abutment. Both are in fault contact having a thin fractured zone. In view of rock durability for dam foundation, both are fresh and hard, though the green rock is weathered to some extent.

A water table of the limestone, however, is found to locate at a lower level than the river level. This indicates that phreatic water leakage from the river to the left abutment is possible to occur probably through a high permeability zone, such as cave and open crack of the limestone mass.

Further, the water pressure tests verify that a part of the vadose zone between top soil and phreatic water table possesses such high permeability to range from 1×10^{-3} cm/sec to 1×10^{-2} cm/sec. Since the limestone occupies most of the left abutment massif, water will leak from the reservoir to a large extent, unless waterstop treatment, such as grouting or blanket is extensively employed. Prior to the treatment, the geohydrological conditions should be clarified in terms of flow potential and direction of phreatic water at the present situation. This study probably consists of extensive drilling, tracing method and detailed digital simulation model study in order to reveal the hydrogeological situation in the surrounding area.

Judging from the required investigation and the treatment demanding much cost and a long period, it is considered at the ultimate stage of the field investigation that the site is geotechnically and economically not recommendable for a damsite.

(2) V-2 Damsite:

(Reference)

Geologic map:	Fig. D-08 and Fig. D-10
Seismic profile:	Fig. D-27

This site is mostly occupied by bedded limestone dipping 35° to the upstream. Limestone is exposed in the river side and in the lower slopes of both abutments. The higher portion of the abutments is covered by talus deposit and the deposit in the left abutment is rather thick judging from the test pitting.

Limestone shows a network open crack along jointing and bedding plane. A detailed investigation is required to check such peculiarity to limestone having corrosive nature. However, on the basis of the results of V-1 damsite, V-2 site probably may bring a problem with special reference to permeability and inferred leakage of water. Therefore, the site is considered as not recommendable for construction of a large dam.

(3) V-3 Weir Site:

(Reference)

Geologic map:	Fig. D-08
Profile:	Fig. D-12
Drilling log:	Log sheet DL-24 and DL-25
Water pressure test:	Table D-23 and D-24 Fig. D-46 and D-47

This site is situated immediate downstream from the confluence of the Yuna river and Arroyo Colorado. The river flows down in a narrow gorge, where both abutments form steep cliffs with a height of approximately 15 m. The steep cliff is formed of well-bedded marl (calcareous clayey stone) and calcareous green tuff.

Two drillings on both abutments reveal that rock quality is durable enough for a concrete gravity weir with a height of 20 to 30 m and the water tables rise up to both mountainsides. Since the vadose zone, however, shows a high permeability like V-1 damsite, a curtain grouting should be treated on both abutments, to some extent, in order to waterstop leakage from the reservoir.

D.3.4 Other Structure Sites for Los Veganos Scheme

The waterway works are planned near the geologic contact of the Duarte Formation and the Tireo Formation. The contact is the extension of the Bonao Fault, striking approximately north-southward continued from Piedra Gorda.

The headrace tunnel from V-3 weir site to No. 2 powerhouse at Boca de Tireo, extending about 3.3 km, is planned to locate in the right abutment of the Yuna river. Approximate half section of the tunnel runs in parallel with the Bonao Fault. The tunnel is inferred to cross the extension of the Bona Fault twice, where the fractured zone is considered to be about 7 m to 8 m in thickness.

(1) Intake Tunnel Inlet:

This inlet is situated in the right abutment immediately upstream of V-3 weir. The inlet exists in the hard marl (silty limestone). Near the inlet, however, the headrace tunnel will meet the fractured zone of approximately 5 m in thickness.

Further groundwater will discharge from the surroundings of the fractured zone during excavation, because Arroyo Pringamosa flows down above the tunnel route. However, an excavation supported by thick concrete lining and reinforce steel enables to overcome such difficulties.

(2) Headrace Tunnel from Los Veganos to Boca de Tireo:

The headrace tunnel (approximately 3.3 km in length and 2 m in diameter) bevels the Bonao Fault twice on its way, and about the half section is aligned in parallel to the Fault. The outcrop in the adjacent area of the Fault, however, reveals that the rock is not deteriorated even in the

immediate interface of the fractured zone. Consequently, it is anticipated that the Ponao Fault does not constrain to construct the headrace tunnel, if the route is aligned away by approximate 100 m from the Fault because of safety countermeasure.

(3) Intake Weir Site on Arroyo Avispa:

(Reference)

Geologic map:	Fig. D-01
Seismic profile:	Fig. D-28

The left abutment and the river side of the proposed site are occupied by hard and fresh diorite, which occurred in a steep cliff to the abutment. On the other hand, the right abutment shows gentle slope consisting of an old river terrace deposit and talus sediment. It is estimated that overlying deposit on the basement diorite is less than 5 m in thickness, based on the refraction interface by seismicity.

(4) Outlet Works and Powerhouse Sites:

Two alternative sites (the left bank site and right bank site) are investigated. The left bank site is selected if and when the headrace tunnel is aligned on the left bank, incorporating the water diversion from Arroyo Caña, as proposed by ENEL study. The right bank site, on the other hand, is selected if the intake is located downstream from the confluence with Arroyo Colorado and the water diversion from Arroyo Caña is not envisaged.

a) Left Bank Site:

(Reference)

Geologic map:	Fig. D-01
Seismic profile:	Fig. D-13 and Fig. D-29
Drilling log:	Log sheet DL-26 to DL-30
Water pressure test:	Table D-26
	Fig. D-48

Such outlet works as surge tank and penstock is firstly proposed in

the left abutment of approximately 1,500 m upstream of Boca de Tireo. The mountain slope, where the penstock and surge tank are planned, dips approximately 30° and consists mainly of porphyritic andesite altered dolerite and calcareous siltstone belonging to the Tireo Formation. A zone decomposed into clay on the mountain slope is less than 3 m in thickness. However, decomposed zone caused by sulphate alteration is observable in the drillings of VTP-1 and VTP-2, as well as in the adjacent stream. The mountain side is landslided to a large extent in the cracky fragile andesite area.

The subsurface geology at the surge tank site is clarified by the drill VT-B1 that debris is down to 3.15 m in depth and the decomposed clay is down to 9.30 m in depth, where the N-value ranges from 5 to 40. The weathered green rock classified in rock grade C_L, underlain by the strongly weathered rock from 9.30 to 15.30 m in depth, can become a foundation rock for the surge tank. The mountain slope can provide a basement for an anchor block of penstock line, after the ground is excavated approximately down to 3 to 5 m from the ground surface.

The flat terrace formed of old river gravel is utilized for powerhouse, though the gravel should be excavated down to about 19 m in depth.

b) Right Bank Site:

(Reference)

Geologic map:	Fig. D-01
Seismic profile:	Fig. D-13 and Fig. D-30
Drilling log:	Log sheet DL-31 and DL-32

This site occupies a steep mountain slope on the right abutment of the Yuna river, located approximately 0.5 km upstream of the alternative powerhouse site in the left abutment. The slope consists of weathered green tuff covered with thin debris, but toward the surge tank site (approximately 500 m in elevation) the zone decomposed into red clay becomes thicker.

The drill VT-B2 at 552.43 m in elevation proves that the residual

soil colored in reddish brown reaches 7.0 m from the ground level, followed by decomposed tuff from 7.0 to 11.5 m in depth. The excavation depth for surge tank foundation is approximately 12 m from the ground level.

The powerhouse site (approximately 3,000 - 4,000 m^2) is located on the old river terrace deposit, which rises its elevation by 20 m above the present river level. The area is explored by two (2) geophysical lines and checked by two (2) drillings. The gravel deposit reaches about 5 m in depth from the ground, which is underlain by intensively weathered andesite of about 2.5 m in thickness. Therefore, the site should be excavated down to approximately 7 m from the ground surface in order to obtain sound foundation for a powerhouse.

D.4 DESIGN EARTHQUAKE ACCELERATION

D.4.1 Seismic Data

Historical data of earthquakes, 138 in number, including data with regard to location (longitude, latitude), depth and magnitude of the major earthquakes are used in this study. Significant events which influence the contemplated damsites are the earthquakes in 1911 (M=7.0), 1946(M=8.1), 1946 (M=7.9) and 1962(M=6.5), whose epicenters are shown on Fig. D-49.

The epicentral location of the earthquakes from 1911 through 1945 includes a probable distance error of about 50 km (Reference: T. Matsumoto, 1981, 82; Technical Report on CDE Seismograph Network). Among them, it was thought that the epicenter of earthquake in 1911 is located 15 km west of Piedra Gorda, which may have a most significant influence on the damsites contemplated in this study.

The period from 1946 to 1953 was an active period on seismicity in the Dominican Republic. The maximum magnitude of M=8.1 was observed in 1946, whose epicenter was estimated to be located 160 km east of the study area.

Prior to analysis, the collected data are evaluated on the basis of their reliability. The nation-wide seismograph network enables to estimate the epicentral locations of the major events after 1946. It is considered that the epicentral location of historical data after 1946 is considered to have an accuracy to estimate the maximum ground acceleration for the proposed damsite.

D.4.2 CDE's Seismograph Network Record

Since December 1979, CDE's Seismograph Network has monitored the seismic activity in the Dominican Republic. The CDE's record is used to estimate relationship between magnitude and frequency of earthquakes in the Dominican Republic from 1980 to 1981, including available 1,200 data in 1980 and 500 data in 1981. Fig. D-50 shows the relations between the number of earthquakes and magnitude in the world, the Dominican Republic, Zone 1

(between longitude 69.75° - 71.50°) and Zone 3 (La Vega - Banao - Bani zone). A linear regression of "Dominica 1980" demonstrates similar inclination of the fitting line to the trend of the world historical earthquake records. On the basis of these relations, following two fitting lines are obtained:

For the Dominican Republic 1980: $\log N = 2.80 - 0.705 \times M$ ...(1)
For Zone 3 : $\log N = 1.81 - 0.529 \times M$ ...(2)

D.4.3 Acceleration

The peak ground acceleration is estimated for the proposed damsite in El Torito (long. 70.45°, lat. 18.77°) which is located in the central part of the Dominican Republic. Taking into account the uncertainty of epicentral location in historical data from 1911 through 1945, following 5 cases are interpreted to estimate the peak ground acceleration at the proposed damsite:

Case 1(A)	Historical earthquake data from 1946 through 1980 is used (data in 1911-45 are excluded).
Case 2(B)	Historical earthquake data from 1911 through 1980 are all included.
Case 3(B-1)	Epicenter of earthquake 1911 (M=7.0) is assumed to be located 70 km (Z=0) west of the proposed damsites (after Taber, 1922).
Case 4(B-2)	Epicenter of earthquake 1911 (M=7.0) is assumed to be located 14.6 km (Z=46) west of Piedra Gorda (after Gutenberg and Richter, 1956).
Case 5(B-3)	Epicenter of earthquake 1911 (M=7.0) is assumed to be located 50 km (Z=0) west of Piedra Gorda.

Each epicenter used in B-1 to B-3 is shown on Fig. D-49.

The first approximation to extimate the expected acceleration at the proposed damsite is given by Estiva's equation. Following equations are used to estimate the hypocentral distance and acceleration.

$$a = (5000 \times \exp.\ (0.8 \times M)) / (HD + 40)^2 \quad \cdots\cdots (3)$$

$$HD = \sqrt{D \times D + Z \times Z} \quad \cdots\cdots (4)$$

$$D = 2 \times 3.14 \times R\ (d/360) \quad \cdots\cdots (5)$$

$$d = \cos^{-1} (\sin(y^0)\sin(y) + \cos(y^0)\cos(y)\cos x\text{-}x^0) \quad \cdots\cdots (6)$$

$$R = Ry \times Ry / \sqrt{(1 - e \times e \times \cos y \times \cos y)} \quad \cdots\cdots (7)$$

$$e = C/Rx \quad \cdots\cdots (8)$$

$$C = \sqrt{Rx \times Rx - Ry \times Ry} \quad \cdots\cdots (9)$$

where, a : Peak ground acceleration in cm/sec^2
M : Magnitude
HD : Hypocentral distance in km
D : Distance between damsite (x0, y0) and epicenter (x,y)
Z : Depth of earthquake in km
R : Radius of earth in km : Rx = 6,378 and Ry = 6,356
d,e,C : Parameters

D.4.4 Design Earthquake Acceleration

On the basis of the equatious as cited above, the peak ground acceleration has been calculated in each case, as summarized hereunder.

(Unit: g)

El Torito	Return Period (year) (34)	(69)	100	200
Case 1 (A)	0.108	-	0.132	0.153
Case 2 (B-1)	-	0.110	-	-
Case 3 (B-2)	-	0.160	-	-
Case 4 (B-3)	-	0.145	-	-

It is considered that Case 1 is relatively equal to the evaluation according to the data reliability. The estimated peak acceleration in Case 1 is also illustrated on Fig. D-51. For the sake of the design earthquake acceleration of the proposed damsites at El Torito, the value of 0.15 g is adopted, including some safe measure, in this study.

D.5 SUMMARY AND RECOMMENDATION

The studied area covers approximately 27 km^2 of rugged terrain on the eastern edge of the Cordillera Central alpine massif in the Dominican Republic. The Yuna river flows down its tortuous way from south to north through the central part of the area. From the upstream damsites at El Torito to the downstream power house near Boca de Tireo, it is approximately 8.5 km in length.

The rocks in the studied area fall naturally into four major groups:

1) Duarte Formation of pre-middle Albian age (uppermost of Lower Cretaceous);
2) Plutonic igneous rocks probably associated with the emplacement of the Duarte Formation;
3) Tireo Formation of middle Albian age; and
4) unconsolidated alluvial deposits of Quaternary age.

The first three groups receive most attention with respect to dam foundation, intact rock of headrace tunnel, basement of such structures as surge tank, penstock and power house to be planned for the project. Meanwhile, the last group draws attention on availability of construction materials to be dealt with in Annex-F. The study area is rather extensively affected by faults and their accompanied fractured zone, which are represented by the Bonao Fault and the El Torito Fault (tentatively named in this study).

The Duarte Formation comprises green schist, amphibolite, foliated diorite gneiss and peridotite, which are inferred to be formed by regional metamorphism. The metamorphism grade rises from the former rock to the latter. The Duarte Formation occupies the dam foundations of T-1, T-2, T-3 and T-4, including half section of the No. 1 headrace tunnel route for El Torito scheme.

At T-1 damsite, it is possible to construct both concrete gravity dam and fill-type dam. From the viewpoint of availability of construction material, methods and project economy, it is recommendable to design a full-type dam at T-1 damsite. As for T-2 damsite, the El Torito Fault has no serious effects on the surrounding rock near the damsite and a fill-type dam is possible to be constructed within a limited height of 50 to 60 m. Construction of a low fill type dam is possible at the T-3 saddle damsite. With regard to T-4 weir site, topographic and geologic conditions favour to construct a concrete weir with a height of 20 to 25 m at maximum.

There is no serious constraint to excavate No. 1 headrace tunnel (approximately 4.4 km in length). However, since the tunnel bevels the schistosity plane of green schist, thick concrete lining work supported by steel is required to pass fractured zone, well-schistosed zone and the zone where overburden intact rock is relatively thin.

In the area of Los Veganos scheme, the Tireo Formation and the Duarte Formation are involved in such structure sites as damsites at V-1, V-2 and V-3, No. 2 headrace tunnel and surge tank, penstock and power house. V-1 damsite is ultimately found to be geotechnically and economically not recommendable because of possibility of water leakage through limestone widely distributed in the left abutment. V-2 damsite is mostly occupied by limestone, which is inferred to have the same constraint factors as V-1 damsite. Construction of a large dam at V-2 damsite is not recommendable. The rock quality of V-3 weir site is durable enough for a concrete gravity weir with a height of 20 to 30 m. However, a curtain grouting should be treated in the intact rock of both abutments to stop leakage from a reservoir.

No. 2 headrace tunnel (approximately 3.3 km in length) bevels the Bonao Fault twice on its way, but the Fault does not constrain to construct the headrace tunnel, if such safety countermeasures as careful lining and support are employed.

The alternative site of surge tank, penstock and power house in the right abutment near Boca de Tireo occupies a steep mountain slope, where weathered green tuff is exposed. The slope as a whole offers sound

geologic foundation, though the rock is rather deeply deteriorated near surge tank and hence excavation work is required to some extent. A power house is located in the old river terrace deposit which should be excavated prior to construction.

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TABLES

Table D-01 DETAILS OF GEOPHYSICAL EXPLORATION
(DETALLE DE LAS EXPLORACIONES GEOFISICAS)

Location/Site		Line No.		Length (m)
EL TORITO:	Damsite T-1	T1-A		365
		T1-B		400
		T1-C		430
		T1-1		170
		T1-2		200
			(sub-total)	(1,565)
	Damsite T-2	T2-A		400
		T2-B		460
		T2-1		115
		T2-2		200
			(sub-total)	(1,175)
	Damsite T-3	T3-A		460
		T3-1		180
			(sub-total)	(640)
	Weir site T-4	T4-A		300
		T4-B		300
			(sub-total)	(600)
	Tunnel inlet	TU-A		460
		TU-B		345
			(sub-total)	(805)
	Quarry site*	TQ-A		150
		TQ-B		245
			(sub-total)	(395)
	Diversion tunnel	TD-A		230
	Surge tank, penstock, power house	TP-A		575
		TP-1		230
		TP-2		115
			(sub-total)	(1,150)
	TOTAL (El Torito)			6,330
LOS VEGANOS:	Damsite V-1	V1-A		425
		V1-B		460
		V1-C		460
		V1-1		230
		V1-2		230
		V1-3		230
		V1-4		230
			(sub-total)	(2,265)
	Damsite V-2	V2-A		345
		V2-1		115
			(sub-total)	(460)

(cont'd)

Location/Site		Line No.		Length (m)
	Tunnel inlet	VU-A		(230)
	Quarry site*	VQ-1		345
		VQ-2		345
		VQ-3		495
			(sub-total)	(1,185)
	Intake sites	AA-1		115
		AA-2		115
		AC-1		115
			(sub-total)	(345)
	Surge tank, penstock, power house	BP-A		650
		BP-1		185
		BP-2		220
		BP-B		500
		BP-3		150
			(sub-total)	(1,705)
	TOTAL (Los Veganos)			6,190
GRAND TOTAL		42 lines		12,520

Note: * Profiles are presented in Annex E.

