



ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS



GOBIERNO DE ESPAÑA

MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

MINISTERIO DE CIENCIA, INNOVACIÓN Y TURISMO



Instituto Geológico y Minero de España



Grupo Tragsa



## Field Trip Guide: Guadiana Channel and Daimiel National Park



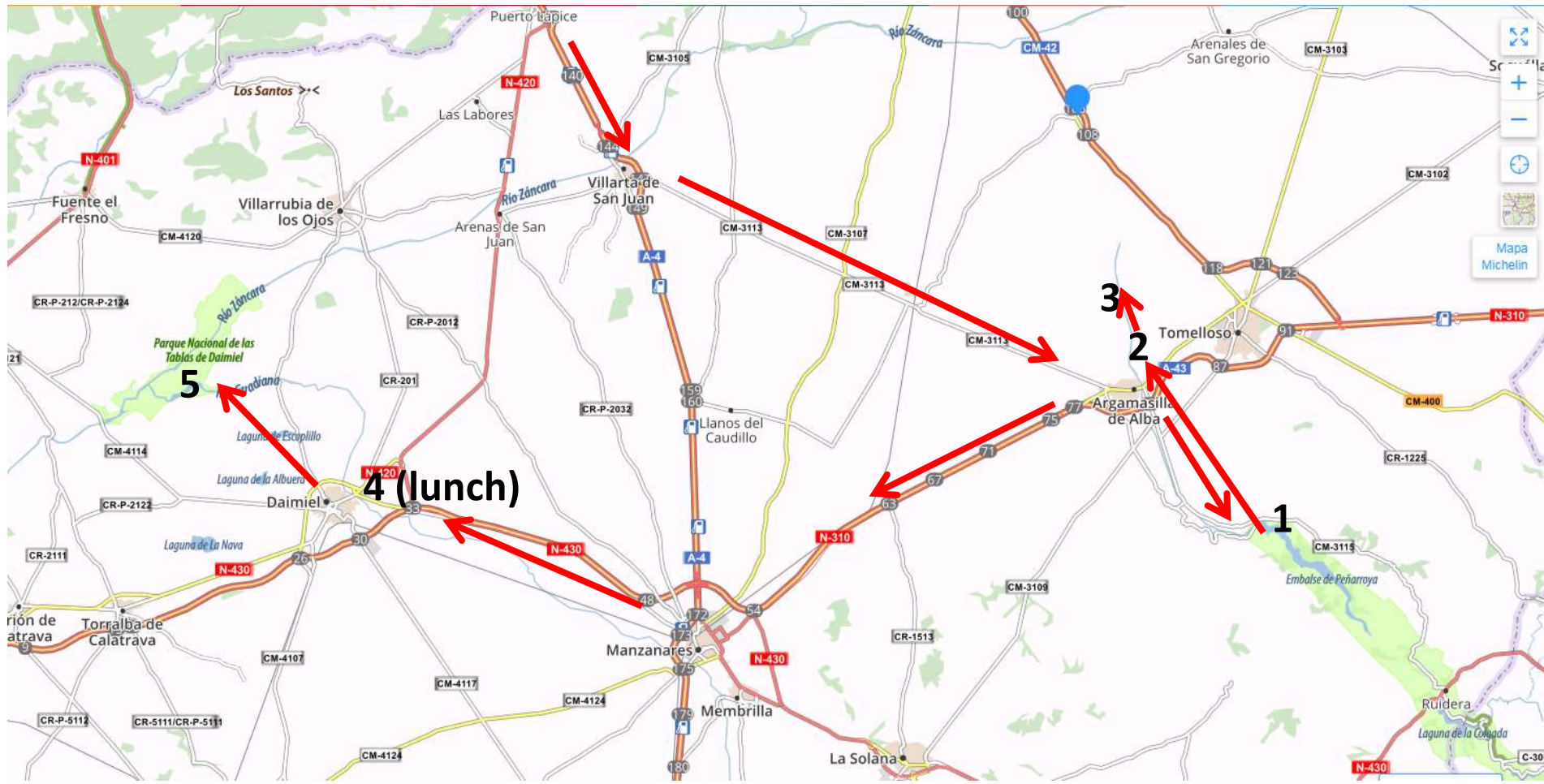
*a battery of 25 MAR wells and boreholes along a canal for temporal and intermittent recharge. The design is unique and is an example of quick recharge to store winter water surpluses. At the end of this battery there are four boreholes more for environmental purposes, recharging Tablas de Daimiel National Park. The visit might be complemented with a visit to the Park before returning to Madrid.*

# INTERNATIONAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE

MADRID, MAY 20-24, 2019

# FIELD TRIP 2 MAP

- Madrid...  
1- Peñarroya dam  
2-3 Canal del Guadiana & MAR wells  
4- Restaurant Las Brujas (Daimiel)  
5- Tablas de Daimiel National Park.  
MAR wells and walk around  
Back to Madrid...







