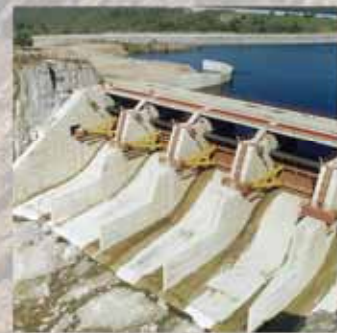




# PANEDILE

**Hydroelectric power plants**

**Hydraulic developments**





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Los Caracoles Hydroelectric  
Power Plant  
Province of San Juan  
Argentina



## Project \*

Construction of two multipurpose hydroelectric power plants: "Los Caracoles" (123 MW) and "Punta Negra" (62 MW) in the Province of San Juan, Argentina.

## Introduction

The works involve the construction of two hydroelectric power plants 20 km apart on the San Juan River.

Each hydroelectric facility took his name from the local name area where is built: "Los Caracoles" - in km 53 of the Provincial Route N° 12 - and "Punta Negra" - in km 34 of the same road-

The main objectives of the project are: (i) the water storage to expand the existing irrigation system (15,000 hectares added to agricultural production) and (ii) the electricity generation (185 MW added to the power grid with an estimated annual generation of 900 GWh).

Other aims to be reached are the development of recreational areas for tourism purposes, flood control, and the optimization of the two existing downstream hydroelectric power plants (Quebrada de Ullúm and Ullúm I&II) through the San Juan river flow regulation.

Additionally a new road (52 km long) was built between Calingasta and the city of San Juan (see section "Roads – New construction").

The works were faced in three stages, the first and the second 100% completed; the third nowadays in progress.



**Los Caracoles – Punta Negra Power plants  
Phase I - Province of San Juan  
Argentina**



**Phase I (finished)**

River diversion works for "Los Caracoles" and "Punta Negra" hydroelectric projects, first stage of "Los Caracoles" dam and the construction of a new road.

**Client**

AES Caracoles S.R.L. and Dirección Provincial de Recursos Energéticos (the San Juan energy resources provincial agency).

**Work's description**

In this stage were executed the river diversion structures for both complexes; partly the dam "Los Caracoles" and a new road between the city of Calingasta and San Juan City.

The river diversion for Los Caracoles dam was built on the right margin of the river through a concrete-lined round-shape tunnel, 745 meters long and diameter of 8.5 meters. After the construction; this tunnel becomes the sluice channel which operate with a system of two rectangular floodgates that will allow discharge a maximum flow of 300 m<sup>3</sup>/s.

In this first stage of the works was built the lower part of Los Caracoles dam placing 1,200,000 m<sup>3</sup> of its body (12,000,000 m<sup>3</sup> of total earthwork). The river diversion for Punta Negra dam was carried out through a double concrete conduit 472 meters long. One conduit discharges directly to the river while the second one feeds during the construction period the existing Ullúm I&II downstream power station.



**Other key data**

Panedile's participation	25 %
Works' value (road to Calingasta included)	USD MM 152
Construction period (main items)	1998 – 2002

**Major items quantities (river diversion and dam)**

Earth excavations	1.750.000 m <sup>3</sup>
Rock excavation and tunnels	627.000 m <sup>3</sup>
Consolidated backfilling	2.100.000 m <sup>3</sup>
Concrete	530.000 m <sup>3</sup>



**Phase II**

Los Caracoles hydroelectric power plant.

**Client**

EPSE - Energía Provincial Sociedad del Estado (State owned energy producer enterprise).

**Work's description**

Los Caracoles is a concrete faced rock-fill (CFR) type dam; it has a crest length of 605 meters, a reservoir capacity of 565 hm<sup>3</sup> and a height of 137 m. It will create a lake of 13 km of length that will cover a surface of 1,300 hectares approximately.