Table D-02 RESULT OF DRILLING CAMPAIGN
(DETALLE DE LOS SONDEOS GEOLOGICOS)

Site	Nos.	Ground Eleva.	JICA Team Depth	P.T	SPT	CDE(Geocivil) Team Depth	P.T	SPT
EL TORITO								
T-1 Damsite	T1-B1	773.05				55.0	8	6
	T1-B2	757.59				40.0	5	
	T1-B3	709.28				45.0	7	-
	T1-B4	754.03				40.0	7	7
	T1-B5	-				cancelled		
	T1-B6	-				cancelled		
	T1-B7	-				cancelled		
						(180.0)	(27)	(13)
T-2 Damsite	T2-B1	752.60	40.0	8	8			
	T2-B2	711.54	40.3	8	-			
	T2-B3	752.09	40.0	7	8			
	T2-B4	713.09	40.4	8	-			
			(160.7)	(31)	(16)			
T-3 Saddle dam	TPA-1	746.44				36.0		12
T-4 Weir site	T4-B1	699.93				30.0	2	-
	T4-B2	669.28				30.0	2	-
Surge tank	TT-B1	-				cancelled		
	LP-B1	716.70	40.0	-				
Penstock	TP-B1	705.71				37.0	-	24
	TP-B2	-				cancelled		
	TP-B3	609.31				32.75		10
	VQ-B1	553.5				30.0		
Power house	TCM-1	543.21				38.5	-	-
	TCM-2	545.68				20.0		
	TH-B3	495.35	20.0	5	-			
Materials*	TQ-B1	831.01				40.0	-	7
	TQ-B2	773.26				24.5	-	24
	TQ-B3	859.59				34.55	-	34
			(60.0)	(5)		(352.8)	(4)	(111)
LOS VEGANOS								
V-1 Damsite	V1-B1	534.53	60.0	12	-			
	V1-B2	514.22	50.0	6	5			
	V1-B3	488.52	70.0	18				
	V1-B4	539.41	50.0	10				
	V1-B5	-	cancelled					
	V1-B6	489.39	55.4	8				
			(285.4)	(54)	(5)			

(cont'd)

Site	Nos.	Ground Eleva.	JICA Team Depth	P.T	SPT	CDE(Geocivil) Team Depth	P.T	SPT
V-2 Damsite	V2-B1	-	cancelled					
	V2-B2	-	cancelled					
	V2-B3	-	cancelled					
V-3 Weir site	V3-B1	490.97	35.0	8				
	V3-B2	523.07	50.0	10	6			
Surge tank	VT-B1	541.90				55.0	4	
	VT-B2	552.43				39.8		
Penstock	VP-B1	495.24				50.0		
	VP-B2	-				cancelled		
	VP-B3	379.89				50.0		
Power house	VCM-1	345.51				23.8		
	VCM-2	348.36				24.25		
	VCM-3	377.12				25.5		
Material*	VQ-B2	616.48				28.8		47
	VQ-B3	640.09				20.0		29
			(85.0)	(18)	(6)	(317.15)	(4)	(76)
TOTAL	(1,441.05 m)		(591.1)	(108)	(27)	(849.95)	(35)	(200)
	(37 holes)		13 holes			24 holes		

Note: *Drill logs are presented in Annex E.
P.T : Permeability test by water pressure test
SPT : Standard penetration test
Ground elevation in meters

Table D-03 PETROGRAPHIC DESCRIPTION OF ROCK SAMPLES
(DESCRIPCION PETROGRAFICA DE LAS ROCAS)

No.	Texture or Structure	Rock Name	Constituent Minerals	Original Rock
2003	Banded	Banded hornblende Diorite	Green hornblende, plagioclase magnetite, picotite	-
1801	Biomicritic	Limestone	Oolitic calcite, detrital shell, micritic calcite, vein calcite	Calcareous Ooze
1808	Banded or Schistose	Chlorite actinolite albite schist	Albite, chlorite, actinolite mosaic quartz	Tuffaceous sandstone
1701	Ophitic	Altered pyroxene andesite	Lath plagioclase, diopside or augite changes to calcite and epidote glassy part thomsonite or mordenite	-
1706	Banded or Schistose	Epidote actinolite albite schist	Epidote, actinolite, calcite, vein calcite	Calcareous tuff or altered andesite
1604	Banded or Schistose	Schistose Amphibolite	Green hornblende, epidote quartz, albite, oligoclase vein epidote	Tuffaceous sandy shale
1605	Banded or Schistose	Schistose Amphibolite	Green hornblende, epidote(?), quartz, albite, oligoclase	Tuffaceous sandy shale
1007	Foliated to Gneissose	Biotite bearing hornblended gneiss	Green hornblende, chlorite, epidote biotite, secondary sericite, oligoclase-andesine, quartz	Granite or arkose sandstone
1806	Spotted	Chlorite actinolite albite schist	Fine actinolite, quartz, albite, calcite, elongated chlorite	Welded tuff
1705	Banded	Epidote chlorite actinolite albite schist	Actinolite, epidote, chlorite, quartz, albite	Basic tuff

(cont'd)

No.	Texture or Structure	Rock Name	Constituent Minerals	Original Rock
1001	Banded or Schistose	Epidote hornblende albite schist	Epidote (poiklitic), albite, quartz, green hornblende, magnetite	Sandstone
1003	Banded or Schistose	Hornbende albite schist	Green bornblende, galaxite, magnetite, albite-oligoclase, quartz	Sandstone
2001	Mesh	Peridotite	Olivine, antigolite, tremolite, picotite, chromite	Serpentinite or peridotite

Sample	Rock Name	Constituent Minerals	Original rock
V3-B2 (39.8m)*	Tuffaceous limestone	Micritic calcite with sparly calcite veinlets	Calcareous marl
72202	Green tuff or green rock	Chlorite, Albite, Quartz, clay-minerals, iron ore	To be welded tuff(?)
PG-B3 (47.2m)*	Oil Conglomerate	Basaltic - andestic pebble matrix: calcareous marl and tuff	with organic matter
PG-B3 (38.0m)*	Conglomerate	Basaltic - andestic pebble matrix: calcareous marl and tuff	with organic matter and foraminifera shell
72701	Calcareous siltstone	A little basaltic to andesific pebble in biomicrite	Foraminifera shell
VPP-1 (37.6m)*	Calcareous siltstone	Biomicritic rock with shale patch	Foraminifera shell
1138	Chert	quartz	

Note: * Sample from drilled core

Sample localities are referred to the numbers in Dwg. D.1.

(cont'd)

Sample	Texture or Structure	Rock Name	Constituent Minerals	Original Rock
VT-Bl* (57 m)	Doleritic T.	Altered Dolerite	Bronzite, Augite, Zoned plagioclose magnetite (Hornblende? Chlorite)	-
1111	Porphyritic T.	Quartz Porphyry	Quartz, plagioclase, magnetite (Sericite, Nontronite, chlorite, epidote)	-
2281	Porphyritic T.	Quartz Porphyry or Welded Tuff	Quartz, plagioclase, magnetite (Sericite, calcite, chlorite epidote)	-
7503	Amygdaloidal T.	Altered Basalt or Altered Andesite	Plagioclase, ground mass and mafic minerals altered to calcite and Irone Ores Cavities are fill with calcite	Amygdal. basult or andesite
12135	Foliated or Gneissose T.	Banded hornblende Diorite	Green hornblende, plagioclase hesting site, Quartz, magnetite (Chlorite, calcite, sericite?)	-
12131	Gneissose T.	Amphibolite or (Epidote hornblende gneiss)	Green hornblende, plagioclase, epidote, quartz, magnetite (Iron ore, sericite? calcite)	Basic Tuff
12162	Hypidiomorphic T.	Amphibolite	Green hornblende, plagioclase, quartz (Calcite, iron ore, sericite?)	Basic Tuff
12123	Poikilitic T.	Amphibolite	Green hornblende, plagioclase, magnetite (Calcite, hematite)	Basic Tuff
12125	Hypidiomorphic T.	Epidote actinolite schist	Actinolite, albite, quartz, calcite, iron ore, epidote	Basic Tuff
2285	Porphyroblastic T.	Epidote actinolite schist	Epidote, actinolite, albite, quartz, calcite	Basic Tuff

(cont'd)

Sample	Texture or Structure	Rock Name	Constituent Minerals	Original Rock
322	Banded T.	Actinolite chlorite schist	Actinolite, chlorite, albite, epidote, quartz, calcite, iron ore	Tuffaceous shale
323	Banded T.	Epidote Actinolite schist	Epidote, chlorite, actinolite, calcite, quartz, albite, iron ore	Lithic Tuff (Basic Tuff)
72201	Porphyroblastic T.	Epidote Actinolite schist	Epidote, actinolite, albite, quartz, iron ore	Basic Tuff

Table D-04 METAMORPHISM GRADE OF THE DUARTE FORMATION
(including the Tireo Formation)
(GRADO DE METAMORFISMO)

Sample No.		Rock name under microscope	
Igneous rock	No.2001	Peridotite - Intrusion -	Anatexis in
	No.2003	Banded hornblende diorite	regional me-
High grade metamorphism	No.1007	Biotite bearing hornblende greiss	tamorphism
	No.1604	Schistose amphibolite	(increase)
	No.1605	Schistose amphibolite	
	No.1003	Hornblende albite schist	
	No.1001	Epidote hornblende albite schist	
	No.1808	Chlorite actinolite albite schist	
	No.1705	Epidote chlorite actinolite albite schist	
Low grade metamorphism	No.1806	Chlorite actinolite albite schist	(decrease)
	No.1706	Epidote actinolite albite schist	
Sedimentary rock (altered by diagenesis)	No.1701	Altered pyroxene andesite	
	No.1801	Limestone	

Table D-05 ROCK NAME AND FORMATION INCLUDED
(NOMENCLATURA DE LAS MUESTRAS DE ROCAS)

Sample	Rock Name by Petrographic Description	Formation
V3-B2 (39.8 m)*	Tuffaceous limestone	
72202	Green tuff or green rock	
PG-B3 (47.2 m)*	Oil conglomerate	
PG-B3 (38.0 m)*	Conglomerate	Tireo Formation
72701	Calcareous siltstone	
VTP-1 (37.6 m)*	Calcareous siltstone	
1138	Chert	
VT-B1 (57 m)*	Altered dolerite	
1111	Quartz porphyry	Tireo Formation
2281	Quartz porphyry or welded tuff	
7503	Altered basalt or andesite	
12135	Banded hornblende diorite	Plutonic igneous rocks
12131	Epidote hornblende gneiss	(High grade
12162	Amphibolite	metamorphism)
12123	Amphibolite	
12125	Epidote actinolite schist	Duarte Formation
2285	Epidote actinolite schist	
322	Actinolite chlorite schist	
323	Epidote actinolite schist	(Low grade
72201	Epidote actinolite schist	metamorphism)

Note: * Sample from drilled core

Table D-06 CRITERIA FOR ROCK GRADE CLASSIFICATION

(CRITERIA PARA CLASIFICACION DE ROCAS)

Grade	Description	RQD (%)	Core Recovery (%)	Remarks
A	Very fresh in lithologic character. Constituent minerals are not weathered and altered at all. The rocks as a whole are very solid and densely hard. Few cracks are seen.	probably more than 70	100	Very good property as concrete dam foundation (height 60m+) and rock fill dam core foundation (height 60m+)
B	Fresh in lithologic character. Constituent minerals are little weathered and altered. The rocks as a whole are solid and densely hard. Cracks are sparsely seen, with close adhesion.	more than 50	100	Very good (the same as the above)
C_H	Almost fresh, solid and hard in lithologic character. Among constituent minerals, feldspars and colored minerals are slightly weathered and altered. Cracks are seen considerably. Crack walls are mostly colored, but closed adhesion. Long cylindric cores.	more than 30	100	Almost good (the same as the above)
C_M	Generally a little weathered and altered in lithologic character. Constituent minerals, feldspars and colored minerals are weathered, often being brown. Cracks are open with thin materials. Short cylindric cores. Rocks often collapse by a strong hammer blow.	20-30	more than 80	Almost durable property as rock fill dam core foundation (height 60m+) and concrete dam foundation
C_L	Constituent minerals are considerably weathered. Rocks are as a whole brown or reddish brown. Cracks are open and contain clay or weathered materials. Rocks often collapse by a light hammer blow. Almost fragment cores.	zero	about 50 or less	Not appropriate but sometimes durable property as rock fill dam foundation abutment
D	Constituent minerals are considerably weathered or altered and sandy or clayey portions are often seen. Cracks are unclear. Generally rocks are soft and friable. Often drilled by no water drill.	zero	Often drilled by no-water	Bad

Table D-07 STRATIGRAPHIC SEQUENCE OF UPPER YUNA PROJECT AREA
(SECUENCIA ESTRATIGRAFICA DE LA CUENCA ALTA DE YUNA)

Geologic Age		Formation	Lithology
Cenozoic	Quaternary	Alluvial deposit	Present river deposit Debris Middle & lower terrace deposit Upper terrace deposit
		(Unconformably)	
Mesozoic	Upper Cretaceous (Middle Albian) *1	Tireo formation	Limestone, Marl Andesite, Dacite, Tuff breccia, Limestone, Tuff, Sandstone, Slate, Chert
		(Fault)	
Age unknown	Pre-Middle Albian	Duarte Formation	Amphibolite, Foliated diorite, Peridotite Green schist Gneiss
		(Intrusion) *2	
Age unknown	Pre-Middle Albian (?)	Plutonic igneous rocks	Coorse grained quartz diorite (Partly foliated)

Note: *1 Uppermost of lower Cretaceous.
*2 Relation is not necessarily confirmed.

Table D-08 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T1-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
16.50	21.00	4.50	7.6	1.0	18.50	0.20	0.80	27.90	22.0	2.2E-04	17.5	1
16.50	21.00	4.50	7.6	3.0	18.50	0.20	0.95	47.75	24.0	1.4E-04	11.2	2
16.50	21.00	4.50	7.6	6.0	18.50	0.20	3.95	74.74	49.0	1.8E-04	14.6	3
16.50	21.00	4.50	7.6	8.0	18.50	0.20	5.94	92.76	60.0	1.8E-04	14.4	4
16.50	21.00	4.50	7.6	10.0	18.50	0.20	8.08	110.62	70.0	1.8E-04	14.1	5
16.50	21.00	4.50	7.6	9.0	18.50	0.20	6.97	101.73	65.0	1.8E-04	14.2	6
16.50	21.00	4.50	7.6	7.0	18.50	0.20	4.81	83.89	54.0	1.8E-04	14.3	7
16.50	21.00	4.50	7.6	5.0	18.50	0.20	3.19	65.51	44.0	1.9E-04	14.9	8
16.50	21.00	4.50	7.6	4.0	18.50	0.20	2.26	56.44	37.0	1.8E-04	14.6	9
16.50	21.00	4.50	7.6	2.0	18.50	0.20	1.03	37.67	25.0	1.9E-04	14.7	10
21.00	26.00	5.00	7.6	1.0	20.85	0.20	0.05	31.00	5.9	4.2E-05	3.2	1
21.00	26.00	5.00	7.6	3.0	20.85	0.20	0.17	50.88	9.0	4.6E-05	3.5	2
21.00	26.00	5.00	7.6	6.0	20.85	0.20	0.84	80.21	20.0	6.5E-05	5.0	3
21.00	26.00	5.00	7.6	8.0	20.85	0.20	1.53	99.52	27.0	7.0E-05	5.4	4
21.00	26.00	5.00	7.6	10.0	20.85	0.20	2.29	118.76	33.0	7.2E-05	5.6	5
21.00	26.00	5.00	7.6	9.0	20.85	0.20	1.89	109.16	30.0	7.1E-05	5.5	6
21.00	26.00	5.00	7.6	7.0	20.85	0.20	1.21	89.84	24.0	6.9E-05	5.3	7
21.00	26.00	5.00	7.6	5.0	20.85	0.20	0.76	70.29	19.0	7.0E-05	5.4	8
21.00	26.00	5.00	7.6	4.0	20.85	0.20	0.61	60.44	17.0	7.3E-05	5.6	9
21.00	26.00	5.00	7.6	2.0	20.85	0.20	0.30	40.75	12.0	7.6E-05	5.9	10
26.00	31.00	5.00	7.6	1.0	26.50	0.35	0.02	36.83	3.0	2.1E-05	1.6	1
26.00	31.00	5.00	7.6	3.0	26.50	0.35	0.04	56.81	4.0	1.8E-05	1.4	2
26.00	31.00	5.00	7.6	6.0	26.50	0.35	0.21	86.64	9.0	2.7E-05	2.1	3
26.00	31.00	5.00	7.6	8.0	26.50	0.35	0.26	106.59	10.0	2.4E-05	1.9	4
26.00	31.00	5.00	7.6	10.0	26.50	0.35	0.44	126.41	13.0	2.7E-05	2.1	5
26.00	31.00	5.00	7.6	9.0	26.50	0.35	0.26	116.59	10.0	2.2E-05	1.7	6
26.00	31.00	5.00	7.6	7.0	26.50	0.35	0.17	96.68	8.0	2.1E-05	1.7	7
26.00	31.00	5.00	7.6	5.0	26.50	0.35	0.09	76.76	6.0	2.0E-05	1.6	8
26.00	31.00	5.00	7.6	4.0	26.50	0.35	0.04	66.81	4.0	1.5E-05	1.2	9
26.00	31.00	5.00	7.6	2.0	26.50	0.35	0.04	46.81	4.0	2.2E-05	1.7	10
31.00	36.00	5.00	7.6	1.0	15.35	0.50	0.00	25.85	1.0	1.0E-05	0.8	1
31.00	36.00	5.00	7.6	3.0	15.35	0.50	0.20	45.65	8.0	4.5E-05	3.5	2
31.00	36.00	5.00	7.6	6.0	15.35	0.50	2.81	73.24	29.0	1.0E-04	7.9	3
31.00	36.00	5.00	7.6	8.0	15.35	0.50	4.48	91.37	38.0	1.1E-04	8.3	4
31.00	36.00	5.00	7.6	10.0	15.35	0.50	7.44	108.41	49.0	1.2E-04	9.0	5
31.00	36.00	5.00	7.6	9.0	15.35	0.50	5.21	100.64	41.0	1.1E-04	8 1	6
31.00	36.00	5.00	7.6	7.0	15.35	0.50	3.58	82.27	34.0	1.1E-04	8.3	7
31.00	36.00	5.00	7.6	5.0	15.35	0.50	2.26	63.59	27.0	1.1E-04	8.5	8
31.00	36.00	5.00	7.6	4.0	15.35	0.50	1.91	53.91	25.0	1.2E-04	9.3	9
31.00	36.00	5.00	7.6	2.0	15.35	0.50	1.12	34.73	19.0	1.4E-04	10.9	10