Google Earth

Image © 2019 DigitalGlobe

4 km

# Irrigation and ecological uses of MAR in Central Spain (Guadiana Basin)

Guadiana Channel and Tablas de Daimiel National Park are located on a karstic aquifer composed of Tertiary limestone layers and detritic Plio-Quaternary and volcanic materials. These layers reside over a thick Jurassic mudstone basement. From the bottom of the aquifer, marl-sandy levels of variable thickness are overlaid with gypsum lenses and sandy matrix conglomerates. Tertiary limestones have a mean thickness of approximately 35 m and a saturated thickness of approximately 21 m. The aquifer is heterogeneous with permeability values ranging from 50 to 20,000 m/day. The average transmissivity ranges from 10,000 to 20,000 m<sup>2</sup>/day; the storage coefficients are approximately 10%. The water tables are generally approximately 50-m deep and are up to 30-m deep in some bores in the confined Jurassic aquifer.





**MAPA GEOLOGICO**  
**E. 1:200.000**  
 SINTESIS DE LA CARTOGRAFIA EXISTENTE



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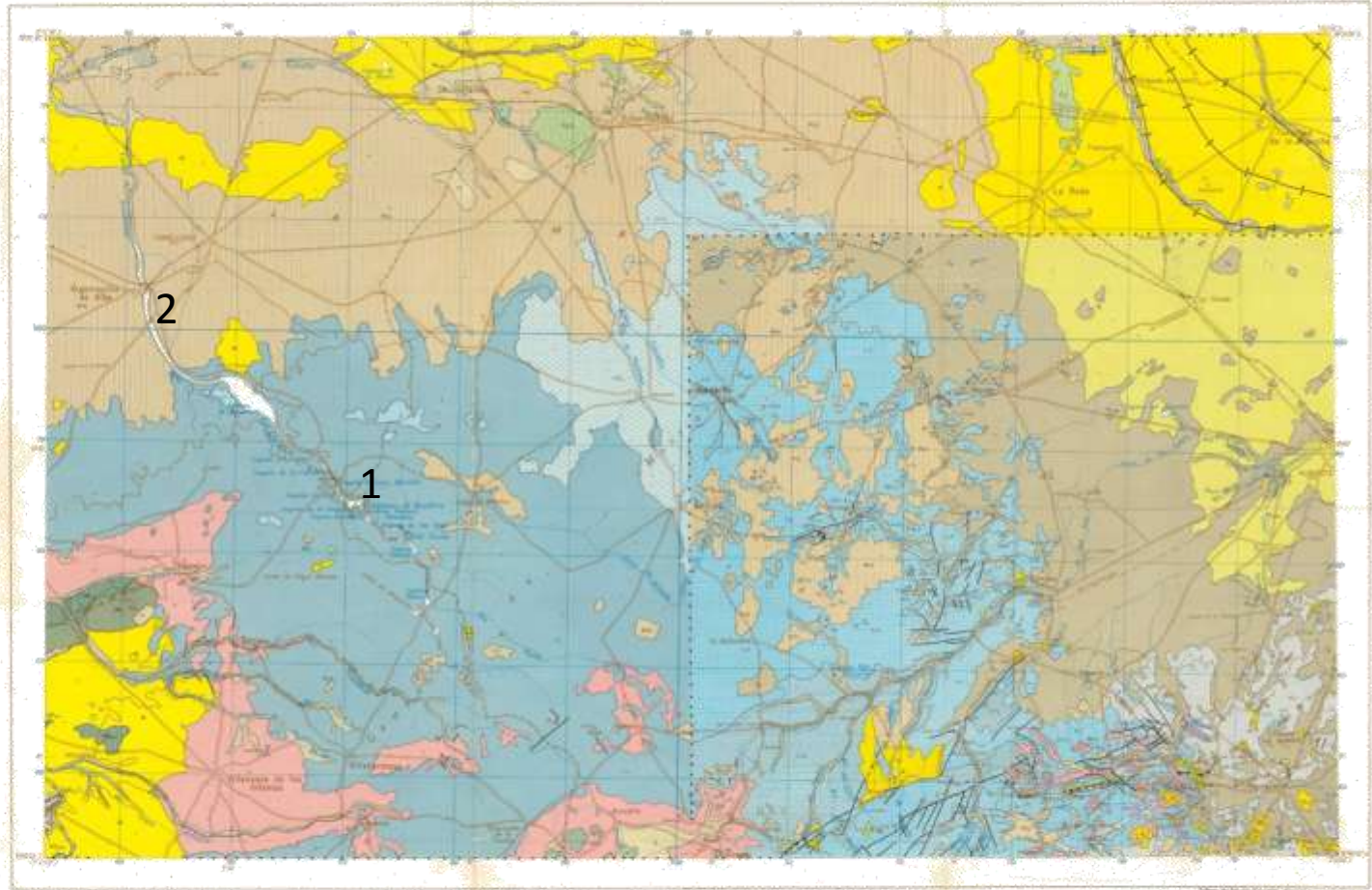
**TOMELLOSO**