A rock-excavated surge tank was constructed to absorb sudden rises of pressure resultant from the turbines operation. Located 40 m before the end of the tunnel, the surge tank is a concrete-lined vertical well excavated in rock, 15.15 m of diameter and 65 m of height.

Downstream, the penstock delivers water from the reservoir to the turbines located in the power station which was designed for a flow of 90 m<sup>3</sup>/s and a net head of 150 m. The power station (123.4 MW) is an exterior type equipped with two Francis turbines and will produce 705 GWh annually. The energy produced will be transmitted through a 132 KV aerial power line, 47 kilometres long, across the mountain up to the San Juan substation.



**Other key data**

Panedile's participation	25 %
Works' value	USD MM 317,5
Construction period (main items)	2004 – 2009

**Major items quantities**

Dam backfilling	8,600,000 m <sup>3</sup>
Earth excavation	5.700,000 m <sup>3</sup>
Rock excavation	1,200,000 m <sup>3</sup>
Tunnel excavation	155,000 m <sup>3</sup>
Concrete	210,000 m <sup>3</sup>



### Phase III

Punta Negra hydroelectric power plant. Dam, power station, access road and appurtenant structures.

### Client

EPSE - Energía Provincial Sociedad del Estado.

### Work's description

Construction of a concrete faced rock-fill (CFR) type dam; it will have a crest length of 700 meters, a reservoir capacity of 500 hm and a height of 397 meters. It will create a lake of 13 km of length that will cover a surface of 1,250 hectares.

The floodwaters will be discharged through a controlled spillway located on the left margin. The water flow will be regulated by two radial floodgates 9.5 m of height and 19.5 m wide.

The water conduction to the power station will be placed in the left margin and included the submerged intake structure, a rock-excavated tunnel of 5.1 m of diameter and 450 m long and a 4.6 meters of diameter steel penstock.

The power station designed for 86 m of net head, will be equipped with two Francis turbines of 30.8 MW of capacity each that will produce 705 GWh annually.



#### Other key data

Panedile's participation	25 %
Works' value (turbines included)	USD MM 405
Construction period (main items)	2009 – 2013

#### Major items quantities

Earthworks – Dam	8,000,000 m3
Earth excavation	8,700,000 m3
Rock excavation (included tunnels)	1,417,000 m3
Concrete	240,000 m3



### Project \*

Rio Grande hydroelectric power plant, with pumped storage (760 MW), Santa Rosa de Calamuchita, Province of Córdoba, Argentina.

### Client

Agua y Energía Eléctrica Sociedad del Estado (state owned energy enterprise).

### Work's description

Construction of two dams and a power station and the procurement, installation, commissioning and start-up of the hydro-mechanical and electromechanical equipment, in a turnkey contract basis.

The dams were executed in the Cerro Pelado valley. The main one has a crest length of 410.5 meters and a height of 104 meters, the lateral one has a height of 50 m. The power station consists in a hydroelectric pump power station constructed in cavern, of mixed operation, 750 MW of installed power and an annual average energy generation of 977 GWh.

The objectives include: generating of hydroelectricity, flood control, supply of drinking water to 350,000 people, flow control of the Rio Grande river, increase of 10% in the generation of the others downstream power stations ("Rio Tercero" hydro generation system) and irrigation of 6,700 hectares.



#### Other key data

Panedile's participation	100 %
Works' value	USD MM 315.8
Construction period (main items)	1976 - 1991

#### Major items quantities

External excavations	3.289.970 m3
Rock excavations	1.475.289 m3
Mas concrete	99.541 m3
Underground concrete	89.409 m3
Backfilling	5.923.471 m3





**Project**

Construction of Tunnel Olivares and related works, Alfalfal Hydro Project, Olivares River valley, Cajón del Maipo, Republic of Chile

**Client**

Compañía Chilena de Generación Eléctrica S.A. (Private Chilean energy producer company)

**Work's description**

The performed works belong to the system of tunnels of the Alfalfal hydroelectric power plant in the Olivares River valley (the Olivares River is one of the main tributaries of the Colorado River), located 70 kilometers southeast of Santiago de Chile.