(cont'd) Borehole Number: T1-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
36.00	41.00	5.00	7.6	1.0	27.25	1.90	0.01	39.14	2.0	1.3E-05	1.0	1
36.00	41.00	5.00	7.6	3.0	27.25	1.90	1.74	57.41	22.0	9.9E-05	7.7	2
36.00	41.00	5.00	7.6	6.0	27.25	1.90	8.64	80.51	49.0	1.6E-04	12.2	3
36.00	41.00	5.00	7.6	8.0	27.25	1.90	10.11	99.04	53.0	1.4E-04	10.7	4
36.00	41.00	5.00	7.6	10.0	27.25	1.90	14.75	114.40	64.0	1.4E-04	11.2	5
36.00	41.00	5.00	7.6	9.0	27.25	1.90	23.62	95.53	81.0	2.2E-04	17.0	6
36.00	41.00	5.00	7.6	7.0	27.25	1.90	19.71	79.44	74.0	2.4E-04	18.6	7
36.00	41.00	5.00	7.6	5.0	27.25	1.90	15.21	63.94	65.0	2.6E-04	20.3	8
36.00	41.00	5.00	7.6	4.0	27.25	1.90	13.40	55.75	61.0	2.8E-04	21.9	9
36.00	41.00	5.00	7.6	2.0	27.25	1.90	9.36	39.79	51.0	3.3E-04	25.6	10
41.00	46.00	5.00	7.6	1.0	40.45	0.10	0.50	50.05	11.0	5.7E-05	4.4	1
41.00	46.00	5.00	7.6	3.0	40.45	0.10	5.61	64.94	37.0	1.5E-04	11.4	2
41.00	46.00	5.00	7.6	6.0	40.45	0.10	9.45	91.10	48.0	1.4E-04	10.5	3
41.00	46.00	5.00	7.6	8.0	40.45	0.10	12.40	108.15	55.0	1.3E-04	10.2	4
41.00	46.00	5.00	7.6	10.0	40.45	0.10	16.79	123.76	64.0	1.3E-04	10.3	5
41.00	46.00	5.00	7.6	9.0	40.45	0.10	14.27	116.28	59.0	1.3E-04	10.1	6
41.00	46.00	5.00	7.6	7.0	40.45	0.10	10.66	99.89	51.0	1.3E-04	10.2	7
41.00	46.00	5.00	7.6	5.0	40.45	0.10	7.94	82.61	44.0	1.4E-04	10.7	8
41.00	46.00	5.00	7.6	4.0	40.45	0.10	6.56	82.61	44.0	1.4E-04	10.8	9
41.00	46.00	5.00	7.6	2.0	40.45	0.10	4.46	56.09	33.0	1.5E-04	11.8	10
46.00	51.00	5.00	7.6	1.0	26.40	1.15	0.11	37.44	5.0	3.5E-05	2.7	1
46.00	51.00	5.00	7.6	3.0	26.40	1.15	1.33	56.22	17.0	7.8E-05	6.0	2
46.00	51.00	5.00	7.6	6.0	26.40	1.15	3.87	83.68	29.0	9.0E-05	6.9	3
46.00	51.00	5.00	7.6	8.0	26.40	1.15	7.36	100.19	40.0	1.0E-04	8.0	4
46.00	51.00	5.00	7.6	10.0	26.40	1.15	11.50	116.05	50.0	1.1E-04	8.6	5
46.00	51.00	5.00	7.6	9.0	26.40	1.15	8.11	109.44	42.0	9.9E-05	7.7	6
46.00	51.00	5.00	7.6	7.0	26.40	1.15	5.63	91.92	35.0	9.9E-05	7.6	7
46.00	51.00	5.00	7.6	5.0	26.40	1.15	5.01	72.54	33.0	1.2E-04	9.1	8
46.00	51.00	5.00	7.6	4.0	26.40	1.15	3.35	64.20	27.0	1.1E-04	8.4	9
46.00	51.00	5.00	7.6	2.0	26.40	1.15	2.23	45.32	22.0	1.3E-04	9.7	10
51.00	55.00	4.00	7.6	1.0	31.70	0.85	0.01	42.54	1.5	1.1E-05	0.9	1
51.00	55.00	4.00	7.6	3.0	31.70	0.85	2.25	60.30	21.0	1.1E-04	8.7	2
51.00	55.00	4.00	7.6	6.0	31.70	0.85	5.90	86.65	34.0	1.2E-04	9.8	3
51.00	55.00	4.00	7.6	8.0	31.70	0.85	9.87	102.68	44.0	1.3E-04	10.7	4
51.00	55.00	4.00	7.6	10.0	31.70	0.85	18.98	113.57	61.0	1.7E-04	13.4	5
51.00	55.00	4.00	7.6	9.0	31.70	0.85	15.99	106.56	56.0	1.6E-04	13.1	6
51.00	55.00	4.00	7.6	7.0	31.70	0.85	13.27	89.28	51.0	1.8E-04	14.3	7
51.00	55.00	4.00	7.6	5.0	31.70	0.85	9.87	72.68	44.0	1.9E-04	15.1	8
51.00	55.00	4.00	7.6	4.0	31.70	0.85	8.16	64.39	40.0	1.9E-04	15.5	9
51.00	55.00	4.00	7.6	2.0	31.70	0.85	4.29	48.26	29.0	1.9E-04	15.0	10

Table D-09 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: H-32

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
14.50	19.85	5.35	7.6	1.0	17.18	1.50	0.18	28.50	11.0	9.5E-05	7.2	1
14.50	19.85	5.35	7.6	3.0	17.18	1.50	1.88	46.80	36.0	1.9E-04	14.4	2
14.50	19.85	5.35	7.6	6.0	17.18	1.50	5.22	73.46	60.0	2.0E-04	15.3	3
14.50	19.85	5.35	7.6	8.0	17.18	1.50	7.94	90.74	74.0	2.0E-04	15.2	4
14.50	19.85	5.35	7.6	10.0	17.18	1.50	10.48	108.20	85.0	1.9E-04	14.7	5
14.50	19.85	5.35	7.6	9.0	17.18	1.50	9.28	99.40	80.0	2.0E-04	15.0	6
14.50	19.85	5.35	7.6	7.0	17.18	1.50	6.90	81.78	69.0	2.1E-04	15.8	7
14.50	19.85	5.35	7.6	5.0	17.18	1.50	4.39	64.29	55.0	2.1E-04	16.0	8
14.50	19.85	5.35	7.6	4.0	17.18	1.50	2.68	56.00	43.0	1.9E-04	14.4	9
14.50	19.85	5.35	7.6	2.0	17.18	1.50	1.58	37.10	33.0	2.2E-04	16.6	10
19.85	25.00	5.15	7.6	1.0	22.43	2.00	3.67	30.76	43.0	3.5E-04	27.1	1
19.85	25.00	5.15	7.6	3.0	22.43	2.00	7.15	47.28	60.0	3.2E-04	24.6	2
19.85	25.00	5.15	7.6	6.0	22.43	2.00	11.17	73.26	75.0	2.6E-04	19.9	3
19.85	25.00	5.15	7.6	8.0	22.43	2.00	12.70	91.73	80.0	2.2E-04	16.9	4
25.00	29.00	4.00	7.6	1.0	27.00	0.45	4.84	32.61	44.0	4.2E-04	33.7	1
25.00	29.00	4.00	7.6	3.0	27.00	0.45	8.41	49.04	58.0	3.7E-04	29.6	2
25.00	29.00	4.00	7.6	6.0	27.00	0.45	14.44	73.01	76.0	3.2E-04	26.0	3
25.00	29.00	4.00	7.6	8.0	27.00	0.45	16.49	91.05	81.0	2.7E-04	22.2	4
25.00	29.00	4.00	7.6	10.0	27.00	0.45	20.70	106.75	91.0	2.6E-04	21.3	5
25.00	29.00	4.00	7.6	9.0	27.00	0.45	17.22	100.23	83.0	2.6E-04	20.7	6
25.00	29.00	4.00	7.6	7.0	27.00	0.45	14.82	82.63	77.0	2.9E-04	23.3	7
25.00	29.00	4.00	7.6	5.0	27.00	0.45	10.24	67.21	64.0	2.9E-04	23.8	8
25.00	29.00	4.00	7.6	4.0	27.00	0.45	8.70	58.75	59.0	3.1E-04	25.1	9
25.00	29.00	4.00	7.6	2.0	27.00	0.45	5.29	42.16	46.0	3.4E-04	27.3	10
25.00	35.00	10.00	7.0	1.0	30.00	0.45	4.41	36.04	42.0	1.7E-04	11.7	1
25.00	35.00	10.00	7.0	3.0	30.00	0.45	8.12	52.33	57.0	1.6E-04	10.9	2
25.00	35.00	10.00	7.0	6.0	30.00	0.45	13.69	76.76	74.0	1.4E-04	9.6	3
25.00	35.00	10.00	7.0	8.0	30.00	0.45	16.31	93.64	82.0	1.3E-04	8.8	4
25.00	35.00	10.00	7.0	10.0	30.00	0.45	20.70	109.75	91.0	1.2E-04	8.3	5
25.00	35.00	10.00	7.0	9.0	30.00	0.45	19.36	101.09	88.0	1.3E-04	8.7	6
25.00	35.00	10.00	7.0	7.0	30.00	0.45	15.21	85.24	78.0	1.4E-04	9.2	7
25.00	35.00	10.00	7.0	5.0	30.00	0.45	11.22	69.23	67.0	1.5E-04	9.7	8
25.00	35.00	10.00	7.0	4.0	30.00	0.45	9.61	60.84	62.0	1.5E-04	10.2	9
25.00	35.00	10.00	7.0	2.0	30.00	0.45	6.00	44.45	49.0	1.7E-04	11.0	10
35.00	40.00	5.00	7.0	1.0	31.10	1.85	0.01	42.94	2.0	1.2E-05	0.9	1
35.00	40.00	5.00	7.0	3.0	31.10	1.85	0.09	62.86	5.0	2.1E-05	1.6	2
35.00	40.00	5.00	7.0	6.0	31.10	1.85	0.28	92.67	9.0	2.6E-05	1.9	3
35.00	40.00	5.00	7.0	8.0	31.10	1.85	1.01	111.94	17.0	4.0E-05	3.0	4
35.00	40.00	5.00	7.0	10.0	31.10	1.85	3.36	129.59	31.0	6.3E-05	4.8	5
35.00	40.00	5.00	7.0	9.0	31.10	1.85	3.81	119.14	33.0	7.3E-05	5.5	6

Table D-10 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T1-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
5.00	10.00	5.00	7.6	1.0	3.25	2.00	0.03	15.22	8.0	1.4E-04	10.5	1
5.00	10.00	5.00	7.6	3.0	3.25	2.00	0.14	35.11	17.0	1.3E-04	9.7	2
5.00	10.00	5.00	7.6	6.0	3.25	2.00	0.45	64.80	30.0	1.2E-04	9.3	3
5.00	10.00	5.00	7.6	8.0	3.25	2.00	0.88	84.37	42.0	1.3E-04	10.0	4
5.00	10.00	5.00	7.6	10.0	3.25	2.00	1.35	103.90	52.0	1.3E-04	10.0	5
5.00	10.00	5.00	7.6	9.0	3.25	2.00	1.15	94.10	48.0	1.3E-04	10.2	6
5.00	10.00	5.00	7.6	7.0	3.25	2.00	0.72	74.53	38.0	1.3E-04	10.2	7
5.00	10.00	5.00	7.6	5.0	3.25	2.00	0.39	54.86	28.0	1.3E-04	10.2	8
5.00	10.00	5.00	7.6	4.0	3.25	2.00	0.26	44.99	23.0	1.3E-04	10.2	9
5.00	10.00	5.00	7.6	2.0	3.25	1.50	0.06	24.69	11.0	1.2E-04	8.9	10
10.00	15.00	5.00	7.0	1.0	3.15	2.06	0.01	15.20	3.0	5.2E-05	3.9	1
10.00	15.00	5.00	7.0	3.0	3.15	2.06	0.04	35.17	6.3	4.5E-05	3.4	2
10.00	15.00	5.00	7.0	6.0	3.15	2.06	0.23	64.99	15.0	6.1E-05	4.6	3
10.00	15.00	5.00	7.0	8.0	3.15	2.06	0.44	847.77	21.0	6.5E-05	5.0	4
10.00	15.00	5.00	7.0	10.0	3.15	2.06	0.96	104.25	31.0	7.8E-05	5.9	5
10.00	15.00	5.00	7.0	9.0	3.15	2.06	0.78	94.43	28.0	7.8E-05	5.9	6
10.00	15.00	5.00	7.0	7.0	3.15	2.06	0.48	74.73	22.0	7.8E-05	5.9	7
10.00	15.00	5.00	7.0	5.0	3.15	2.06	0.29	54.92	17.0	8.2E-05	6.2	8
10.00	15.00	5.00	7.0	4.0	3.15	2.06	0.23	44.99	15.0	8.8E-05	6.7	9
10.00	15.00	5.00	7.0	2.0	3.15	2.06	0.10	25.11	10.0	1.0E-04	8.0	10
15.00	20.00	5.00	7.0	1.0	3.15	1.50	0.15	14.50	10.0	1.8E-04	13.8	1
15.00	20.00	5.00	7.0	3.0	3.15	1.50	0.66	33.99	21.0	1.6E-04	12.4	2
15.00	20.00	5.00	7.0	6.0	3.15	1.50	1.26	63.39	29.0	1.2E-04	9.1	3
15.00	20.00	5.00	7.0	8.0	3.15	1.50	1.84	82.81	35.0	1.1E-04	8.5	4
15.00	20.00	5.00	7.0	10.0	3.15	1.50	2.65	102.00	42.0	1.1E-04	8.2	5
15.00	20.00	5.00	7.0	9.0	3.15	1.50	1.94	92.71	36.0	1.0E-04	7.8	6
15.00	20.00	5.00	7.0	7.0	3.15	1.50	1.01	73.64	26.0	9.3E-05	7.1	7
15.00	20.00	5.00	7.0	5.0	3.15	1.50	0.49	54.16	18.0	8.8E-05	6.6	8
15.00	20.00	5.00	7.0	4.0	3.15	1.50	0.34	44.31	15.0	8.9E-05	6.8	9
15.00	20.00	5.00	7.0	2.0	3.15	1.50	0.07	24.58	7.0	7.3E-05	5.7	10
20.00	25.00	5.00	7.0	1.0	3.15	1.50	0.29	14.36	12.0	2.2E-04	16.7	1
20.00	25.00	5.00	7.0	3.0	3.15	1.50	1.06	33.59	23.0	1.8E-04	13.7	2
20.00	25.00	5.00	7.0	6.0	3.15	1.50	1.68	62.97	29.0	1.2E-04	9.2	3
20.00	25.00	5.00	7.0	8.0	3.15	1.50	2.89	91.76	38.0	1.2E-04	9.3	4
20.00	25.00	5.00	7.0	10.0	3.15	1.50	3.36	101.29	41.0	1.1E-04	8.1	5
20.00	25.00	5.00	7.0	9.0	3.15	1.50	2.05	92.60	32.0	9.1E-05	6.9	6
20.00	25.00	5.00	7.0	7.0	3.15	1.50	1.15	73.50	24.0	8.6E-05	6.5	7
20.00	25.00	5.00	7.0	5.0	3.15	1.50	0.65	54.00	18.0	8.8E-05	6.7	8
20.00	25.00	5.00	7.0	4.0	3.15	1.50	0.39	44.26	14.0	8.3E-05	6.3	9
20.00	25.00	5.00	7.0	2.0	3.15	1.50	0.13	24.52	8.0	8.6E-05	6.5	10