**62**

**LEYENDA**

CLASIFICACION	DESIGNACION	DESCRIPCION
CUATERNARIO	Q1	Aluviós reciente
	Q2	Aluviós antiguo
TERCIARIO	T1	Terrier
	T2	Aluviós reciente
	T3	Aluviós antiguo
	T4	Aluviós reciente
CRETACEO	C1	Aluviós reciente
	C2	Aluviós antiguo
	C3	Aluviós reciente
JURASICO	J1	Aluviós reciente
	J2	Aluviós antiguo
TRIASICO	T1	Aluviós reciente
	T2	Aluviós antiguo
PERMIANO	P1	Aluviós reciente
	P2	Aluviós antiguo
CARBONIFERO	C1	Aluviós reciente
	C2	Aluviós antiguo
DEVONIANO	D1	Aluviós reciente
	D2	Aluviós antiguo
PRIMARIO	P1	Aluviós reciente
	P2	Aluviós antiguo
SECUNDARIO	S1	Aluviós reciente
	S2	Aluviós antiguo
TERTIARIO	T1	Aluviós reciente
	T2	Aluviós antiguo

NOTA: En las zonas de distribución de los ríos indicados en los cartógrafos anteriores, como, especialmente a estos designados como "Mares".



SIMBOLOS GEOLOGICOS	
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo

DIVISION ADMINISTRATIVA	
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio
[Symbol]	Municipio



SITUACION DEL MAPA	
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo
[Symbol]	Aluviós reciente
[Symbol]	Aluviós antiguo

Referencia Mapa Sinescopo E. 1:50.000		
18	78	62
19	78	62
19	79	62
20	78	62

Referencia Mapa Sinescopo E. 1:50.000		
17	78	62
18	78	62
19	78	62
20	78	62
21	78	62
22	78	62
23	78	62
24	78	62
25	78	62