The duties involved the intake structures and the water flow channels and conduits for the Olivares River and La Jarilla stream –one of its tributary-; both part of the Colorado River valley.

There were two main items of jobs: the underground works and the related works. The underground works included the excavation of 5.4 kilometers of tunnel with variable area between 10 and 17 square meters and the excavation of a vertical shaft named "La Jarilla", 150 meters long with an area of 4 square meter

The related works included the Olivares River intake structure, La Jarilla stream intake structure and sand traps for both intakes.



**Other key data**

Panedile's participation	50 %
Works' value	USD MM 15.6
Construction period (main items)	1987 – 1990

**Major items quantities**

Excavations	100,000 m3
Concrete	18,000 m3
Backfilling	30,000 m3



### Projects

- 1.- Civil works for the Futaleufú hydroelectric power plant (448 MW) on the Futaleufu River, Province of Chubut (Contracts N° 268/269/287)
- 2.- Enlargement of the riprap slope protection on the upstream slope of the embankment in the Futaleufú dam, Province of Chubut

### Client

Agua y Energía Eléctrica Sociedad del Estado  
(state owned energy enterprise)

### Work's description

Works included in project 1: (i) completion of the civil works for the Futaleufú earth filled dam, (ii) spillway and a complementary bridge superstructure, (iii) the intake structure, (iv) adduction tunnel completion, (v) penstock, (vi) river diversion tunnels, (vii) surge tank, and (viii) access and service roads.

Works included in project 2: Increase of the riprap upstream embankment protection in the Futaleufú earth filled dam. For the accomplishment of the works were constructed two service roads with "stair-step" shape. From those roads were dumped and distributed 22,000 m<sup>3</sup> of aggregate material extracted from a borrow pit planned for such purpose.

The material were spread out in an extension of 600 m long from the level +470 m to +487 m and in an extension of 300 m long from the level +487 m to the level +500 m.



#### Other key data (project # 1)

Panedile's participation	15 %
Works' value	USD MM 42
Construction period (main items)	1975 – 1982

#### Other key data (project # 2)

Panedile's participation	100 %
Works' value	USD MM 2
Construction period (main items)	1984



### Project

Agua del Toro hydroelectric power plant (130 MW). Power station, equipments, access roads and appurtenant structures on the river Diamante, Province of Mendoza.

### Client

Agua y Energía Eléctrica Sociedad del Estado

### Work's description

Civil works, procurement, assembly, and start-up of the hydro and electromechanical equipment in a turnkey contract basis.

The dam is a concrete arch-gravity type dam, 120 m of height and 309 m of crest length. It has 4.60 m of top thickness and 22.70 m wide at the foundation level.

The river diversion tunnel has 242 m of length. It was executed on the right margin through a concrete-coated rock excavated gallery with 5.40 ms of inner diameter. The spillway is located on the left margin. It corresponds to a structure of 8.50 m of span furnished with a hinged crest type floodgate. The spillway was design to evacuate 400 m<sup>3</sup>/s.

The related power station works consist of the construction of the intake structure, floodgate chamber, the head race tunnel, the surge tank, the penstock, the power station building, the outlet, the 220 kV substation, access roads and an annexed park. Two Francis vertical-axis turbines provide 130 MW generating 400 GWh annual power output (average).



#### Other key data

Panedile's participation		100 %
Works' value		USD MM 115
Construction period	Dam	1966 – 1973
	Power station	1973-1982

#### Major items quantities (dam and power station)

Earthworks	8.000.000 m <sup>3</sup>
Excavation	1.120.000 m <sup>3</sup>
Consolidated backfilling	51.000 m <sup>3</sup>
Reinforced concrete	570.000 m <sup>3</sup>



**Project**

Quebrada de Ullum dam on the San Juan River. Province of San Juan (45 MW).