(cont'd) Borehole Number: TI-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
25.00	30.00	5.00	7.0	1.0	3.60	2.00	0.01	15.59	1.5	2.5E-05	1.9	1
25.00	30.00	5.00	7.0	3.0	3.60	2.00	0.04	35.56	4.0	3.0E-05	2.2	2
25.00	30.00	5.00	7.0	6.0	3.60	2.00	0.25	65.35	10.0	4.0E-05	3.1	3
25.00	30.00	5.00	7.0	8.0	3.60	2.00	0.42	85.19	13.0	4.0E-05	3.1	4
25.00	30.00	5.00	7.0	10.0	3.69	2.00	0.81	104.79	18.0	4.5E-05	3.4	5
25.00	30.00	5.00	7.0	9.0	3.60	2.00	0.64	94.96	16.0	4.4E-05	3.4	6
25.00	30.00	5.00	7.0	7.0	3.60	2.00	0.42	75.18	13.0	4.6E-05	3.5	7
25.00	30.00	5.00	7.0	5.0	3.60	2.00	0.30	55.30	11.0	5.2E-05	4.0	8
25.00	30.00	5.00	7.0	4.0	3.60	2.00	0.20	45.40	9.0	5.2E-05	4.0	9
25.00	30.00	5.00	7.0	2.0	3.60	2.00	0.06	25.54	5.0	5.2E-05	3.9	10
30.00	35.00	5.00	7.0	1.0	3.00	1.50	0.87	13.63	17.0	3.3E-04	24.9	1
30.00	35.00	5.00	7.0	3.0	3.00	1.50	2.70	31.89	30.0	2.5E-04	18.9	2
30.00	35.00	5.00	7.0	6.0	3.00	1.50	6.35	58.15	45.0	2.1E-04	15.8	3
30.00	35.00	5.00	7.0	8.0	3.00	1.50	8.11	76.39	52.0	1.8E-04	13.6	4
30.00	35.00	5.00	7.0	10.0	3.00	1.50	10.44	94.06	59.0	1.7E-04	12.5	5
30.00	35.00	5.00	7.0	9.0	3.00	1.50	9.07	85.43	55.0	1.7E-04	12.9	6
30.00	35.00	5.0	7.0	7.0	3.00	1.50	7.50	67.00	50.0	2.0E-04	14.9	7
30.00	35.00	5.00	7.0	5.0	3.00	1.50	4.80	49.70	40.0	2.1E-04	16.1	8
30.00	35.00	5.00	7.0	4.0	3.00	1.50	3.67	40.83	35.0	2.3E-04	17.1	9
30.00	35.00	5.00	7.0	2.0	3.00	1.50	1.59	22.91	23.0	2.6E-04	20.1	10
35.00	40.00	5.00	7.0	1.0	3.00	2.00	0.02	14.98	2.5	4.4E-05	3.3	1
35.00	40.00	5.00	7.0	3.0	3.00	2.00	0.17	34.83	7.0	5.3E-05	4.0	2
35.00	40.00	5.00	7.0	6.0	3.00	2.00	0.69	64.31	14.0	5.7E-05	4.4	3
35.00	40.00	5.00	7.0	8.0	3.00	2.00	1.13	83.87	18.0	5.7E-05	4.3	4
35.00	40.00	5.00	7.0	10.0	3.00	2.00	1.40	103.60	20.0	5.1E-05	3.9	5
35.00	40.00	5.00	7.0	9.0	3.00	2.00	1.13	93.87	18.0	5.0E-05	3.8	6
35.00	40.00	5.00	7.0	7.0	3.00	2.00	0.69	74.31	14.0	5.0E-05	3.8	7
35.00	40.00	5.00	7.0	5.0	3.00	2.00	0.35	54.65	10.0	4.8E-05	3.7	8
35.00	40.00	5.00	7.0	4.0	3.00	2.00	0.22	44.78	8.0	4.7E-05	3.6	9
35.00	40.00	5.00	7.0	2.0	3.00	2.00	0.09	24.91	5.0	5.3E-05	4.0	10
40.00	45.00	5.00	7.0	1.0	3.15	2.00	0.90	14.25	15.0	2.8E-04	21.1	1
40.00	45.00	5.00	7.0	3.0	3.15	2.00	2.30	32.85	24.0	1.9E-04	14.6	2
40.00	45.00	5.00	7.0	6.0	3.15	2.00	4.36	60.79	33.0	1.4E-04	10.9	3
40.00	45.00	5.00	7.0	8.0	3.15	2.00	6.08	79.07	39.0	1.3E-04	9.9	4
40.00	45.00	5.00	7.0	10.0	3.15	2.00	8.10	97.05	45.0	1.2E-04	9.3	5
40.00	45.00	5.00	7.0	9.0	3.15	2.00	6.40	88.75	40.0	1.2E-04	9.0	6
40.00	45.00	5.00	7.0	7.0	3.15	2.00	4.36	70.79	33.0	1.2E-04	9.3	7
40.00	45.00	5.00	7.0	5.0	3.15	2.00	2.70	52.45	26.0	1.3E-04	9.9	8
40.00	45.00	5.00	7.0	4.0	3.15	2.00	1.94	43.21	22.0	1.3E-04	10.2	9
40.00	45.00	5.00	7.0	2.0	3.15	2.00	0.58	24.57	12.0	1.3E-04	9.8	10

Table D-11 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: H-34

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
7.00	12.00	5.0	7.6	1.0	9.50	0.00	0.91	18.59	36.0	5.0E-04	38.7	1
7.00	12.00	5.00	7.6	3.0	9.50	0.00	2.20	37.30	56.9	3.9E-04	30.0	2
7.00	12.00	5.00	7.6	6.0	9.50	0.00	4.59	64.91	81.0	3.2E-04	25.0	3
7.00	12.00	5.00	7.6	8.0	9.50	0.00	6.05	83.45	93.0	2.9E-04	22.3	4
7.00	12.00	5.00	7.6	7.0	9.50	0.00	5.18	74.32	86.0	3.0E-04	23.1	5
7.00	12.00	5.00	7.6	5.0	9.50	0.00	3.73	55.77	73.0	3.4E-04	26.2	6
7.00	12.00	5.00	7.6	4.0	9.50	0.00	3.05	46.45	66.0	3.7E-04	28.4	7
7.00	12.00	5.00	7.6	2.0	9.50	0.00	1.55	27.95	47.0	4.4E-04	33.6	8
12.00	16.00	4.00	7.6	1.0	14.00	0.23	0.69	23.54	24.0	3.1E-04	25.5	1
12.00	16.00	4.00	7.6	3.0	14.00	0.23	1.39	42.84	34.0	2.5E-04	19.8	2
12.00	16.00	4.00	7.6	6.0	14.00	0.23	3.55	68.68	68.0	3.1E-04	24.8	3
12.00	16.00	4.00	7.6	8.0	14.00	0.23	7.30	86.93	78.0	2.8E-04	22.4	4
12.00	16.00	4.00	7.6	10.0	14.00	0.23	8.88	105.35	86.0	2.5E-04	20.4	5
12.00	16.00	4.00	7.6	9.0	14.00	0.23	8.27	95.96	83.0	2.7E-04	21.6	6
12.00	16.00	4.00	7.6	7.0	14.00	0.23	6.39	77.84	73.0	2.9E-04	23.4	7
12.00	16.00	4.00	7.6	4.0	14.00	0.23	3.63	50.60	55.0	3.4E-04	27.2	9
12.00	16.00	4.00	7.6	2.0	14.00	0.23	1.92	32.31	40.0	3.8E-04	31.0	10
16.00	21.00	5.00	7.6	1.0	15.25	1.35	0.58	26.02	19.0	1.9E-04	14.6	1
16.00	21.00	5.00	7.6	3.0	15.25	1.35	1.96	44.64	35.0	2.0E-04	15.7	2
16.00	21.00	5.00	7.6	6.0	15.25	1.35	2.69	73.91	41.0	1.4E-04	11.1	3
16.00	21.00	5.00	7.6	8.0	15.25	1.35	4.33	92.27	52.0	1.5E-04	11.3	4
16.00	21.00	5.00	7.6	10.0	15.25	1.35	5.95	110.65	61.0	1.4E-04	11.0	5
16.00	21.00	5.00	7.6	9.0	15.25	1.35	4.00	102.60	50.0	1.3E-04	9.7	6
16.00	21.00	5.00	7.6	7.0	15.25	1.35	1.44	85.16	30.0	9.1E-05	7.0	7
16.00	21.00	5.00	7.6	5.0	15.25	1.35	0.31	66.29	14.0	5.5E-05	4.2	8
16.00	21.00	5.00	7.6	4.0	15.25	1.35	0.13	56.47	9.0	4.1E-05	3.2	9
16.00	21.00	5.00	7.6	2.0	15.25	1.35	0.03	36.57	4.0	2.8E-05	2.2	10
21.00	26.00	5.00	7.6	1.0	20.75	1.50	0.01	32.24	2.0	1.6E-05	1.2	1
21.00	26.00	5.00	7.6	3.0	20.75	1.50	0.03	52.22	4.0	2.0E-05	1.5	2
21.00	26.00	5.00	7.6	6.0	20.75	1.50	0.30	81.95	12.0	3.8E-05	2.9	3
21.00	26.00	5.00	7.6	8.0	20.75	1.50	1.31	100.94	25.0	6.4E-05	5.0	4
21.00	26.00	5.00	7.6	10.0	20.75	1.50	4.64	117.61	47.0	1.0E-04	8.0	5
21.00	26.00	5.00	7.6	9.0	20.75	1.50	4.64	107.61	47.0	1.1E-04	8.7	6
21.00	26.00	5.00	7.6	7.0	20.75	1.50	3.03	89.22	38.0	1.1E-04	8.5	7
21.00	26.00	5.00	7.6	5.0	20.75	1.50	1.11	71.14	23.0	8.4E-05	6.5	8
21.00	26.00	5.00	7.6	4.0	20.75	1.50	0.68	61.57	18.0	7.6E-05	5.8	9
21.00	26.00	5.00	7.6	2.0	20.75	1.50	0.13	42.12	8.0	4.9E-05	3.8	10

(cont'd) Borehole Number: TT-B4

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
26.00	31.00	5.00	7.6	1.0	27.00	2.00	0.06	38.94	5.0	3.3E-05	2.6	1
26.00	31.00	5.00	7.6	3.0	27.00	2.00	0.59	58.42	15.0	6.6E-05	5.1	2
26.00	31.00	5.00	7.6	6.0	27.00	2.00	4.37	84.63	41.0	1.3E-04	9.7	3
26.00	31.00	5.00	7.6	8.0	27.00	2.00	7.86	101.14	55.0	1.4E-04	10.9	4
26.00	31.00	5.00	7.6	10.0	27.00	2.00	11.33	117.67	66.0	1.5E-04	11.2	5
26.00	31.00	5.00	7.6	9.0	27.00	2.00	9.67	109.33	61.0	1.4E-04	11.2	6
26.00	31.00	5.00	7.6	7.0	27.00	2.00	7.03	91.97	52.0	1.5E-04	11.3	7
26.00	31.00	5.00	7.6	5.0	27.00	2.00	4.81	74.19	43.0	1.5E-04	11.6	8
26.00	31.00	5.00	7.6	4.0	27.00	2.00	3.95	65.05	39.0	1.6E-04	12.0	9
26.00	31.00	5.00	7.6	2.0	27.00	2.00	2.19	45.81	29.0	1.6E-04	12.4	10
31.00	36.00	5.00	6.9	1.0	25.30	0.50	0.08	35.72	5.0	3.7E-05	2.8	1
31.00	36.00	5.00	6.9	3.0	25.30	0.50	1.00	54.80	18.0	8.7E-05	6.6	2
31.00	36.00	5.00	6.9	6.0	25.30	0.50	5.47	80.33	42.0	1.4E-04	10.5	3
31.00	36.00	5.00	6.9	8.0	25.30	0.50	9.04	96.76	54.0	1.5E-04	11.2	4
31.00	36.00	5.00	6.9	10.0	25.30	0.50	13.10	112.70	65.0	1.5E-04	11.5	5
31.00	36.00	5.00	6.9	9.0	25.30	0.50	11.16	104.64	60.0	1.5E-04	11.5	6
31.00	36.00	5.00	6.9	7.0	25.30	0.50	8.06	87.74	51.0	1.5E-04	11.6	7
31.00	36.00	5.00	6.9	5.0	25.30	0.50	5.47	70.33	42.0	1.6E-04	11.9	8
31.00	36.00	5.00	6.9	4.0	25.30	0.50	3.80	62.00	35.0	1.5E-04	11.3	9
31.00	36.00	5.00	6.9	2.0	25.30	0.50	2.26	43.54	27.0	1.6E-04	12.4	10
36.00	40.00	4.00	6.9	1.0	26.40	2.05	0.01	38.44	2.0	1.6E-05	1.3	1
36.00	40.00	4.00	6.9	3.0	26.40	2.05	0.03	58.42	3.0	1.6E-05	1.3	2
36.00	40.00	4.00	6.9	6.0	26.40	2.05	0.36	88.09	10.0	3.6E-05	2.3	3
36.00	40.00	4.00	6.9	9.0	26.40	2.05	3.92	104.53	33.0	10.0E-05	7.9	4
36.00	40.00	4.00	6.9	10.0	26.40	2.05	6.97	121.48	44.0	1.1E-04	9.1	5
36.00	40.00	4.00	6.9	9.0	26.40	2.05	6.35	112.10	42.0	1.2E-04	9.4	6
36.00	40.00	4.00	6.9	7.0	26.40	2.05	4.16	91.29	34.0	1.1E-04	9.0	7
36.00	40.00	4.00	6.9	3.0	26.40	2.05	2.43	76.02	26.0	1.1E-04	8.6	8
36.00	40.00	4.00	6.9	4.0	26.40	2.05	2.07	66.38	24.0	1.1E-04	9.0	9
36.00	40.00	4.00	6.9	2.0	26.40	2.05	1.04	47.41	17.0	1.1E-04	9.0	10

Table D-12 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T2-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (m)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient or Permeability (cm/s)	Lugeon Unit	Step No.
10.00	15.00	5.00	5.5	1.0	12.06	1.15	2.59	20.62	36.0	4.8E-04	34.9	1
10.00	15.00	5.00	5.5	3.0	12.06	1.15	4.61	38.60	48.0	3.4E-04	24.9	2
10.00	15.00	5.00	5.5	2.5	12.06	1.15	11.25	26.96	75.0	7.7E-04	55.6	3
10.00	15.00	5.00	5.5	2.0	12.06	1.15	5.20	28.01	51.0	5.0E-04	36.4	4
15.00	20.00	5.00	5.5	1.0	12.34	1.15	4.80	18.69	40.0	5.3E-04	42.8	1
15.00	20.00	5.00	5.5	2.0	12.34	1.15	12.67	20.82	65.0	8.5E-04	62.5	2
20.00	25.00	5.00	5.5	0.8	22.50	1.15	15.83	15.77	63.0	1.1E-03	79.9	1
20.00	25.00	5.00	5.5	1.2	22.50	1.15	16.90	18.75	65.0	9.6E-04	69.3	2
20.00	25.00	5.00	5.5	1.0	22.50	1.15	14.88	18.77	61.0	9.0E-04	65.0	3
25.00	30.00	5.00	5.5	3.0	22.20	1.15	8.82	44.53	42.0	2.6E-04	18.9	1
25.00	30.00	5.00	5.5	5.0	22.20	1.15	24.50	45.85	70.0	4.0E-04	28.7	2
25.00	30.00	5.00	5.5	2.0	22.20	1.15	13.00	30.35	51.0	4.6E-04	33.6	3
30.00	35.00	5.00	5.5	1.0	26.10	1.15	0.01	37.24	1.0	7.4E-06	0.5	1
30.00	35.00	5.00	5.5	3.0	26.10	1.15	0.22	57.03	6.0	2.9E-05	2.1	2
30.00	35.00	5.00	5.5	5.0	26.10	1.15	1.94	75.31	18.0	6.6E-05	4.8	3
30.00	35.00	5.00	5.5	7.0	26.10	1.15	2.90	94.35	22.0	6.4E-05	4.7	4
30.00	35.00	5.00	5.5	10.0	26.10	1.15	7.35	119.90	35.0	8.1E-05	5.8	5
30.00	35.00	5.00	5.5	8.0	26.10	1.15	5.40	101.85	30.0	8.1E-05	5.9	6
30.00	35.00	5.00	5.5	6.0	26.10	1.15	3.37	84.08	23.0	7.6E-05	5.5	7
30.00	35.00	5.00	5.5	4.0	26.10	1.15	1.94	65.31	18.0	7.6E-05	5.5	8
30.00	35.00	5.00	5.5	2.0	26.10	1.15	1.18	46.07	14.0	8.4E-05	6.1	9
35.00	40.00	5.00	5.5	1.0	28.50	1.15	25.20	14.45	60.0	1.1E-03	83.0	1
35.00	40.00	5.00	5.5	1.2	28.50	1.15	34.30	7.35	70.0	2.6E-03	190.5	2
35.00	40.00	5.00	5.5	1.0	28.50	1.15	31.42	8.23	67.0	2.2E-03	162.9	3

Table D-13 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: B2-B2

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (m)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient or Permeability (cm/s)	Lugeon Unit -	Step No.
10.00	15.00	5.00	5.5	1.0	0.45	2.00	0.89	11.65	20.0	4.7E-04	34.3	1
10.00	15.00	5.00	5.5	3.0	0.45	2.00	2.89	29.56	38.0	3.5E-04	25.7	2
10.00	15.00	5.00	5.5	5.0	0.45	2.00	0.00	52.45	0.0	0.0E-00	0.0	3
15.00	20.00	5.00	5.5	1.0	0.15	2.00	4.33	7.82	38.0	1.3E-03	97.2	1
15.00	20.00	5.00	5.5	3.0	0.15	2.00	15.12	17.03	71.0	1.2E-03	83.4	2
20.20	25.00	4.80	5.5	1.0	0.15	2.00	0.40	11.75	10.0	2.4E-04	17.7	1
20.20	25.00	4.80	5.5	3.0	0.15	2.00	1.96	30.19	22.0	2.1E-04	15.2	2
20.20	25.00	4.80	5.5	5.0	0.15	2.00	2.33	49.82	24.0	1.4E-04	10.0	3
20.20	25.00	4.80	5.5	7.0	0.15	2.00	3.64	68.51	30.0	1.2E-04	9.1	4
20.20	25.00	4.80	5.5	10.0	0.15	2.00	4.67	97.48	34.0	10.0E-05	7.3	5
20.20	25.00	4.80	5.5	8.0	0.15	2.00	2.14	80.01	23.0	8.2E-05	6.0	6
20.20	25.00	4.80	5.5	6.0	0.15	2.00	1.03	61.12	16.0	7.5E-05	5.5	7
20.20	25.00	4.80	5.5	4.0	0.15	2.00	0.33	41.82	9.0	6.1E-05	4.5	8
20.20	25.00	4.80	5.5	2.0	0.15	2.00	0.02	22.13	2.0	2.8E-05	1.9	9
24.00	30.00	6.00	5.5	1.0	0.15	2.00	0.39	11.76	9.0	1.8E-04	12.8	1
24.00	30.00	6.00	5.5	3.0	0.15	2.00	1.08	31.07	15.0	1.1E-04	8.0	2
24.00	30.00	6.00	5.5	5.0	0.15	2.00	2.12	50.03	21.0	10.0E-05	7.0	3
24.00	30.00	6.00	5.5	7.0	0.15	2.00	6.33	65.22	38.0	1.4E-04	9.7	4
24.00	30.00	6.00	5.5	10.0	0.15	2.00	15.05	87.10	56.0	1.5E-04	10.7	5
24.00	30.00	6.00	5.5	8.0	0.15	2.00	9.72	72.43	45.0	1.5E-04	10.4	6
24.00	30.00	6.00	5.5	6.0	0.15	2.00	6.22	55.93	36.0	1.5E-04	10.7	7
24.00	30.00	6.00	5.5	4.0	0.15	2.00	3.00	39.15	25.0	1.5E-04	10.6	8
24.00	30.00	6.00	5.5	2.0	0.15	2.00	1.92	20.23	20.0	2.4E-04	16.5	9
30.00	35.00	5.00	5.5	1.0	-0.05	2.00	0.05	11.90	3.0	7.0E-05	5.0	1
30.00	35.00	5.00	5.5	3.0	-0.05	2.00	0.15	31.80	5.0	4.3E-05	3.1	2
30.00	35.00	5.00	5.5	5.0	-0.05	2.00	0.73	51.22	11.0	5.9E-05	4.3	3
30.00	35.00	5.00	5.5	7.0	-0.05	2.00	1.54	70.41	16.0	6.3E-05	4.5	4
30.00	35.00	5.00	5.5	10.0	-0.05	2.00	8.40	63.55	10.0	3.5E-04	5.2	5
32.50	40.30	7.80	5.5	1.0	-3.00	2.00	1.10	7.90	13.0	3.2E-04	21.1	1
32.50	40.30	7.80	5.5	3.0	-3.00	2.00	18.95	10.05	54.0	1.0E-03	68.9	2
32.50	40.30	7.80	5.5	5.0	-3.00	2.00	29.18	19.82	67.0	6.5E-04	43.3	3