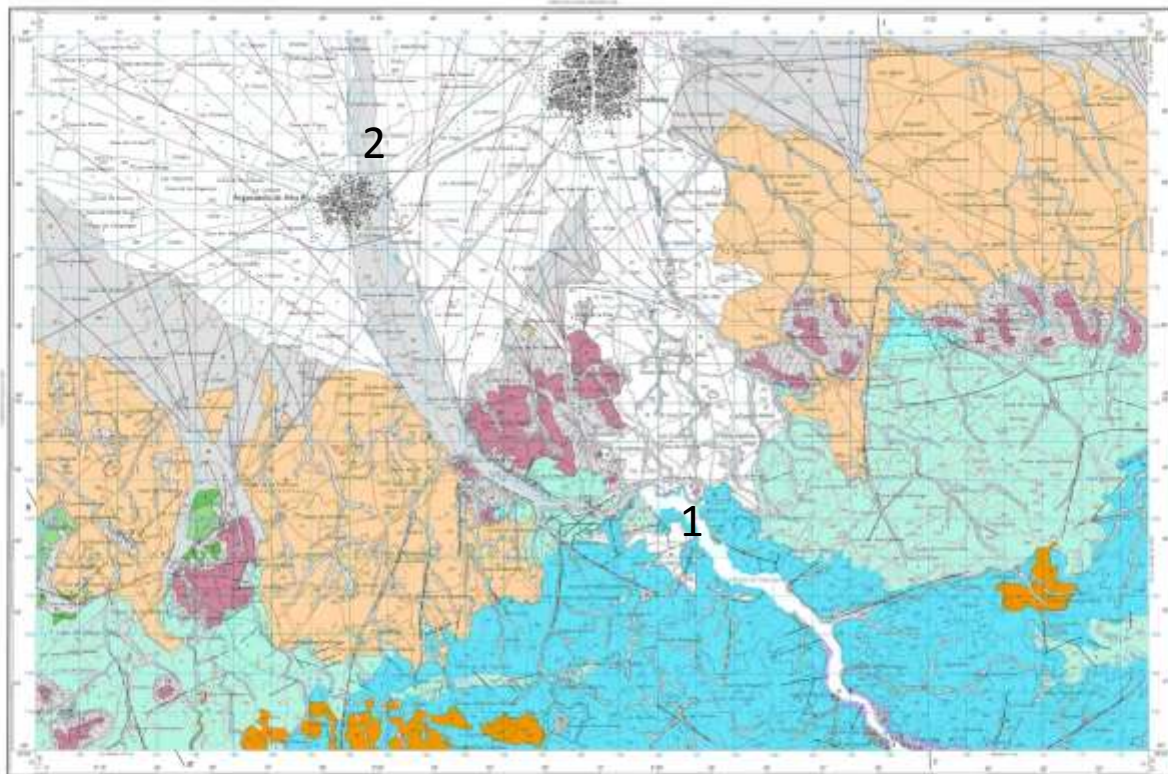
LEYENDA



SÍMBOLOS CONVENCIONALES

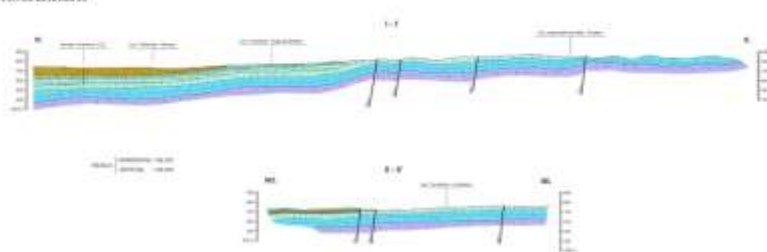


MAPA DE ANOMALIAS DE DENSIDAD (g/cm³)