**Client**

Secretaría de Estado de Recursos Hídricos del Gobierno de San Juan, Argentina (San Juan provincial estate hydric resources agency).

**Work's description**

The works involved the construction of an earth and rock fill gravity dam -300 m of crest length and 53 m of height-, the spillway, the outlet for irrigation channel (a rock excavated tunnel, 6 m of diameter), outlet (a rock excavated tunnel, 6.20 ms of diameter), a lateral complementary dam and complementary works that included the relocation of the Provincial Route N° 14 and drainage channels.

The dam includes three main elements: an impervious core, filters and embankments. The core is made up of granulated fine materials compacted with a concrete slab of 80 m of length x 40 m of wide. The filters, of graduated sand, are located downstream and upstream of the core and the embankments are made up of compacted alluvial material.

It was constructed a lateral complementary dam in the "water divide" line between Ullum and Zonda. It consists in a gravity dam (crest length of 2,700 m and a total volume of 330,000 m3) with impervious vertical core and alluvium embankments.



**Other key data**

Panedile's participation	100 %
Works' value	USD MM 112,8
Construction period (main items)	1971 - 1980

**Major items quantities**

Excavation	4.671.011 m3
Consolidated backfilling	5.064.360 m3
Reinforced concrete	357.583 m3



### Project

Cabra Corral hydroelectric power plant (General Belgrano dam / Cabra Corral power station), on the Juramento River, Province of Salta (102 MW).

### Client

Agua y Energía Eléctrica Sociedad del Estado

### Phase I Work's description

Construction of a main dam and a complementary lateral dam, a spillway, the river diversion tunnel, the irrigation and generation intake structures, a rock-excavated head race tunnel, access and internal service roads.

The main and the lateral dams are embankment-earthfill type dams, zoned-earth. The main one is curved in the shape of an arch 450 ms of radio; it has a crest length of 510 ms and a height of 100 m. The capacity of the reservoir is 3,135 hm<sup>3</sup> at level 1,037 m above sea level, and the created lake has a surface of 11,500 has.

The spillway is a concrete-ogee-crest one with tainter (radial) gates. It is located in an existent gorge, 500 m from the right abutment.

The diversion tunnels and the irrigation intake structures, located in the right margin, are two concrete-coated rock excavated galleries, 6 m of diameter. The surge tank is a vertical well with variable diameter from 4.80 m at level 1000 m to 10.80 m at level 1048 m.