Table D-14 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T2-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (m)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
15.00	20.00	5.00	5.5	1.0	17.50	1.70	10.44	18.76	59.0	8.7E-04	62.9	1
15.00	20.00	5.00	5.5	1.5	17.50	1.70	12.67	21.53	65.0	8.3E-04	60.4	2
15.00	20.00	5.00	5.5	1.0	17.50	1.70	8.75	20.45	54.0	7.3E-04	52.8	3
20.00	25.00	5.00	5.5	1.0	22.50	1.70	10.00	24.20	50.0	5.7E-04	41.3	1
20.00	25.00	5.00	5.5	1.5	22.50	1.70	16.90	22.30	65.0	8.0E-04	58.3	2
20.00	25.00	5.00	5.5	1.0	22.50	1.70	10.00	24.20	50.0	5.7E-04	41.3	3
25.00	30.00	5.00	5.5	1.0	27.50	1.70	11.52	27.68	48.0	4.8E-04	34.7	1
25.00	30.00	5.00	5.5	3.0	27.50	1.70	18.61	40.60	61.0	4.1E-04	30.1	2
25.00	30.00	5.00	5.5	2.0	27.50	1.70	14.05	35.16	53.0	4.2E-04	30.2	3
29.50	35.00	5.50	5.5	1.0	32.25	1.70	2.13	41.82	19.0	1.2E-04	8.3	1
29.50	35.00	5.50	5.5	3.0	32.25	1.70	3.99	59.96	26.0	1.1E-04	7.9	2
29.50	35.00	5.50	5.5	5.0	32.25	1.70	8.08	75.87	37.0	1.2E-04	8.9	3
29.50	35.00	5.50	5.5	6.5	32.25	1.70	13.59	85.36	48.0	1.4E-04	10.2	4
29.50	35.00	5.50	5.5	4.0	32.25	1.70	6.82	67.13	34.0	1.3E-04	9.2	5
29.50	35.00	5.50	5.5	2.0	32.25	1.70	3.40	50.55	24.0	1.2E-04	8.6	6
35.00	40.00	5.00	5.5	1.0	34.22	1.70	0.17	45.75	5.0	3.0E-05	2.2	1
35.00	40.00	5.00	5.5	3.0	34.22	1.70	0.34	65.58	7.0	2.9E-05	2.1	2
35.00	40.00	5.00	5.5	5.0	34.22	1.70	0.45	85.47	8.0	2.6E-05	1.9	3
35.00	40.00	5.00	5.5	7.0	34.22	1.70	1.18	104.74	13.0	3.4E-05	2.5	4
35.00	40.00	5.00	5.5	10.0	34.22	1.70	1.79	134.13	16.0	3.3E-05	2.4	5
35.00	40.00	5.00	5.5	8.0	34.22	1.70	1.37	114.55	14.0	3.4E-05	2.4	6
35.00	40.00	5.00	5.5	6.0	34.22	1.70	0.70	95.22	10.0	2.9E-05	2.1	7
35.00	40.00	5.00	5.5	4.0	34.22	1.70	0.45	75.47	8.0	2.9E-05	2.1	8
35.00	40.00	5.00	5.5	2.0	34.22	1.70	0.25	55.67	6.0	3.0E-05	2.2	9

Table D-15 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T2-B4

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (m)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
5.50	10.00	4.50	5.5	0.5	1.60	1.75	5.24	3.11	69.0	6.7E-03	492.6	1
10.00	15.00	5.00	5.5	1.0	1.80	3.00	1.80	13.00	30.0	6.4E-04	45.2	1
10.00	15.00	5.00	5.5	2.0	1.80	3.00	4.80	20.00	49.0	6.8E-04	45.0	2
15.00	20.00	5.00	5.5	1.0	1.80	3.00	0.51	14.29	13.0	2.5E-04	18.2	1
15.00	20.00	5.00	5.5	3.0	1.80	3.00	1.73	33.07	24.0	2.0E-04	14.5	2
15.00	20.00	5.00	5.5	5.0	1.80	3.00	4.33	50.47	38.0	2.1E-04	15.1	3
15.00	20.00	5.00	5.5	4.0	1.80	3.00	3.67	41.13	35.0	2.3E-04	17.0	4
15.00	20.00	5.00	5.5	2.0	1.80	3.00	1.32	23.48	21.0	2.5E-04	17.9	5
20.00	25.00	5.00	5.5	1.0	1.60	3.00	0.40	14.20	10.0	1.9E-04	14.1	1
20.00	25.00	5.00	5.5	3.0	1.60	3.00	2.30	32.30	24.0	2.1E-04	14.9	2
20.00	25.00	5.00	5.5	5.0	1.60	3.00	4.36	50.24	33.0	1.8E-04	13.1	3
20.00	25.00	5.00	5.5	7.0	1.60	3.00	6.40	68.20	40.0	1.6E-04	11.7	4
20.00	25.00	5.00	5.5	10.0	1.60	3.00	8.45	96.14	46.0	1.3E-04	9.6	5
20.00	25.00	5.00	5.5	8.0	1.60	3.00	5.48	79.12	37.0	1.3E-04	9.4	6
20.00	25.00	5.00	5.5	6.0	1.60	3.00	1.76	62.84	21.0	9.2E-05	6.7	7
20.00	25.00	5.00	5.5	4.0	1.60	3.00	0.68	43.92	13.0	8.2E-05	5.9	8
20.00	25.00	5.00	5.5	2.0	1.60	3.00	0.10	24.50	5.0	5.6E-05	4.1	9
25.00	30.00	5.00	5.5	1.0	1.40	3.00	0.18	14.22	6.0	1.2E-04	8.4	1
25.00	30.00	5.00	5.5	3.0	1.40	3.00	1.62	32.78	18.0	1.5E-04	11.0	2
25.00	30.00	5.00	5.5	5.0	1.40	3.00	3.38	51.02	26.0	1.4E-04	10.2	3
25.00	30.00	5.00	5.5	7.0	1.40	3.00	4.30	69.90	30.0	1.2E-04	8.6	4
25.00	30.00	5.00	5.5	10.0	1.40	3.00	8.40	96.00	41.0	1.2E-04	8.5	5
25.00	30.00	5.00	5.5	8.0	1.40	3.00	6.85	77.56	37.0	1.3E-04	9.5	6
25.00	30.00	5.00	5.5	6.0	1.40	3.00	2.20	62.20	21.0	9.3E-05	6.8	7
25.00	30.00	5.00	5.5	4.0	1.40	3.00	0.84	43.56	13.0	8.2E-05	6.0	8
25.00	30.00	5.00	5.5	2.0	1.40	3.00	0.18	24.22	6.0	6.8E-05	5.0	9
30.00	35.00	5.00	5.5	1.0	1.40	3.00	5.05	9.35	29.0	8.6E-04	62.0	1
30.00	35.00	5.00	5.5	3.0	1.40	3.00	21.60	12.80	69.0	1.3E-03	93.7	2
30.00	35.00	5.00	5.5	2.0	1.40	3.00	9.60	14.80	49.0	7.5E-04	54.1	3
35.00	40.00	5.00	5.5	1.0	1.60	3.00	0.00	14.60	0.0	0.0E+00	0.0	1
35.00	40.00	5.00	5.5	3.0	1.60	3.00	0.03	34.57	2.0	1.6E-05	1.2	2
35.00	40.00	5.00	5.5	5.0	1.60	3.00	0.11	54.49	4.0	2.0E-05	1.5	3
35.00	40.00	5.00	5.5	7.0	1.60	3.00	0.45	73.15	8.0	3.0E-05	2.2	4
35.00	40.00	5.00	5.5	10.0	1.60	3.00	2.27	102.33	18.0	4.9E-05	3.5	5
35.00	40.00	5.00	5.5	8.0	1.60	3.00	1.18	83.42	13.0	4.3E-05	3.1	6
35.00	40.00	5.00	5.5	6.0	1.60	3.00	0.57	64.03	9.0	3.9E-05	2.8	7
35.00	40.00	5.00	5.5	4.0	1.60	3.00	0.25	44.35	6.0	3.7E-05	2.7	8
35.00	40.00	5.00	5.5	2.0	1.60	3.00	0.06	24.54	3.0	3.4E-05	2.4	9

Table D-16 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: T4-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
12.00	16.00	4.00	7.6	1.0	8.50	2.20	0.63	20.07	23.0	3.5E-04	28.7	1
12.00	16.00	4.00	7.6	3.0	8.50	2.20	1.31	39.39	33.0	2.6E-04	20.9	2
12.00	16.00	4.00	7.6	6.0	8.5	2.20	3.76	66.94	56.0	2.6E-04	20.9	3
12.00	16.00	4.00	7.6	5.0	8.50	2.20	3.37	57.33	53.0	2.9E-04	23.1	4
12.00	16.00	4.00	7.6	4.0	8.50	2.20	2.22	48.48	43.0	2.7E-04	22.2	5
12.00	16.00	4.00	7.6	2.0	8.50	2.20	0.75	29.95	25.0	2.6E-04	20.9	6
25.00	30.00	5.00	7.6	1.0	20.00	0.10	0.12	29.98	7.0	6.0E-05	4.7	1
25.00	30.00	5.00	7.6	3.0	20.00	0.10	0.30	49.80	11.0	5.7E-05	4.4	2
25.00	30.00	5.00	7.6	6.0	20.00	0.10	1.56	78.54	25.0	8.2E-05	6.4	3
25.00	30.00	5.00	7.6	8.0	20.00	0.10	3.06	97.04	35.0	9.3E-05	7.2	4
25.00	30.00	5.00	7.6	10.0	20.00	0.10	4.41	115.69	42.0	9.4E-05	7.3	5
25.00	30.00	5.00	7.6	9.0	20.00	0.10	3.61	106.49	38.0	9.2E-05	7.1	6
25.00	30.00	5.00	7.6	7.0	20.00	0.10	2.56	87.54	32.0	9.5E-05	7.3	7
25.00	30.00	5.00	7.6	5.0	20.00	0.10	1.21	68.89	22.0	8.3E-05	6.4	8
25.00	30.00	5.00	7.6	4.0	20.00	0.10	0.90	59.20	19.0	8.3E-05	6.4	9
25.00	30.00	5.00	7.6	2.0	20.00	0.10	0.42	39.68	13.0	8.5E-05	6.6	10

Table D-17 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Numbers T4-B2

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
20.00	25.00	5.00	7.6	1.0	0.00	0.25	0.01	10.24	2.0	5.1E-05	3.9	1
20.00	25.00	5.00	7.6	3.0	0.00	0.25	0.34	29.91	13.0	1.1E-04	8.7	2
20.00	25.00	5.00	7.6	6.0	0.00	0.25	1.80	58.45	30.0	1.3E-04	10.3	3
20.00	25.00	5.00	7.6	8.0	0.00	0.25	3.36	76.89	41.0	1.4E-04	10.7	4
20.00	25.00	5.00	7.6	9.0	0.00	0.25	2.45	87.80	33.0	1.0E-04	8.0	5
20.00	25.00	5.00	7.6	7.0	0.00	0.25	1.35	68.90	26.0	9.5E-05	7.5	6
20.00	25.00	5.00	7.6	5.0	0.00	0.25	0.97	49.28	22.0	1.2E-04	3.9	7
20.00	25.00	5.00	7.6	4.0	0.00	0.25	0.34	39.91	13.0	8.4E-05	6.5	8
20.00	25.00	5.00	7.6	2.0	0.00	0.25	0.20	20.05	10.0	1.3E-04	10.0	9
25.00	30.00	5.00	7.6	1.0	0.00	0.25	0.02	10.33	2.5	6.3E-05	4.9	1
25.00	30.00	5.00	7.6	3.0	0.00	0.25	0.01	30.24	1.5	1.3E-05	1.0	2
25.00	30.00	5.00	7.6	6.0	0.00	0.25	0.02	60.23	3.0	1.3E-05	1.0	3
25.00	30.00	5.00	7.6	8.0	0.00	0.25	0.05	80.30	4.5	1.5E-05	1.1	4
25.00	30.00	5.00	7.6	10.0	0.00	0.25	0.11	100.14	6.5	1.7E-05	1.3	5
25.00	30.00	5.00	7.6	9.0	0.00	0.25	0.09	90.16	6.0	1.7E-05	1.3	6
25.00	30.00	5.00	7.6	7.0	0.00	0.25	0.02	70.23	3.0	1.1E-05	0.9	7
25.00	30.00	5.00	7.6	5.0	0.00	0.25	0.01	50.24	1.5	7.7E-06	0.6	8
25.00	30.00	5.00	7.6	4.0	0.00	0.25	0.00	40.25	1.0	6.4E-06	0.5	9
25.00	30.00	5.00	7.6	2.0	0.00	0.25	0.00	20.25	0.0	0.0E+00	0.0	10

Table D-18 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: VI-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
10.60	15.00	4.40	5.5	0.6	12.80	1.90	13.91	6.79	81.0	3.6E-03	271.1	1
15.00	20.00	5.00	5.5	1.0	17.50	1.90	8.43	20.97	33.0	7.0E-04	50.5	1
15.00	20.00	5.00	5.5	2.0	17.50	1.90	12.67	26.75	65.0	6.7E-04	48.6	2
15.00	20.00	5.00	5.5	3.0	17.50	1.90	16.67	32.53	75.0	6.4E-04	46.1	3
20.00	25.00	5.00	5.5	1.0	22.50	1.90	7.06	27.34	42.0	4.2E-04	30.7	1
20.00	25.00	5.00	5.5	2.0	22.50	1.90	12.10	32.30	55.0	4.7E-04	34.1	2
20.00	25.00	5.00	5.5	3.5	22.50	1.90	23.72	35.68	77.0	6.0E-04	43.2	3
25.00	30.00	5.00	5.5	1.0	27.50	1.90	0.00	39.40	0.0	0.0E+00	0.0	1
25.00	30.00	5.00	5.5	3.0	27.50	1.90	0.13	59.28	5.0	2.3E-05	1.7	2
25.00	30.00	5.00	5.5	5.0	27.50	1.90	0.72	78.68	12.0	4.2E-05	3.1	3
25.00	30.00	5.00	5.5	7.0	27.50	1.90	2.20	97.20	21.0	6.0E-05	4.3	4
25.00	30.00	5.00	5.5	10.0	27.50	1.90	8.00	121.40	40.0	9.1E-05	6.6	5
25.00	30.00	5.00	5.5	8.0	27.50	1.90	5.78	103.62	34.0	9.1E-05	6.6	6
25.00	30.00	5.00	5.5	6.8	27.50	1.90	3.65	85.76	27.0	8.7E-05	6.3	7
25.00	30.00	5.00	5.5	4.0	27.50	1.90	2.00	67.40	20.0	8.2E-05	5.9	8
25.00	30.00	5.00	5.5	2.0	27.50	1.90	0.98	48.42	14.0	8.0E-05	5.8	9
30.00	35.00	5.00	5.5	1.0	29.58	1.90	19.49	21.99	57.0	7.2E-04	51.9	1
30.00	35.00	5.00	5.5	1.5	29.58	1.90	27.74	16.74	68.0	1.0E-03	72.6	2
33.00	40.00	5.00	5.5	1.0	29.58	1.90	29.57	11.91	65.0	1.5E-05	109.2	1
40.00	45.00	5.00	5.5	1.0	42.50	1.90	0.00	54.40	0.0	0.0E+00	0.0	1
40.00	45.00	5.00	5.5	3.0	42.50	1.90	14.79	59.61	43.0	2.0E-04	14.4	2
40.00	45.00	5.00	5.5	3.0	42.50	1.90	26.91	67.49	58.0	2.4E-04	17.2	3
40.00	45.00	5.00	5.5	7.0	42.50	1.90	31.20	63.20	80.0	3.5E-04	25.3	5
40.00	45.00	5.00	5.5	6.0	42.50	1.90	36.99	67.41	68.0	2.8E-04	20.2	6
40.00	45.00	5.00	5.5	4.0	42.50	1.90	31.75	52.65	63.0	3.5E-04	23.9	7
40.00	45.00	5.00	5.5	2.0	42.50	1.90	25.09	39.31	58.0	3.9E-04	28.5	8
45.00	49.95	4.95	5.5	1.0	45.10	1.90	0.00	57.00	0.0	0.0E+00	0.0	1
45.00	49.95	4.95	5.5	3.0	45.10	1.90	0.00	77.00	0.0	0.0E+00	0.0	2
45.00	49.95	4.95	5.5	5.0	45.10	1.90	0.00	97.00	0.0	0.0E+00	0.0	3
45.00	49.95	4.95	5.5	7.0	45.10	1.90	0.00	117.00	0.0	0.0E+00	0.0	4
45.00	49.95	4.95	5.5	10.0	45.10	1.90	0.00	147.00	0.0	0.0E+00	0.0	5
45.00	49.95	4.95	5.5	8.0	45.10	1.90	0.00	127.00	0.0	0.0E+00	0.0	6
45.00	49.95	4.95	5.5	6.0	45.10	1.90	0.00	107.00	0.0	0.0E+00	0.0	7
45.00	49.95	4.95	5.5	4.0	45.10	1.90	0.00	87.00	0.0	0.0E+00	0.0	8
45.00	49.95	4.95	5.5	2.0	45.10	1.90	0.00	67.00	0.0	0.0E+00	0.0	9
50.00	55.15	5.15	5.5	1.0	48.15	1.90	2.25	57.30	15.0	7.0E-05	5.0	1
50.00	55.15	5.15	5.5	3.0	48.15	1.90	4.84	75.21	22.0	7.9E-05	5.7	2
50.00	55.15	5.15	5.5	5.0	48.15	1.90	12.25	87.80	35.0	1.1E-04	7.7	3
50.00	55.15	5.15	5.5	7.0	48.15	1.90	23.04	97.01	48.0	1.3E-04	916	4
50.00	55.15	5.15	5.5	10.0	48.15	1.90	39.69	110.36	63.0	1.5E-04	11.1	5