Escala 1:50.000

CORTES GEOLÓGICOS



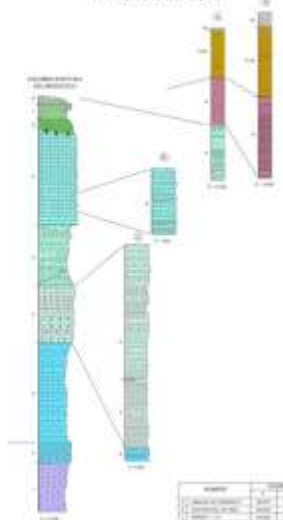
ESQUEMA REGIONAL



ESQUEMA TECTÓNICO

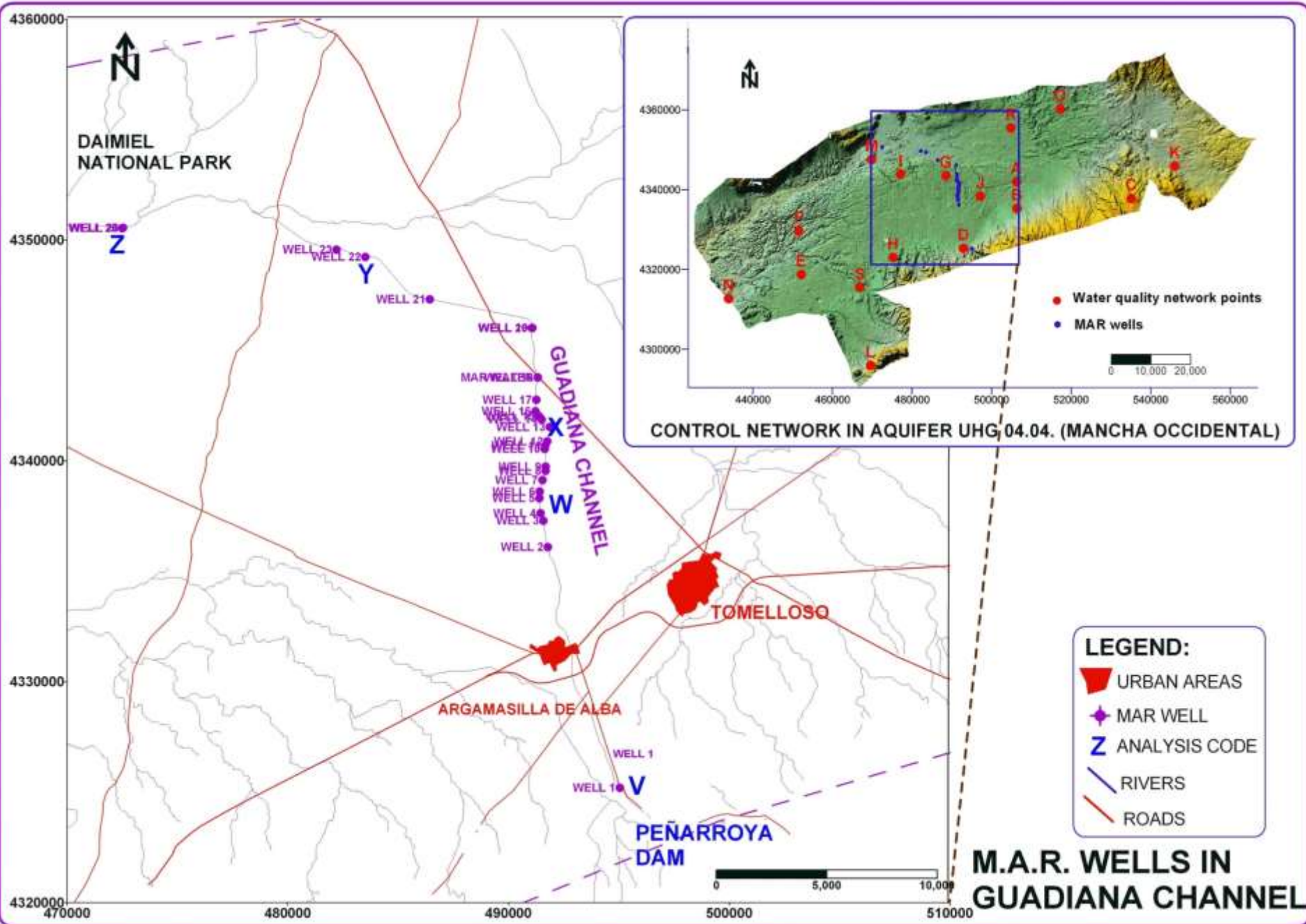


ESQUEMAS ESTRATIGRAFICOS DE LAS PRINCIPALES UNIDADES O ZONAS



UNIDAD	ESQUEMA	ESQUEMA
1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30
31	32	33
34	35	36
37	38	39
40	41	42
43	44	45
46	47	48
49	50	51
52	53	54
55	56	57
58	59	60
61	62	63
64	65	66
67	68	69
70	71	72
73	74	75
76	77	78
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82	83	84
85	86	87
88	89	90
91	92	93
94	95	96
97	98	99
100	101	102