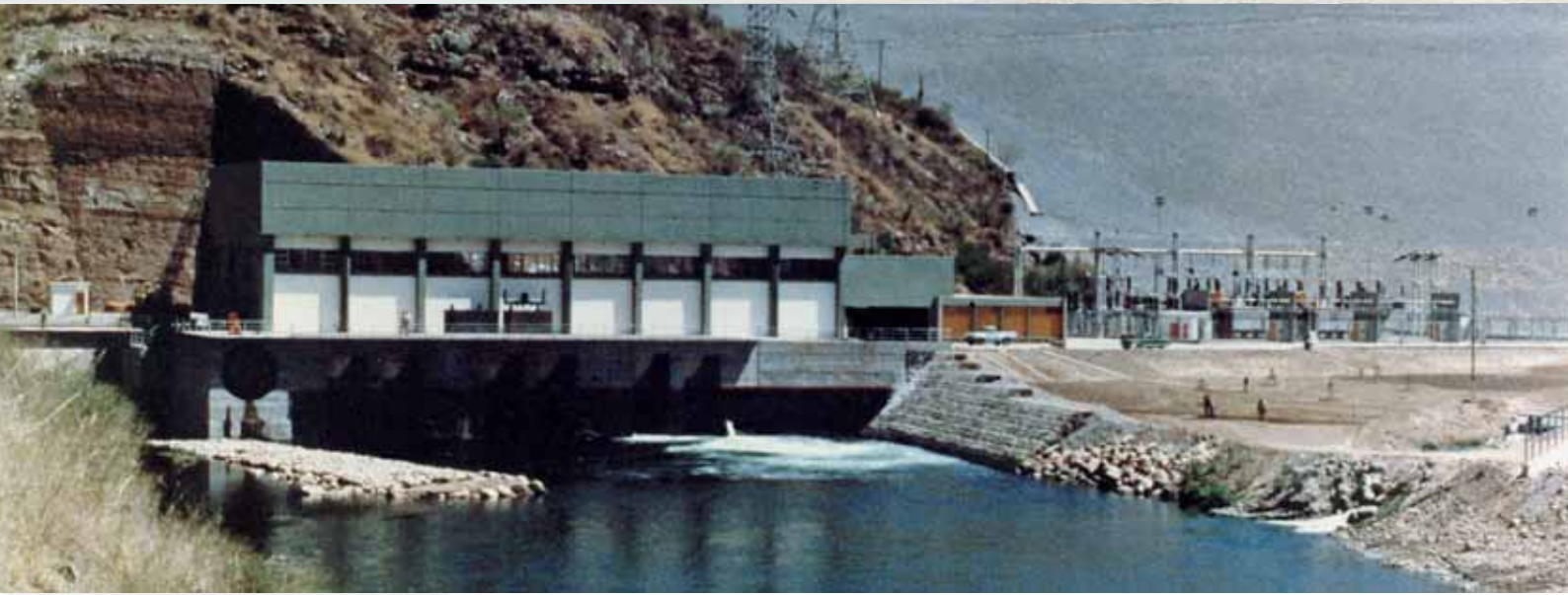


#### Other key data

Panedile's participation	100 %
Works' value	USD MM 38,6
Construction period (main items)	1966 – 1973

#### Major items quantities

Excavations	3.741.000 m <sup>3</sup>
Backfilling	9.121.000 m <sup>3</sup>
Concrete	88.000 m <sup>3</sup>
Pavements	164.000 m <sup>3</sup>



### Project

Cabra Corral hydroelectric power plant (General Belgrano dam / Cabra Corral power station), on the Juramento River, Province of Salta (102 MW).

### Client

Agua y Energía Eléctrica Sociedad del Estado

### Phase II Work's description

Civil and architectural works for Cabra Corral power station.

Located downstream of the General Belgrano dam, included the power house, machine hall, tailrace conduit, bus bar tunnel, control and circuit rooms, substation and complementary architecture works. It was designed to produce 250 GWh/year; energy that was incorporated to the national system grid.

The intake tower provides the water to the power station for its operation. The water is carried from the reservoir to the turbines inside the power station through a concrete-lined head race tunnel of 545 m of length and 6 m of diameter running trough a distributor penstock in steel pipe. The three branches that born there, access to the spherical valves in each turbine.

The power station is equipped with three Francis turbines of 46,500 HP and its corresponding synchronous generators of 40,000 kVA.