(cont'd) Borehole Number: V1-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
55.00	60.00	5.00	5.5	1.0	48.10	1.90	0.00	60.00	0.0	0.0E+00	0.0	1
55.00	60.00	5.00	5.5	3.0	48.10	1.90	0.40	79.60	6.0	2.1E-05	1.5	2
55.00	60.00	5.00	5.5	5.0	48.10	1.90	2.47	97.53	15.0	4.2E-05	3.1	3
55.00	60.00	5.00	5.5	7.0	48.10	1.90	5.82	114.18	23.0	5.6E-05	4.0	4
55.00	60.00	5.00	5.5	10.0	48.10	1.90	21.30	128.70	44.0	9.4E-05	6.8	5
55.00	60.00	5.00	5.5	8.0	48.10	1.90	15.06	114.94	37.0	8.9E-05	6.4	6
55.00	60.00	5.00	5.5	6.0	48.10	1.90	8.62	101.38	28.0	7.6E-05	5.5	7
55.00	60.00	5.00	5.5	4.0	48.10	1.90	3.18	86.82	17.0	5.4E-05	3.9	8
55.00	60.00	5.00	5.5	2.0	48.10	1.90	2.16	67.84	14.0	5.7E-05	4.1	9

Table D-19 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: YI-B2

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l'min)	Coefficient of Permeability (cm/s)	Lugeon Unit	Step No.
15.00	20.00	5.00	5.5	0.2	17.50	2.40	6.91	14.99	48.0	8.8E-04	64.1	1
15.00	20.00	5.00	5.5	0.5	17.50	2.40	15.55	9.35	72.0	2.1E-03	154.0	2
15.00	20.00	5.00	5.5	0.6	17.50	2.40	19.20	6.70	30.0	3.3E-03	238.8	3
20.00	25.00	5.00	5.5	1.0	22.50	2.40	0.48	34.42	11.0	8.8E-05	6.4	1
20.00	25.00	5.00	5.5	3.0	22.50	2.40	2.70	52.20	26.0	1.4E-04	10.0	2
20.00	25.00	5.00	5.5	5.0	22.50	2.40	10.82	64.08	52.0	2.2E-04	16.2	3
20.00	25.00	5.00	5.5	7.0	22.50	2.40	23.10	71.80	76.0	2.9E-04	21.2	4
20.00	25.00	5.00	5.5	4.0	22.50	2.40	17.42	47.48	66.0	3.8E-04	27.8	5
20.00	25.00	5.00	5.5	2.0	22.50	2.40	8.10	36.80	45.0	3.4E-04	24.5	6
25.00	30.00	5.00	5.5	0.5	27.50	2.40	28.12	6.78	75.0	3.1E-03	221.4	1
30.00	35.00	5.00	5.5	1.0	29.60	2.40	32.86	9.14	74.0	2.2E-03	161.9	1
30.00	35.00	5.00	5.5	1.5	29.60	2.40	43.35	3.65	85.0	6.4E-03	465.8	2
30.00	35.00	5.00	5.5	1.0	29.60	2.40	39.37	2.63	81.0	8.5E-03	615.0	3
35.00	40.00	5.00	5.5	1.0	32.40	2.40	26.05	18.75	61.0	9.0E-04	65.1	1
35.00	40.00	5.00	5.5	2.5	32.40	2.40	36.29	23.51	72.0	8.5E-04	61.2	2
35.00	40.00	5.00	5.5	3.0	32.40	2.40	47.07	17.73	82.0	1.3E-03	92.5	3
35.00	40.00	5.00	5.5	2.0	32.40	2.40	31.42	23.38	67.0	7.8E-04	57.3	4
40.00	45.00	5.00	5.5	1.0	35.20	2.40	14.79	32.81	43.0	3.6E-04	26.2	1
40.00	45.00	5.00	5.5	3.0	35.20	2.40	24.20	43.40	55.0	3.5E-04	25.3	2
40.00	45.00	5.00	5.5	5.0	35.20	2.40	47.43	40.17	77.0	5.3E-04	38.3	3
40.00	45.00	5.00	5.5	5.3	35.20	2.40	55.11	35.49	83.0	6.5E-04	46.8	4
40.00	45.00	5.00	5.5	4.0	35.20	2.40	47.43	30.17	77.0	7.0E-04	51.0	5
40.00	45.00	5.00	5.5	2.0	35.20	2.40	35.91	21.69	67.0	8.5E-04	61.8	6
45.00	50.00	5.00	5.5	1.0	37.50	2.40	0.14	49.76	4.0	2.2E-05	1.6	1
45.00	50.00	5.00	5.5	3.0	37.50	2.40	0.90	69.00	10.0	4.0E-05	2.9	2
45.00	50.00	5.00	5.5	5.0	37.30	2.40	2.02	87.88	15.0	4.7E-05	3.4	3
45.00	50.00	5.00	5.5	7.0	37.50	2.40	2.92	106.98	18.0	4.6E-05	3.4	4
45.00	50.00	5.00	5.5	10.0	37.50	2.40	5.18	134.72	24.0	4.9E-05	3.6	5
45.00	50.00	5.00	5.5	8.0	37.50	2.40	3.60	116.30	20.0	4.7E-05	3.4	6
45.00	50.00	5.00	5.5	6.0	37.50	2.40	2.92	96.98	18.0	5.1E-05	3.7	7
45.00	50.00	5.00	5.5	4.0	37.50	2.40	2.30	77.60	16.0	5.7E-05	4.1	8
45.00	50.00	5.00	5.5	2.0	37.50	2.40	0.58	59.32	8.0	3.7E-05	2.7	9

Table D-20 RESULT OF WATER PRESSURE TEST
(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: V1-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
5.00	10.00	5.00	5.5	1.0	0.27	2.20	0.00	12.47	0.0	0.0E+00	0.0	1
5.00	10.00	5.00	5.5	3.0	0.27	2.20	0.00	32.47	0.0	0.0E+00	0.0	2
5.00	10.00	5.00	5.5	5.0	0.27	2.20	0.00	52.47	0.0	0.0E+00	0.0	3
5.00	10.00	5.00	5.5	7.0	0.27	2.20	0.00	72.47	0.0	0.0E+00	0.0	4
5.00	10.00	5.00	5.5	10.0	0.27	2.20	0.00	102.47	0.0	0.0E+00	0.0	5
10.00	15.00	5.00	5.5	1.0	0.15	2.20	0.00	12.35	0.0	0.0E+00	0.0	1
10.00	15.00	5.00	5.5	3.0	0.15	2.20	0.00	32.35	0.0	0.0E+00	0.0	2
10.00	15.00	5.00	5.5	5.0	0.15	2.20	0.00	52.35	0.0	0.0E+00	0.0	3
10.00	15.00	5.00	5.5	7.0	0.15	2.20	0.00	72.35	0.0	0.0E+00	0.0	4
10.00	15.00	5.00	5.5	10.0	0.15	2.20	0.00	102.35	0.0	0.0E+00	0.0	5
10.00	15.00	5.00	5.5	8.0	0.15	2.20	0.00	82.35	0.0	0.0E+00	0.0	6
10.00	15.00	5.00	5.5	6.0	0.15	2.20	0.00	62.35	0.0	0.0E+00	0.0	7
10.00	15.00	5.00	5.5	4.0	0.15	2.20	0.00	42.35	0.0	0.0E+00	0.0	8
10.00	15.00	5.00	5.5	2.0	0.15	2.20	0.00	22.35	0.0	0.0E+00	0.0	9
15.00	20.00	5.00	5.5	1.0	0.55	2.20	0.00	12.75	0.0	0.0E+00	0.0	1
15.00	20.00	5.00	5.5	3.0	0.55	2.20	0.00	32.75	0.0	0.0E+00	0.0	2
15.00	20.00	5.00	5.5	5.0	0.55	2.20	0.01	52.74	2.0	1.0E-05	0.8	3
15.00	20.00	5.00	5.5	7.0	0.55	2.20	0.07	72.68	5.0	1.9E-05	1.4	4
15.00	20.00	5.00	5.5	10.0	0.55	2.20	0.19	102.56	8.0	2.2E-05	1.6	5
15.00	20.00	5.00	5.5	20.0	0.55	2.20	0.77	201.98	16.0	2.2E-05	1.6	6
15.00	20.00	5.00	5.5	8.0	0.55	2.20	0.19	82.56	8.0	2.7E-05	1.9	7
15.00	20.00	5.00	5.5	6.0	0.55	2.20	0.03	62.72	3.0	1.3E-05	1.0	8
15.00	20.00	5.00	5.5	4.0	0.55	2.20	0.01	42.74	2.0	1.3E-05	0.9	9
15.00	20.00	5.00	5.5	2.0	0.55	2.20	0.00	22.75	1.0	1.2E-05	0.9	10
20.00	25.00	5.00	5.5	1.0	0.67	2.20	0.00	12.87	0.0	0.0E+00	0.0	1
20.00	25.00	5.00	5.5	3.0	0.67	2.20	0.00	32.87	0.0	0.0E+00	0.0	2
20.00	25.00	5.00	5.5	5.0	0.67	2.20	0.00	52.87	0.0	0.0E+00	0.0	3
20.00	25.00	5.00	5.5	7.0	0.67	2.20	0.00	72.87	0.0	0.0E+00	0.0	4
20.00	25.00	5.00	5.5	10.0	0.67	2.20	0.00	102.87	0.0	0.0E+00	0.0	5
20.00	25.00	5.00	5.5	8.0	0.67	2.20	0.00	82.87	0.0	0.0E+00	0.0	6
20.00	25.00	5.00	5.5	6.0	0.67	2.20	0.00	62.87	0.0	0.0E+00	0.0	7
20.00	25.00	5.00	5.5	4.0	0.67	2.20	0.00	42.87	0.0	0.0E+00	0.0	8
20.00	25.00	5.00	5.5	2.0	0.67	2.20	0.00	22.87	0.0	0.0E+00	0.0	9
25.00	30.00	5.00	5.5	1.0	0.90	2.20	0.00	13.10	0.0	0.0E+00	0.0	1
25.00	30.00	5.00	5.5	3.0	0.90	2.20	0.00	33.10	0.0	0.0E+00	0.0	2
25.00	30.00	5.00	5.5	5.0	0.90	2.20	0.00	53.10	0.0	0.0E+00	0.0	3
25.00	30.00	5.00	5.5	7.0	0.90	2.20	0.00	73.10	0.0	0.0E+00	0.0	4
25.00	30.00	5.00	5.5	10.0	0.90	2.20	0.00	103.10	0.0	0.0E+00	0.0	5
25.00	30.00	5.00	5.5	8.0	0.90	2.20	0.00	83.10	0.0	0.0E+00	0.0	6
25.00	30.00	5.00	5.5	6.0	0.90	2.20	0.00	63.10	0.0	0.0E+00	0.0	7

(cont'd) Borehole Number: YI-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
25.00	30.00	5.00	5.5	4.0	0.90	2.20	0.00	43.10	0.0	0.0E+00	0.0	8
25.00	30.00	5.00	5.5	2.0	0.90	2.20	0.00	23.10	0.0	0.0E+00	0.0	9
30.00	35.00	5.00	5.5	1.0	0.90	2.20	3.17	9.93	23.0	6.4E-04	46.3	1
30.00	35.00	5.00	5.5	3.0	0.90	2.20	6.94	26.16	34.0	3.6E-04	26.0	2
30.00	35.00	5.00	5.5	5.0	0.90	2.20	10.09	43.01	41.0	2.6E-04	19.1	3
30.00	35.00	5.00	5.5	7.0	0.90	2.20	13.25	59.85	47.0	2.2E-04	15.7	4
30.00	35.00	5.00	5.5	10.0	0.90	2.20	19.49	83.61	57.0	1.9E-04	13.6	5
30.00	35.00	5.00	5.5	8.0	0.90	2.20	18.15	64.95	55.0	2.3E-04	16.9	6
30.00	35.00	5.00	5.5	6.0	0.90	2.20	7.78	55.32	36.0	1.8E-04	13.0	7
30.00	35.00	5.00	5.5	4.0	0.90	2.20	4.06	39.04	26.0	1.8E-04	13.3	8
30.00	35.00	5.00	5.5	2.0	0.90	2.20	1.94	21.16	18.0	2.3E-04	17.0	9
35.00	40.00	5.00	5.5	1.0	1.10	2.20	0.00	13.30	0.0	0.0E+00	0.0	1
35.00	40.00	5.00	5.5	3.0	1.10	2.20	0.00	33.30	0.0	0.0E+00	0.0	2
35.00	40.00	5.00	5.5	5.0	1.10	2.20	0.00	53.30	0.0	0.0E+00	0.0	3
35.00	40.00	5.00	5.5	7.0	1.10	2.20	0.00	73.30	0.0	0.0E+00	0.0	4
35.00	40.00	5.00	5.5	10.0	1.10	2.20	0.00	103.30	0.0	0.0E+00	0.0	5
35.00	40.00	5.00	5.5	8.0	1.10	2.20	0.00	83.30	0.0	0.0E+00	0.0	6
35.00	40.00	5.00	5.5	6.0	1.10	2.20	0.00	63.30	0.0	0.0E+00	0.0	7
35.00	40.00	5.00	5.5	4.0	1.10	2.20	0.00	43.30	0.0	0.0E+00	0.0	8
35.00	40.00	5.00	5.5	2.0	1.10	2.20	0.00	23.30	0.0	0.0E+00	0.0	9
40.00	45.00	5.00	5.5	1.0	1.10	2.20	0.07	13.23	3.0	6.3E-04	4.5	1
40.00	45.00	5.00	5.5	3.0	1.10	2.20	0.20	33.10	5.0	4.2E-05	3.0	2
40.00	45.00	5.00	5.5	5.0	1.10	2.20	0.39	52.91	7.0	3.7E-05	2.6	3
40.00	45.00	5.00	5.5	7.0	1.10	2.20	1.15	72.15	12.0	4.6E-05	3.3	4
40.00	45.00	5.00	5.5	10.0	1.10	2.20	2.59	100.71	18.0	4.9E-05	3.6	5
40.00	45.00	5.00	5.5	8.0	1.10	2.20	2.05	81.25	16.0	5.4E-05	3.9	6
40.00	45.00	5.00	5.5	6.0	1.10	2.20	0.97	62.33	11.0	4.9E-05	3.5	7
40.00	45.00	5.00	5.5	4.0	1.10	2.20	0.51	42.79	8.0	5.2E-05	3.7	8
40.00	45.00	5.00	5.5	2.0	1.10	2.20	0.29	23.01	6.0	7.2E-05	5.2	9
45.00	50.00	5.00	5.5	1.0	1.10	2.20	1.76	11.54	14.0	1.3E-04	24.3	1
45.00	50.00	5.00	5.5	3.0	1.10	2.20	6.56	26.74	27.0	2.8E-04	20.2	2
45.00	50.00	5.00	5.5	5.0	1.10	2.20	10.40	42.90	34.0	2.2E-04	15.9	3
45.00	50.00	5.00	5.5	7.0	1.10	2.20	16.64	56.66	43.0	2.1E-04	15.2	4
45.00	50.00	5.00	5.5	10.0	1.10	2.20	27.22	76.08	55.0	2.0E-04	14.5	5
45.00	50.00	5.00	5.5	8.0	1.10	2.20	18.22	65.08	45.0	1.9E-04	13.8	6
45.00	50.00	5.00	5.5	6.0	1.10	2.20	11.69	49.61	39.0	2.2E-04	15.7	7
45.00	50.00	5.00	5.5	4.0	1.10	2.20	6.10	35.20	30.0	2.4E-04	17.0	8
45.00	50.00	5.00	5.5	2.0	1.10	2.20	3.60	19.70	20.0	2.8E-04	20.3	9
50.00	55.00	5.00	5.5	1.0	1.10	2.20	4.00	9.30	20.0	5.9E-04	43.0	1
50.00	55.00	5.00	5.5	3.0	1.10	2.20	17.30	17.30	40.0	6.4E-04	46.2	2