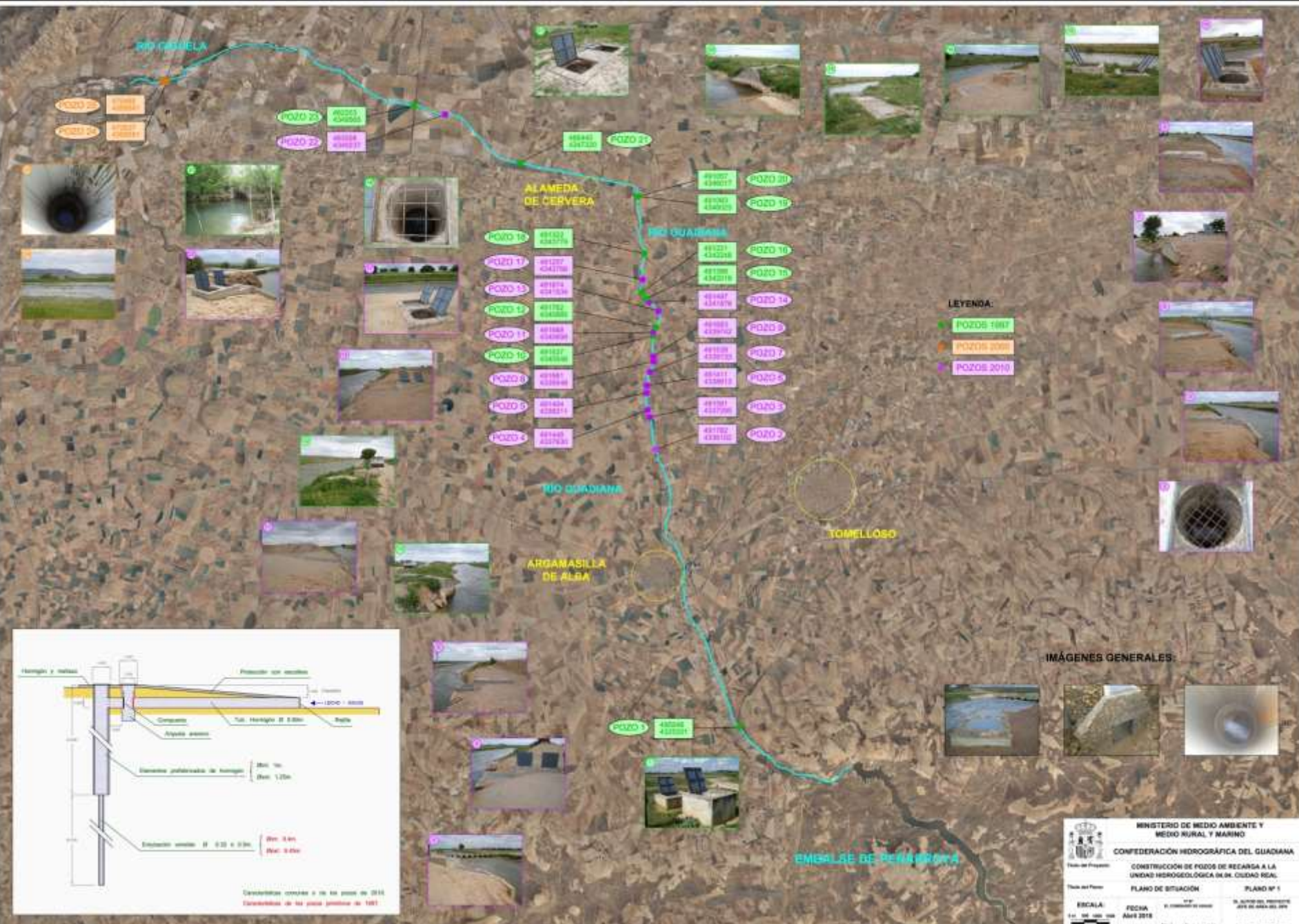


CONTROL NETWORK IN AQUIFER UHG 04.04. (MANCHA OCCIDENTAL)