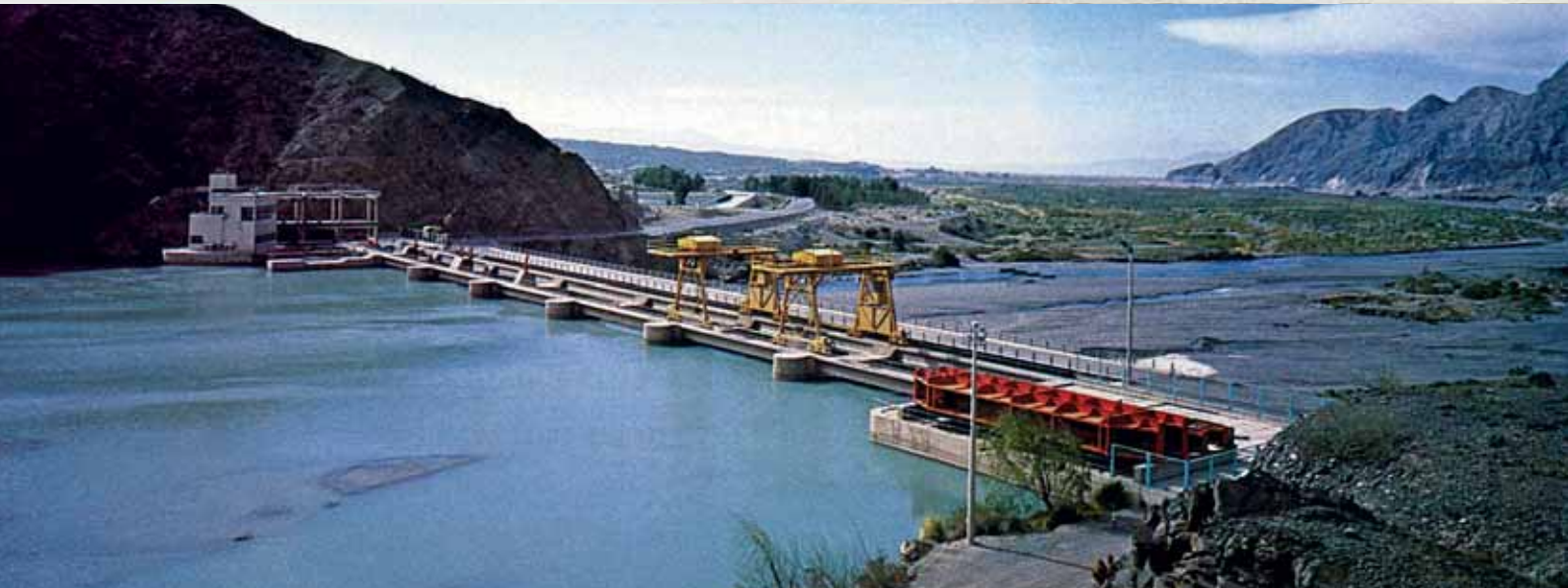


#### Otros datos

Participación de Panedile	100 %
Monto de las obras	USD MM 33,5
Período ejecución trabajos principales	1972 – 1978

#### Magnitudes de obra

Excavaciones exteriores	97.000 m3
Rellenos compactados	42.000 m3
Hormigón estructuras	25.500 m3



### Projects

Civil works for Ullum I & II power plant (45 MW) on the San Juan River, Province de San Juan.

### Client

Agua y Energía Eléctrica Sociedad del Estado (state owned energy enterprise).

### Work's description

Ullum I & II hydroelectric power plant is located on the San Juan River about 34 kilometers west from the city of San Juan. It was the first power plant constructed to take advantage of the San Juan River.

The works involved the construction of a low-head dam (weir), a first sand-trap, the intake structures, a tunnel 170 meters long and 0,72 meters of diameter, a concrete lined headrace tunnel excavated in rock, a second sand-trap, an open-sky headrace channel 9.5 kilometers long, the power station and the tailrace channel of 2.8 kilometers long.

The low-head dam has a span of 176 meters with six circular sluice gates 20 meters width and 7 meters height mounted over concrete columns 3 x 1 meters founded on rock.

The main sand-trap has 24 room cells in an area of 10000 squared meters. Each cell has a rectangular shape 80 meters of length, 5 meters width and a variable height between 2.75 meters to 4.75 meters.



#### Other key data

Panedile's participation	100 %
Works' value	USD MM 15,1
Construction period (main items)	1958 – 1969

#### Major items quantities

Excavations	1,800,000 m3
Concrete	128,000 m3



## Projects

Hydroelectric power plant on the "Rio Dulce" River (17.5 MW) 3 km upstream of the City of Río Hondo, Province of Santiago del Estero.

## Client

Agua y Energía Eléctrica Sociedad del Estado.

## Work's description

The works involved the civil works, and the procurement, installation, performance testing and start-up of the hydro and electromechanical equipment, in a turnkey contract basis

The dam has two lateral earth-fill artificial abutments and a central gravity concrete section. The total crest length is 4,347 m long.