(cont'd) Borehole Number: VI-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm²)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
50.00	55.00	5.00	5.5	5.0	1.10	2.20	27.04	26.26	52.0	5.5E-04	39.6	3
50.00	55.00	5.00	5.5	7.0	1.10	2.20	37.21	36.09	63.0	4.7E-04	33.8	4
50.00	55.00	5.00	5.5	10.0	1.10	2.20	56.25	47.05	75.0	4.4E-04	31.9	5
50.00	55.00	5.00	5.5	8.0	1.10	2.20	49.00	34.30	70.0	5.6E-04	40.8	6
50.00	55.00	5.00	5.5	6.0	1.10	2.20	30.25	33.05	55.0	4.6E-04	33.3	7
50.00	55.00	5.00	5.5	4.0	1.10	2.20	19.36	23.94	44.0	5.1E-04	36.8	8
50.00	55.00	5.00	5.5	2.0	1.10	2.20	8.41	14.89	29.0	5.4E-04	39.0	9
55.00	60.00	5.00	5.5	1.0	1.10	2.20	0.00	13.30	0.0	0.0E+00	0.0	1
55.00	60.00	5.00	5.5	3.0	1.10	2.20	0.00	33.30	0.0	0.0E+00	0.0	2
55.00	60.00	5.00	5.5	5.0	1.10	2.20	0.10	53.20	3.0	1.6E-05	1.1	3
55.00	60.00	5.00	5.5	7.0	1.10	2.20	0.27	73.02	5.0	1.5E-05	1.4	4
55.00	60.00	5.00	5.5	10.0	1.10	2.20	0.70	102.60	8.0	2.2E-05	1.6	5
55.00	60.00	5.00	5.5	8.0	1.10	2.20	0.40	82.90	6.0	2.0E-05	1.4	6
55.00	60.00	5.00	5.5	6.0	1.10	2.20	0.27	63.03	5.0	2.2E-05	1.6	7
55.00	60.00	5.00	5.5	4.0	1.10	2.20	0.01	43.29	1.0	6.4E-06	0.5	8
55.00	60.00	5.00	5.5	2.0	1.10	2.20	0.00	23.30	0.5	5.9E-06	0.4	9
60.00	65.00	5.00	5.5	1.0	1.10	2.20	0.00	13.30	0.0	0.0E+00	0.0	1
60.00	65.00	5.00	5.5	3.0	1.10	2.20	0.59	32.71	7.0	5.9E-05	4.3	2
60.00	65.00	5.00	5.5	5.0	1.10	2.20	2.70	50.60	15.0	8.2E-05	5.9	3
60.00	65.00	5.00	5.5	7.0	1.10	2.20	3.47	69.83	17.0	6.7E-05	4.9	4
60.00	65.00	5.00	5.5	10.0	1.10	2.20	8.11	55.19	26.0	7.5E-05	5.5	5
60.00	65.00	5.00	5.5	8.0	1.10	2.20	3.89	79.41	19.0	6.3E-05	4.5	6
60.00	65.00	5.00	5.5	6.0	1.10	2.20	3.07	60.23	16.0	7.3E-05	5.3	7
60.00	65.00	5.00	5.5	4.0	1.10	2.20	1.45	41.83	11.0	7.3E-05	5.3	8
60.00	65.00	5.00	5.5	2.0	1.10	2.20	0.30	23.00	5.0	6.0E-05	4.3	9
65.00	70.00	5.00	5.5	1.0	1.10	2.20	0.00	13.30	0.0	0.0E-00	0.0	1
65.00	70.00	5.00	5.5	3.0	1.10	2.20	0.00	33.30	0.0	0.0E+00	0.0	2
65.00	70.00	5.00	5.5	5.0	1.10	2.20	0.00	53.30	0.0	0.0E+00	0.0	3
65.00	70.00	5.00	5.5	7.0	1.10	2.20	0.00	73.30	0.0	0.0E+00	0.0	4
65.00	70.00	5.00	5.5	10.0	1.10	2.20	0.00	103.30	0.0	0.0E+00	0.0	5
65.00	70.00	5.00	5.5	8.0	1.10	2.20	0.00	83.30	0.0	0.0E+00	0.0	6
65.00	70.00	5.00	5.5	6.0	1.10	2.20	0.00	63.30	0.0	0.0E+00	0.0	7
65.00	70.00	5.00	5.5	4.0	1.10	2.20	0.00	43.30	0.0	0.0E+00	0.0	8
65.00	70.00	5.00	5.5	2.0	1.10	2.20	0.00	23.30	0.0	0.0E+00	0.0	9

Table D-21 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: V1-B4

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
10.00	15.00	5.00	5.5	1.0	12.50	2.53	5.83	19.20	54.0	7.8E-04	56.3	1
10.00	15.00	5.00	5.5	2.0	12.50	2.53	8.98	26.05	67.0	7.1E-04	51.4	2
10.00	15.00	5.00	5.5	2.5	12.50	2.53	13.45	26.58	82.0	8.5E-04	61.7	3
15.00	20.00	5.00	5.5	0.5	7.73	2.53	7.50	7.76	50.0	1.8E-03	128.9	1
15.00	20.00	5.00	5.5	0.8	7.73	2.53	19.68	-1.42	81.0	-1.6E-02	-1138.4	2
20.00	25.00	5.00	5.5	1.0	19.30	2.53	0.00	31.83	0.0	0.0E-00	0.0	1
20.00	25.00	5.00	5.5	3.0	19.30	2.53	0.68	51.15	13.0	7.0E-05	5.1	2
20.00	25.00	5.00	5.5	5.0	19.30	2.53	3.36	68.47	29.0	1.2E-04	8.5	3
20.00	25.00	5.00	5.5	7.0	19.30	2.53	10.00	81.83	50.0	1.7E-04	12.2	4
20.00	25.00	5.00	5.5	10.0	19.30	2.53	24.34	97.49	78.0	2.2E-04	16.0	5
20.00	25.00	5.00	5.5	8.0	19.30	2.53	17.96	83.87	67.0	2.2E-04	16.0	6
20.00	25.00	5.00	5.5	6.0	19.30	2.53	13.00	68.83	57.0	2.3E-04	16.6	7
20.00	25.00	5.00	5.5	4.0	19.30	2.53	7.06	54.77	42.0	2.1E-04	15.3	8
20.00	25.00	5.00	5.5	2.0	19.30	2.53	2.70	39.13	26.0	1.8E-04	13.3	9
25.00	30.00	5.00	5.5	1.0	19.30	2.53	0.13	31.71	5.0	4.4E-05	3.2	1
25.00	30.00	5.00	5.5	3.0	19.30	2.53	0.60	51.23	11.0	5.9E-05	4.3	2
25.00	30.00	5.00	5.5	5.0	19.30	2.53	3.65	68.19	27.0	1.1E-04	7.9	3
25.00	30.00	5.00	5.5	7.0	19.30	2.53	10.58	81.25	45.0	1.6E-04	11.3	4
25.00	30.00	5.00	5.5	10.0	19.30	2.53	12.50	109.33	50.0	1.3E-04	9.1	5
25.00	30.00	5.00	5.5	8.0	19.30	2.53	11.04	90.79	47.0	1.4E-04	10.4	6
25.00	30.00	5.00	5.5	6.0	19.30	2.53	6.48	75.35	36.0	1.3E-04	9.6	7
25.00	30.00	5.00	5.5	4.0	19.30	2.53	2.20	59.63	21.0	9.7E-05	7.0	8
25.00	30.00	5.00	5.5	2.0	19.30	2.53	0.98	40.85	14.0	9.5E-05	6.9	9
30.00	35.00	5.00	5.5	1.0	19.35	2.53	0.00	31.88	0.0	0.0E+00	0.0	1
30.00	35.00	5.00	5.5	3.0	19.35	2.53	0.15	51.73	5.0	2.7E-05	1.9	2
30.00	35.00	5.00	5.5	5.0	19.35	2.53	1.01	70.87	13.0	5.1E-05	3.7	3
30.00	35.00	5.00	5.5	7.0	19.35	2.53	1.94	89.94	18.0	5.5E-05	4.0	4
30.00	35.00	5.00	5.5	10.0	19.35	2.53	5.40	116.48	30.0	7.1E-05	5.2	5
30.00	35.00	5.00	5.5	8.0	19.35	2.53	4.37	97.51	27.0	7.6E-05	5.5	6
30.00	35.00	5.00	5.5	6.0	19.35	2.53	3.17	78.71	23.0	8.1E-05	5.8	7
30.00	35.00	5.00	5.5	4.0	19.35	2.53	1.73	60.15	17.0	7.8E-05	5.7	8
30.00	35.00	5.00	5.5	2.0	19.35	2.53	0.60	41.28	10.0	6.7E-05	4.8	9
35.00	40.00	5.00	5.5	1.0	18.65	2.53	0.00	31.18	0.0	0.0E+00	0.0	1
35.00	40.00	5.00	5.5	3.0	18.65	2.53	0.00	51.18	0.0	0.0E+00	0.0	2
35.00	40.00	5.00	5.5	5.0	18.65	2.53	0.00	71.18	0.0	0.0E+00	0.0	3
35.00	40.00	5.00	5.5	7.0	18.65	2.53	0.00	91.16	1.5	4.5E-06	0.3	4
35.00	40.00	5.00	5.5	10.0	18.65	2.53	0.70	120.48	10.0	2.3E-05	1.7	5
35.00	40.00	5.00	5.5	8.0	18.65	2.53	0.45	100.73	8.0	2.2E-05	1.6	6
35.00	40.00	5.00	5.5	6.0	18.65	2.53	0.17	81.01	5.0	1.7E-05	1.2	7
35.00	40.00	5.00	5.5	4.0	18.65	2.53	0.06	61.12	3.0	1.4E-05	1.0	8
35.00	40.00	5.00	5.5	2.0	18.65	2.53	0.01	41.17	1.0	6.7E-06	0.5	9

(cont'd) Borehole Number: VI-B4

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
40.00	45.00	5.00	5.5	1.0	19.50	2.53	0.00	32.03	0.0	0.0E+00	0.0	1
40.00	45.00	5.00	5.5	3.0	19.50	2.53	0.00	52.03	0.0	0.0E+00	0.0	2
40.00	45.00	5.00	5.5	5.0	19.50	2.53	0.00	72.03	0.5	1.9E-06	0.1	3
40.00	45.00	5.00	5.5	7.0	19.50	2.53	0.07	91.96	3.0	9.0E-06	0.7	4
40.00	45.00	5.00	5.5	10.0	19.50	2.53	0.97	121.06	11.0	2.5E-05	1.8	5
40.00	45.00	5.00	5.5	8.0	19.50	2.53	0.65	101.38	9.0	2.5E-05	1.8	6
40.00	45.00	5.00	5.5	6.0	19.50	2.53	0.13	81.90	4.0	1.3E-05	1.0	7
40.00	45.00	5.00	5.5	4.0	19.50	2.53	0.02	62.01	1.5	6.7E-06	0.5	8
40.00	45.00	5.00	5.5	2.0	19.50	2.53	0.00	42.03	0.5	3.3E-06	0.2	9
45.00	50.00	5.00	5.5	1.0	19.30	2.53	0.00	31.83	0.0	0.0E+00	0.0	1
45.00	50.00	5.00	5.5	3.0	19.30	2.53	0.00	51.83	0.0	0.0E+00	0.0	2
45.00	50.00	5.00	5.5	5.0	19.30	2.53	0.00	71.83	0.0	0.0E+00	0.0	3
45.00	50.00	5.00	5.5	7.0	19.30	2.53	0.00	91.83	0.0	0.0E+00	0.0	4
45.00	50.00	5.00	5.5	10.0	19.30	2.53	0.00	121.83	0.0	0.0E+00	0.0	5
45.00	50.00	5.00	5.5	15.0	19.30	2.53	0.73	171.10	9.0	1.5E-05	1.1	6
45.00	50.00	5.00	5.5	8.0	19.30	2.53	0.00	101.83	0.0	0.0E+00	0.0	7
45.00	50.00	5.00	5.5	6.0	19.30	2.53	0.00	81.83	0.0	0.0E+00	0.0	8
45.00	50.00	5.00	5.5	4.0	19.30	2.53	0.00	61.83	0.0	0.0E+00	0.0	9
45.00	50.00	5.00	5.5	2.0	19.30	2.53	0.00	41.83	0.0	0.0E+00	0.0	10

Table D-22 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: Y1-B6

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
7.15	10.20	3.05	5.5	1.0	0.12	3.00	0.00	13.12	0.0	0.0E+00	0.0	1
7.15	10.20	3.05	5.5	3.0	0.12	3.00	0.00	33.12	0.0	0.0E+00	0.0	2
7.15	10.20	3.05	5.5	5.0	0.12	3.00	0.00	53.12	0.0	0.0E+00	0.0	3
7.15	10.20	3.05	5.5	7.0	0.12	3.00	0.00	73.12	0.0	0.0E+00	0.0	4
7.15	10.20	3.05	5.5	10.0	0.12	3.00	0.00	103.12	0.0	0.0E+00	0.0	5
7.15	10.20	3.05	5.5	8.0	0.12	3.00	0.00	83.12	0.0	0.0E+00	0.0	6
7.15	10.20	3.05	5.5	6.0	0.12	3.00	0.00	63.12	0.0	0.0E+00	0.0	7
7.15	10.20	3.05	5.5	4.0	0.12	3.00	0.00	43.12	0.0	0.0E+00	0.0	8
7.15	10.20	3.05	5.5	2.0	0.12	3.00	0.00	23.12	0.0	0.0E+00	0.0	9
10.00	15.00	5.00	5.5	1.0	0.08	3.00	0.00	13.08	0.0	0.0E+00	0.0	1
10.00	15.00	5.00	5.5	3.0	0.08	3.00	0.00	33.08	0.0	0.0E+00	0.0	2
10.00	15.00	5.00	5.5	5.0	0.00	3.00	0.00	53.00	0.0	0.0E+00	0.0	3
10.00	15.00	5.00	5.5	7.0	0.08	3.00	0.00	73.08	0.0	0.0E+00	0.0	4
10.00	15.00	5.00	5.5	10.0	0.08	3.00	0.00	103.08	0.0	0.0E+00	0.0	5
10.00	15.00	5.00	5.5	8.0	0.08	3.00	0.00	83.08	0.0	0.0E+00	0.0	6
10.00	15.00	5.00	5.5	6.0	0.08	3.00	0.00	63.08	0.0	0.0E+00	0.0	7
10.00	15.00	5.00	5.5	4.0	0.08	3.00	0.00	43.08	0.0	0.0E+00	0.0	8
10.00	15.00	5.00	5.5	2.0	0.08	3.00	0.00	23.08	0.0	0.0E+00	0.0	9
15.05	19.70	4.65	5.5	1.0	0.18	3.00	0.00	13.18	0.0	0.0E+00	0.0	1
15.05	19.70	4.65	5.5	3.0	0.18	3.00	0.00	33.18	0.0	0.0E+00	0.0	2
15.05	19.70	4.65	5.5	5.0	0.18	3.00	0.00	53.18	0.0	0.0E+00	0.0	3
15.05	19.70	4.65	5.5	7.0	0.18	3.00	0.00	73.18	0.0	0.0E+00	0.0	4
15.05	19.70	4.65	5.5	10.0	0.18	3.00	0.00	103.18	0.0	0.0E+00	0.0	5
15.05	19.70	4.65	5.5	8.0	0.18	3.00	0.00	83.18	0.0	0.0E+00	0.0	6
15.05	19.70	4.65	5.5	6.0	0.18	3.00	0.00	63.18	0.0	0.0E+00	0.0	7
40.00	45.00	5.00	5.5	1.0	0.16	3.00	0.00	13.16	0.0	0.0E+00	0.0	1
40.00	45.00	5.00	5.5	3.0	0.16	3.00	0.00	33.16	0.0	0.0E+00	0.0	2
40.00	45.00	5.00	5.5	5.0	0.16	3.00	0.00	53.16	0.0	0.0E+00	0.0	3
40.00	45.00	5.00	5.5	7.0	0.16	3.00	0.01	73.15	1.0	3.8E-06	0.3	4
40.00	45.00	5.00	5.5	10.0	0.16	3.00	0.20	102.96	5.0	1.3E-05	1.0	5
40.00	45.00	5.00	5.5	8.0	0.16	3.00	0.03	83.13	2.0	6.6E-06	0.5	6
40.00	45.00	5.00	5.5	6.0	0.16	3.00	0.00	63.16	0.0	0.0E+00	0.0	7
40.00	45.00	5.00	5.5	4.0	0.16	3.00	0.00	43.16	0.0	0.0E+00	0.0	8
40.00	45.00	5.00	5.5	2.0	0.16	3.00	0.00	23.16	0.0	0.0E+00	0.0	9

(cont'd) Borehole Number: VH-86

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
45.00	49.90	4.90	5.5	1.0	0.16	3.00	0.00	13.16	0.0	0.0E+00	0.0	1
45.00	49.90	4.90	5.5	3.0	0.16	3.00	0.00	33.16	0.0	0.0E+00	0.0	2
45.00	49.90	4.90	5.5	5.0	0.16	3.00	0.00	53.16	0.0	0.0E+00	0.0	3
45.00	49.90	4.90	5.5	7.0	0.16	3.00	0.00	73.16	0.0	0.0E+00	0.0	4
45.00	49.90	4.90	5.5	10.0	0.16	3.00	0.00	103.16	0.0	0.0E+00	0.0	5
45.00	49.90	4.90	5.5	8.0	0.16	3.00	0.00	83.16	0.0	0.0E+00	0.0	6
45.00	49.90	4.90	5.5	6.0	0.16	3.00	0.00	63.16	0.0	0.0E+00	0.0	7
45.00	49.90	4.90	5.5	4.0	0.16	3.00	0.00	43.16	0.0	0.0E+00	0.0	8
45.00	49.90	4.90	5.5	2.0	0.16	3.00	0.00	23.16	0.0	0.0E+00	0.0	9
49.90	55.40	5.50	5.5	1.0	0.16	3.00	0.00	13.16	0.0	0.0E+00	0.0	1
49.90	55.40	5.50	5.5	3.0	0.16	3.00	0.00	33.16	0.0	0.0E+00	0.0	2
49.90	55.40	5.50	5.5	5.0	0.16	3.00	0.00	53.16	0.0	0.0E+00	0.0	3
49.90	55.40	5.50	5.5	7.0	0.16	3.00	0.00	73.16	0.0	0.0E+00	0.0	4
49.90	55.40	5.50	5.5	10.0	0.16	3.00	0.01	103.15	1.0	2.5E-06	0.2	5
49.90	55.40	5.50	5.5	8.0	0.16	3.00	0.00	83.16	0.0	0.0E+00	0.0	6
49.90	55.40	5.50	5.5	6.0	0.16	3.00	0.00	63.16	0.0	0.0E+00	0.0	7
49.90	55.40	5.50	5.5	4.0	0.16	3.00	0.00	43.16	0.0	0.0E+00	0.0	8
49.90	55.40	5.50	5.5	2.0	0.16	3.00	0.00	23.16	0.0	0.0E+00	0.0	9