- LEGEND:**
-  URBAN AREAS
  -  MAR WELL
  -  ANALYSIS CODE
  -  RIVERS
  -  ROADS

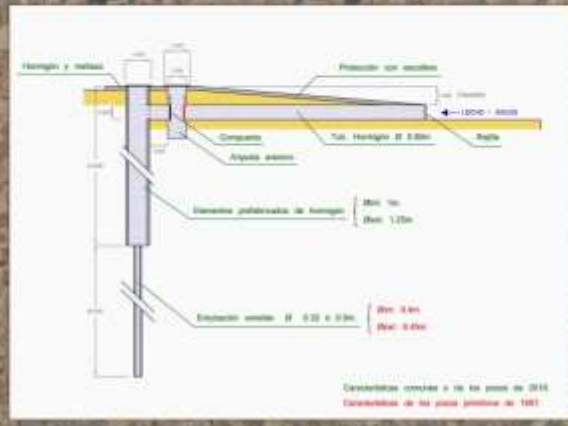
**M.A.R. WELLS IN GUADIANA CHANNEL**





**LEYENDA:**  
 POZOS 1987  
 POZOS 2009  
 POZOS 2010

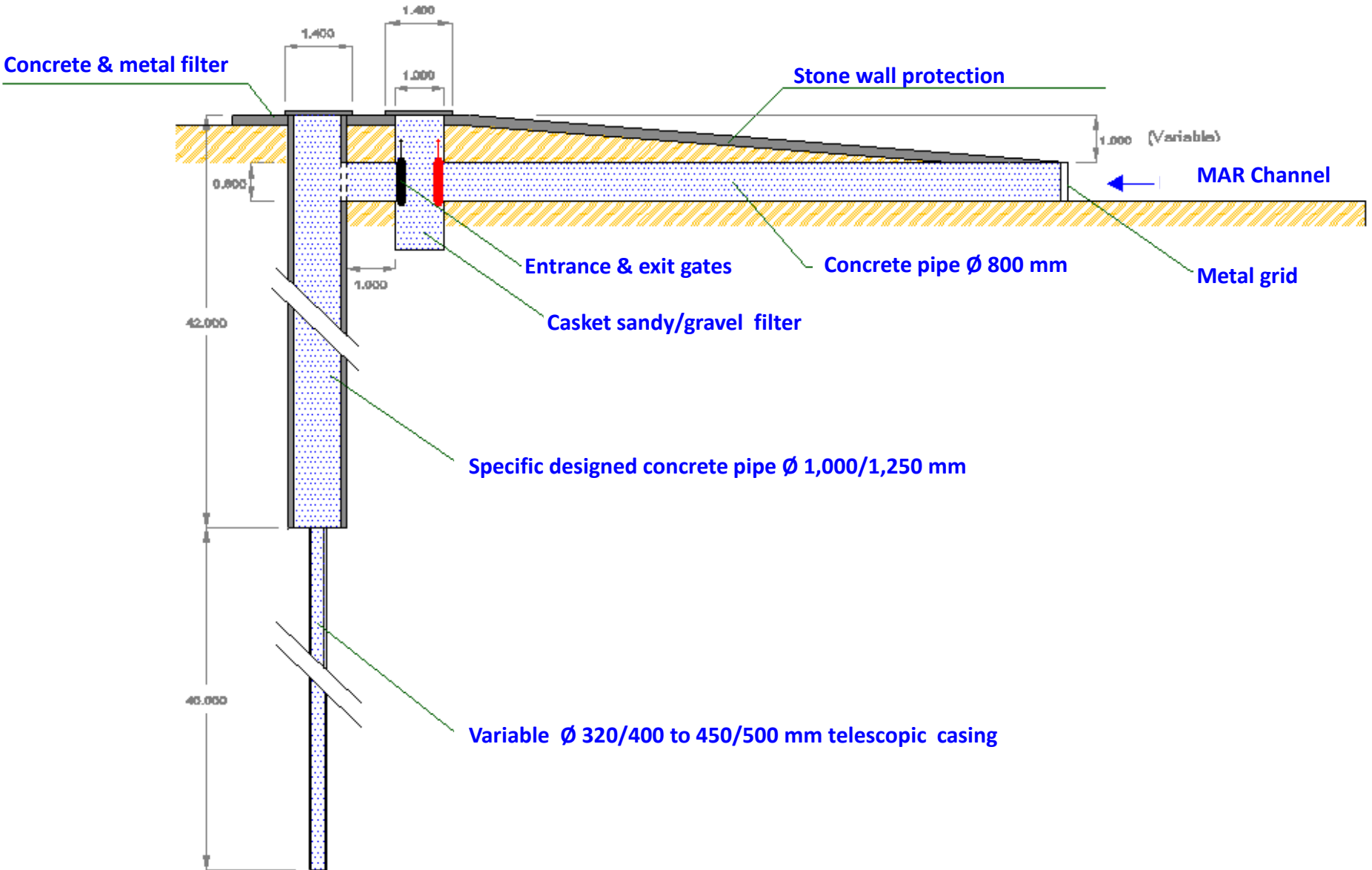
**IMÁGENES GENERALES**




**MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO**  
**CONFEDERACIÓN HIDROGRÁFICA DEL GUADALQUIVIR**  
 Título del Proyecto: **CONSTRUCCIÓN DE POZOS DE RECARGA A LA UNIDAD HIDROGRÁFICA DE LA CIUDAD DE BSA.**  
 Título del Plano: **PLANO DE SITUACIÓN PLANO Nº 1**  
 ESCALA: **1:1.000** FECHA: **04/04/2018**  
 Elab. por: **ING. JOSÉ ANTONIO GARCÍA GARCÍA**