The protection of the upstream slope was made in three layers. The first layer is made of clean sand and grave. The second one made of rolled rock. The third layer made of large uncoursed stones placed in random fashion (rip-rap).

The concrete part of the dam, is located near the right bank of the river, funded on consolidated grave of 20 m of thickness, has a controlled tainter gate spillway with 21 Creager-Scimemi-shape sections. In the last two sections on the right there are 2 Kaplan turbines, on the next four sections the derivation Howell-Bunger type valves of 1.80 m of diameter for control a volume flow up to 47 m<sup>3</sup>/s. On the last four sections there are 4 sluiceways with plane gates.



### Other key data

Panedile's participation	100 %
Works' value	USD MM 40
Construction period (main items)	1958 – 1968

### Major items quantities

Earthwork – Abutments	8,000,000 m <sup>3</sup>
Excavations	4,000,000 m <sup>3</sup>
Rip-rap	210,000 m <sup>2</sup>
Concrete	130,000 m <sup>3</sup>





**Project \***

Reconstruction of the Figueroa System, Figueroa Department, Province of Santiago del Estero.  
 (\*) In progress.

**Client**

Secretaría del Agua de la Provincia de Santiago del Estero (Santiago del Estero provincial water agency).

**Work's description**

The Government of the Province of Santiago del Estero has faced the complete and integral rehabilitation of the Figueroa Irrigation System and the Left Margin Channel projects with the purpose to satisfy the basic water supply needs of the dependent communities. The works involve the repair of the Figueroa dam and El Cero dam, the recovering of the lateral embankment in the left margin flow channel and the intake structure of San Jorge channel.

Furthermore, should be carried out the repair of the Gini channel, the reconstruction of the energy dispersers, the construction of two channel crossings and three branch canals (2 m<sup>3</sup>/s future flow), the reconstruction of the intake for El Cero dam, the spillway in the left margin channel, and different channeling in the Figueroa basin. Also the works include the construction of a complementary access road parallel to the Gini Channel between km 0 and km 30 (10.5 m wide -including the shoulders-).



**Other key data**

Panedile's participation	100 %
Works' value	USD MM 83.3
Construction period (main items)	2007 – 2010**
** works end forecast	

**Major items quantities**

Excavations	740,000 m <sup>3</sup>
Concrete	138,000 m <sup>3</sup>
Embankments	740,000 m <sup>3</sup>



### Project \*

Los Nogales emergent wall (cutoff wall), Jesus Maria, Province of Córdoba.

### Client

Hydraulic Provincial Agency dependent of the Ministry of Public Works of the Province of Córdoba.

### Work's description

Construction of an emergent screen in the riverbed of the Jesus María River to raise the ground water for the irrigation of 10.000 hectares in the surrounding area of Colonia Caroya.

Near the confluence of the rivers Ascochinga and Santa Catalina, the Jesús María River leaked down the river bed in the alluvium material, creating a subterranean waterway.

The Hydraulic Provincial Agency proposed this project that consists in the construction of an impervious wall in the riverbed, in a gorge called Los Nogales located near the city of Jesus Maria.

This cutoff wall was constructed via waterproofing the alluvium material, handling the soil in the riverbed with consolidated grouting.

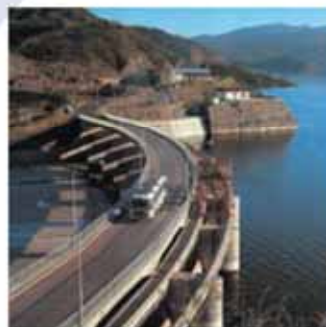


#### Other key data

Panedile's participation	100 %
Works' value	USD MM 2
Construction period (main items)	1965 - 1968

#### Major items quantities

Grouting	13,000 t
Treated area	8,000 m2
Treated volume material	48,500 m3



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