Table D-23 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: VJ-31

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
5.00	10.00	5.00	5.5	1.0	5.00	2.00	0.00	17.00	0.0	0.0E+00	0.0	1
5.00	10.00	5.00	5.5	3.0	5.00	2.00	0.00	37.00	2.0	1.5E-05	1.1	2
5.00	10.00	5.00	5.5	5.0	5.00	2.00	0.04	56.96	6.0	2.9E-05	2.1	3
5.00	10.00	5.00	5.5	7.0	5.00	2.00	0.10	76.90	10.0	3.6E-05	2.6	4
5.00	10.00	5.00	5.5	10.0	5.00	2.00	0.68	106.32	26.0	6.8E-05	4.9	5
5.00	10.00	5.00	5.5	8.0	5.00	2.00	0.36	96.64	19.0	6.1E-05	4.4	6
5.00	10.00	5.00	5.5	6.0	5.00	2.00	0.17	66.83	13.0	5.4E-05	3.9	7
5.00	10.00	5.00	5.5	4.0	5.00	2.00	0.08	46.92	9.0	5.3E-05	3.8	8
5.00	10.00	5.00	5.5	2.0	5.00	2.00	0.02	26.98	4.0	4.1E-05	3.0	9
10.00	15.00	5.00	5.5	1.0	12.20	2.00	0.00	24.20	0.0	0.0E+00	0.0	1
10.00	15.00	5.00	5.5	3.0	12.20	2.00	0.03	44.17	4.0	2.5E-05	1.8	2
10.00	15.00	5.00	5.5	5.0	12.20	2.00	0.16	64.04	9.0	3.9E-05	2.8	3
10.00	15.00	5.00	5.5	7.0	12.20	2.00	0.29	83.91	12.0	3.9E-05	2.9	4
10.00	15.00	5.00	5.5	10.0	12.20	2.00	0.80	113.40	20.0	4.9E-05	3.5	5
10.00	15.00	5.00	5.5	8.0	12.20	2.00	0.39	93.81	14.0	4.1E-05	3.0	6
10.00	15.00	5.00	5.5	6.0	12.20	2.00	0.16	74.04	9.0	3.4E-05	2.4	7
10.00	15.00	5.00	5.5	4.0	12.20	2.00	0.10	54.10	7.0	3.6E-05	2.6	8
10.00	15.00	5.00	5.5	2.0	12.20	2.00	0.02	34.18	3.0	2.4E-05	1.8	9
15.00	20.00	5.00	5.5	1.0	15.20	2.00	0.87	26.33	17.0	1.8E-04	12.9	1
15.00	20.00	5.00	5.5	3.0	15.20	2.00	1.87	45.33	25.0	1.5E-04	11.0	2
15.00	20.00	5.00	5.5	5.0	15.20	2.00	3.67	63.53	35.0	1.5E-04	11.0	3
15.00	20.00	5.00	5.5	7.0	15.20	2.00	4.56	82.64	39.0	1.3E-04	9.4	4
15.00	20.00	5.00	5.5	10.0	15.20	2.00	7.80	109.40	51.0	1.3E-04	9.3	5
15.00	20.00	5.00	5.5	8.0	15.20	2.00	5.04	92.16	41.0	1.2E-04	8.9	6
15.00	20.00	5.00	5.5	6.0	15.20	2.00	3.07	74.33	32.0	1.2E-04	8.6	7
15.00	20.00	5.00	5.5	4.0	15.20	2.00	2.35	54.85	28.0	1.4E-04	10.2	8
15.00	20.00	5.00	5.5	2.0	15.20	2.00	1.20	36.00	20.0	1.5E-04	11.1	9
20.00	25.00	5.00	5.5	1.0	15.20	2.00	0.00	27.20	0.0	0.0E+00	0.0	1
20.00	25.00	5.00	5.5	3.0	15.20	2.00	0.00	47.20	0.0	0.0E+00	0.0	2
20.00	25.00	5.00	5.5	5.0	15.20	2.00	0.00	67.20	0.0	0.0E+00	0.0	3
20.00	25.00	5.00	5.5	7.0	15.20	2.00	0.00	87.20	0.0	0.0E+00	0.0	4
20.00	25.00	5.00	5.5	10.0	15.20	2.00	0.00	117.20	0.0	0.0E+00	0.0	5
20.00	25.00	5.00	5.5	8.0	15.20	2.00	0.00	97.20	1.0	2.8E-06	0.2	6
20.00	25.00	5.00	5.5	6.0	15.20	2.00	0.00	77.20	0.0	0.0E+00	0.0	7
20.00	25.00	5.00	5.5	4.0	15.20	2.00	0.00	57.20	0.0	0.0E+00	0.0	8
20.00	25.00	5.00	5.5	2.0	15.20	2.00	0.00	37.20	0.0	0.0E+00	0.0	9
25.00	30.20	5.20	5.5	1.0	16.90	2.00	28.12	0.78	75.0	2.6E-02	1861.0	1
31.30	35.00	3.70	5.5	1.2	16.90	2.00	28.95	1.95	68.0	1.2E-02	940.7	1

Table D-24 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: V3-B2

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
15.30	20.00	4.70	5.5	1.0	14.10	2.00	0.37	25.73	11.0	1.2E-04	9.1	1
15.30	20.00	4.70	5.5	3.0	14.10	2.00	3.75	42.35	35.0	2.4E-04	17.6	2
15.30	20.00	4.70	5.5	5.0	14.10	2.00	14.15	51.95	68.0	3.8E-04	27.8	3
15.30	20.00	4.70	5.5	4.0	14.10	2.00	8.60	47.50	53.0	3.2E-04	23.7	4
15.30	20.00	4.70	5.5	2.0	14.10	2.00	3.97	32.13	36.0	3.3E-04	23.8	5
20.10	25.50	5.40	5.5	1.0	19.50	2.00	18.59	12.91	68.0	1.4E-03	97.5	1
25.00	30.50	5.50	5.5	1.0	20.50	2.00	21.13	11.38	65.0	1.5E-04	103.9	1
25.00	30.50	5.50	5.5	1.0	20.50	2.00	18.00	14.50	60.0	1.1E-03	75.2	2
30.50	35.20	4.70	5.5	1.0	30.20	2.00	5.13	37.07	29.0	2.3E-04	16.6	1
30.50	35.20	4.70	5.5	3.0	30.20	2.00	7.47	54.73	35.0	1.9E-04	13.6	2
30.50	35.20	4.70	5.5	5.0	30.20	2.00	10.76	71.44	42.0	1.7E-04	12.5	3
30.50	35.20	4.70	5.5	7.0	30.20	2.00	14.65	87.55	49.0	1.6E-04	11.9	4
30.50	35.20	4.70	5.5	10.0	30.20	2.00	28.21	103.99	68.0	1.9E-04	13.9	5
30.50	35.20	4.70	5.5	8.0	30.20	2.00	21.96	90.24	60.0	1.9E-04	14.1	6
30.50	35.20	4.70	5.5	6.0	30.20	2.00	16.49	76.71	52.0	2.0E-04	14.6	7
30.50	35.20	4.70	5.5	4.0	30.20	2.00	12.91	59.29	46.0	2.3E-04	16.5	8
30.50	35.20	4.70	5.5	2.0	30.20	2.00	7.91	44.29	36.0	2.4E-04	17.3	9
35.00	40.00	5.00	5.5	1.0	30.20	2.00	1.79	40.41	16.0	1.1E-04	7.9	1
35.00	40.00	5.00	5.5	3.0	30.20	2.00	3.39	58.81	22.0	1.0E-04	7.5	2
35.00	40.00	5.00	5.5	5.0	30.20	2.00	4.73	77.47	26.0	9.3E-05	6.7	3
35.00	40.00	5.00	5.5	7.0	30.20	2.00	6.73	95.47	31.0	9.0E-05	6.5	4
35.00	40.00	5.00	5.5	10.0	30.20	2.00	11.77	120.43	41.0	9.4E-05	6.8	5
35.00	40.00	5.00	5.5	8.0	30.20	2.00	8.57	103.63	35.0	9.3E-05	6.8	6
35.00	40.00	5.00	5.5	6.0	30.20	2.00	6.30	85.90	30.0	9.6E-05	7.0	7
35.00	40.00	5.00	5.5	4.0	30.20	2.00	4.37	67.83	25.0	1.0E-04	7.4	8
35.00	40.00	5.00	5.5	2.0	30.20	2.00	2.80	49.40	20.0	1.1E-04	8.1	9
40.00	45.20	5.20	5.5	1.0	31.50	2.00	0.00	43.50	0.0	0.0E+00	0.0	1
40.00	45.20	5.20	5.5	3.0	31.50	2.00	0.07	63.43	3.0	1.3E-05	0.9	2
40.00	45.20	5.20	5.5	5.0	31.50	2.00	0.29	83.21	6.0	1.9E-05	1.4	3
40.00	45.20	5.20	5.5	7.0	31.50	2.00	0.65	102.85	9.0	2.3E-05	1.7	4
40.00	45.20	5.20	5.5	10.0	31.50	2.00	2.31	131.19	17.0	3.5E-05	2.5	5
40.00	45.20	5.20	5.5	8.0	31.50	2.00	1.57	111.93	14.0	3.3E-05	2.4	6
40.00	45.20	5.20	5.5	6.0	31.50	2.00	0.97	92.53	11.0	3.2E-05	2.3	7
40.00	45.20	5.20	5.5	4.0	31.50	2.00	0.51	72.99	8.0	2.9E-05	2.1	8
40.00	45.20	5.20	5.5	2.0	31.50	2.00	0.29	53.21	6.0	3.0E-05	2.2	9

(cont'd) Borehole Number: V3-B2

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
45.00	50.00	5.00	5.5	1.0	38.50	2.00	1.30	49.20	12.0	6.7E-05	4.9	1
45.00	50.00	5.00	5.5	3.0	38.50	2.00	2.60	67.90	17.0	6.9E-05	5.0	2
45.00	50.00	5.00	5.5	5.0	38.50	2.00	3.60	86.90	20.0	6.4E-05	4.6	3
45.00	50.00	5.00	5.5	7.0	38.50	2.00	4.76	105.74	23.0	6.0E-05	4.4	4
45.00	50.00	5.00	5.5	10.0	38.50	2.00	8.10	132.40	30.0	6.3E-05	4.5	5
45.00	50.00	5.00	5.5	8.0	38.50	2.00	4.76	115.74	23.0	5.5E-05	4.0	6
45.00	50.00	5.00	5.5	6.0	38.50	2.00	3.97	96.53	21.0	6.0E-05	4.4	7
45.00	50.00	5.00	5.5	4.0	38.50	2.00	2.60	77.90	17.0	6.0E-05	4.4	8
45.00	50.00	5.00	5.5	2.0	38.50	2.00	1.52	58.98	13.0	6.1E-05	4.4	9

Table D-25 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: TH-B3

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit -	Step No.
1.10	5.00	3.90	5.5	1.0	3.05	3.00	0.25	15.80	34.0	7.3E-04	55.2	1
1.10	5.00	3.90	5.5	3.0	3.05	3.00	1.08	34.97	70.0	6.7E-04	51.3	2
1.10	5.00	3.90	5.5	2.0	3.05	3.00	0.69	25.36	56.0	7.4E-04	56.6	3
1.10	5.00	3.90	5.5	1.0	3.05	3.00	0.17	15.88	28.0	5.9E-04	45.2	4
5.50	10.00	4.50	5.5	1.0	7.75	3.00	0.99	19.76	30.0	4.6E-04	33.7	1
5.50	10.00	4.50	5.5	3.0	7.75	3.00	3.70	37.05	58.0	4.7E-04	34.8	2
5.50	10.00	4.50	5.5	2.0	7.75	3.00	2.75	28.00	50.0	5.4E-04	39.7	3
5.50	10.00	4.50	5.5	0.5	7.75	3.00	0.44	15.31	20.0	3.9E-04	29.0	4
10.40	14.80	4.40	5.5	1.0	12.60	3.00	1.52	24.08	27.0	3.4E-04	25.5	1
10.40	14.80	4.40	5.5	3.0	12.60	3.00	5.20	40.40	50.0	3.8E-04	28.1	2
10.40	14.80	4.40	5.5	3.5	12.60	3.00	5.41	45.19	51.0	3.5E-04	25.6	3
10.40	14.80	4.40	5.5	4.0	12.60	3.00	7.49	48.11	60.0	3.8E-04	28.3	4
10.40	14.80	4.40	5.5	4.0	12.60	3.00	5.20	50.40	50.0	3.0E-04	22.5	5
10.40	14.80	4.40	5.5	2.0	12.60	3.00	3.16	32.44	39.0	3.7E-04	27.3	6
15.00	20.00	5.00	5.5	1.0	12.60	3.00	2.52	23.08	29.0	3.5E-04	25.1	1
15.00	20.00	5.00	5.5	3.0	12.60	3.00	6.31	38.69	48.0	3.4E-04	24.8	2
15.00	20.00	5.00	5.5	5.0	12.60	3.00	14.70	50.90	70.0	3.8E-04	27.5	3
15.00	20.00	5.00	5.5	4.0	12.60	3.00	10.44	45.16	59.0	3.6E-04	26.1	4
15.00	20.00	5.00	5.5	2.0	12.60	3.00	5.55	30.05	43.0	3.9E-04	28.6	5

Table D-26 RESULT OF WATER PRESSURE TEST

(PRUEBA DE LA PRESION DE AGUA)

Borehole Number: VT-B1

Depth (from) (m)	Depth (to) (m)	Length Tested (m)	Hole Dia. (cm)	Pressure Reading (kg/cm^2)	Static Head (m)	Gauge Height (m)	Friction Loss (m)	Total Head (m)	Water Injected (l/min)	Coefficient of Permeability (cm/s)	Lugeon Unit –	Step No.
34.00	39.20	5.20	6.9	1.0	36.60	1.90	4.41	44.09	36.0	2.1E-04	15.7	1
34.00	39.20	5.20	6.9	3.0	36.60	1.90	6.29	62.21	43.0	1.8E-04	13.3	2
34.00	39.20	5.20	6.9	6.0	36.60	1.90	14.81	83.69	66.0	2.0E-04	15.2	3
34.00	39.20	5.20	6.9	8.0	36.60	1.90	19.64	98.86	76.0	2.0E-04	14.8	4
34.00	39.20	5.20	6.9	10.0	36.60	1.90	26.93	111.57	89.0	2.0E-04	15.3	5
34.00	39.20	5.20	6.9	9.0	36.60	1.90	17.14	111.36	71.0	1.6E-04	12.3	6
34.00	39.20	5.20	6.9	7.0	36.60	1.90	15.26	93.24	67.0	1.8E-04	13.8	7
34.00	39.20	5.20	6.9	5.0	36.60	1.90	18.12	70.38	73.0	2.7E-04	19.9	8
34.00	39.20	5.20	6.9	2.0	36.60	1.90	8.50	50.00	50.0	2.6E-04	19.2	9
39.20	44.60	5.40	6.9	1.0	41.90	1.50	9.80	43.60	50.0	2.8E-04	21.2	1
39.20	44.60	5.40	6.9	3.0	41.90	1.50	19.21	54.19	70.0	3.2E-04	23.9	2
39.20	44.60	5.40	6.9	6.0	41.90	1.50	28.32	75.08	85.0	2.8E-04	21.0	3
39.20	44.60	5.40	6.9	8.0	41.90	1.50	32.46	99.94	91.0	2.5E-04	18.5	4
39.20	44.60	5.40	6.9	10.0	41.90	1.50	39.99	103.41	101.0	2.4E-04	18.1	5
39.20	44.60	5.40	6.9	9.0	41.90	1.50	38.42	94.98	99.0	2.6E-04	19.3	6
39.20	44.60	5.40	6.9	7.0	41.90	1.50	28.32	85.08	85.0	2.5E-04	18.5	7
39.20	44.60	5.40	6.9	5.0	41.90	1.50	23.85	69.55	78.0	2.8E-04	20.8	8
39.20	44.60	5.40	6.9	2.0	41.90	1.50	19.21	44.19	70.0	3.9E-04	29.3	9
45.00	50.00	5.00	6.9	1.0	47.50	1.75	22.05	37.20	70.0	5.0E-04	37.6	1
45.00	50.00	5.00	6.9	3.0	47.50	1.75	26.68	52.57	77.0	3.9E-04	29.3	2
45.00	50.00	5.00	6.9	6.0	47.50	1.75	35.64	73.61	89.0	3.2E-04	24.2	3
45.00	50.00	5.00	6.9	8.0	47.50	1.75	45.00	84.25	100.0	3.1E-04	23.7	4
45.00	50.00	5.00	6.9	10.0	47.50	1.75	47.74	101.51	103.0	2.7E-04	20.3	5
45.00	50.00	5.00	6.9	9.0	47.50	1.75	44.10	95.15	99.0	2.7E-04	20.8	6
45.00	50.00	5.00	6.9	7.0	47.50	1.75	38.92	80.33	93.0	3.1E-04	23.2	7
45.00	50.00	5.00	6.9	5.0	47.50	1.75	34.06	65.19	87.0	3.5E-04	26.7	8
45.00	50.00	5.00	6.9	2.0	47.50	1.75	19.01	50.24	65.0	3.4E-04	25.9	9
50.00	55.00	5.00	6.9	1.0	52.50	0.30	12.50	50.30	50.0	2.6E-04	19.9	1
50.00	55.00	5.00	6.9	3.0	52.50	0.30	48.02	34.78	98.0	7.4E-04	56.4	2
50.00	55.00	5.00	6.9	6.0	52.30	0.30	60.50	52.30	110.0	5.6E-04	42.1	3
50.00	55.00	5.00	6.9	8.0	52.50	0.30	67.28	65.52	116.0	4.7E-04	35.4	4
50.00	55.00	5.00	6.9	10.0	52.50	0.30	72.00	80.80	120.0	3.9E-04	29.7	5
50.00	55.00	3.00	6.9	9.0	52.50	0.30	69.62	73.18	118.0	4.3E-04	32.2	6
50.00	55.00	5.00	6.9	7.0	52.50	0.30	66.13	56.68	115.0	5.4E-04	40.6	7
50.00	55.00	5.00	6.9	5.0	52.50	0.30	53.05	49.76	103.0	5.5E-04	41.4	8
50.00	55.00	5.00	6.9	2.0	52.50	0.30	12.01	60.80	49.0	2.1E-04	16.1	9