# GUADIANA CHANNEL INFILTRATION WELLS. GENERAL DESIGN & COMMON ELEMENTS



2010 May











2019 May 2<sup>nd</sup>





2019 May 2<sup>nd</sup>





MAPA GEOLOGICO DE ESPAÑA

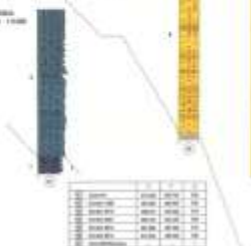
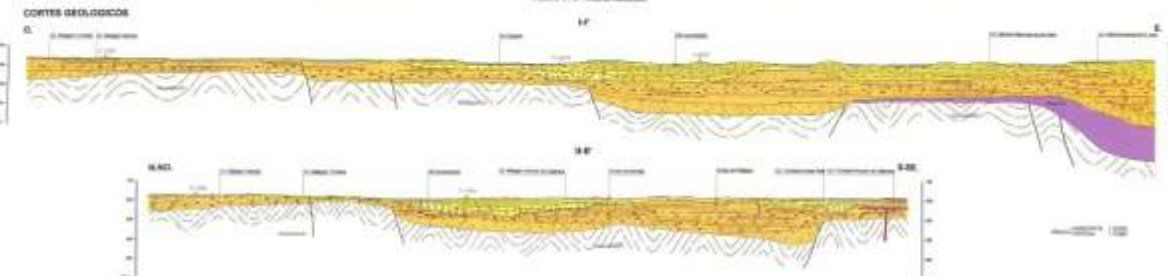
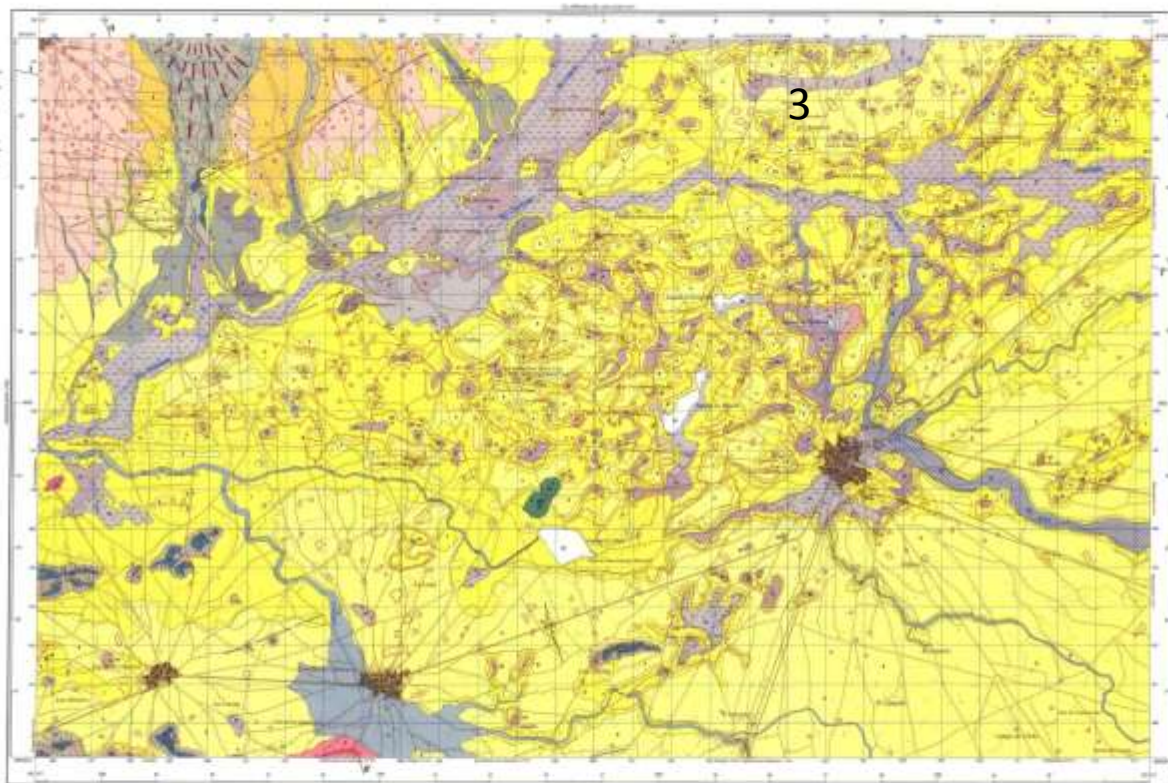
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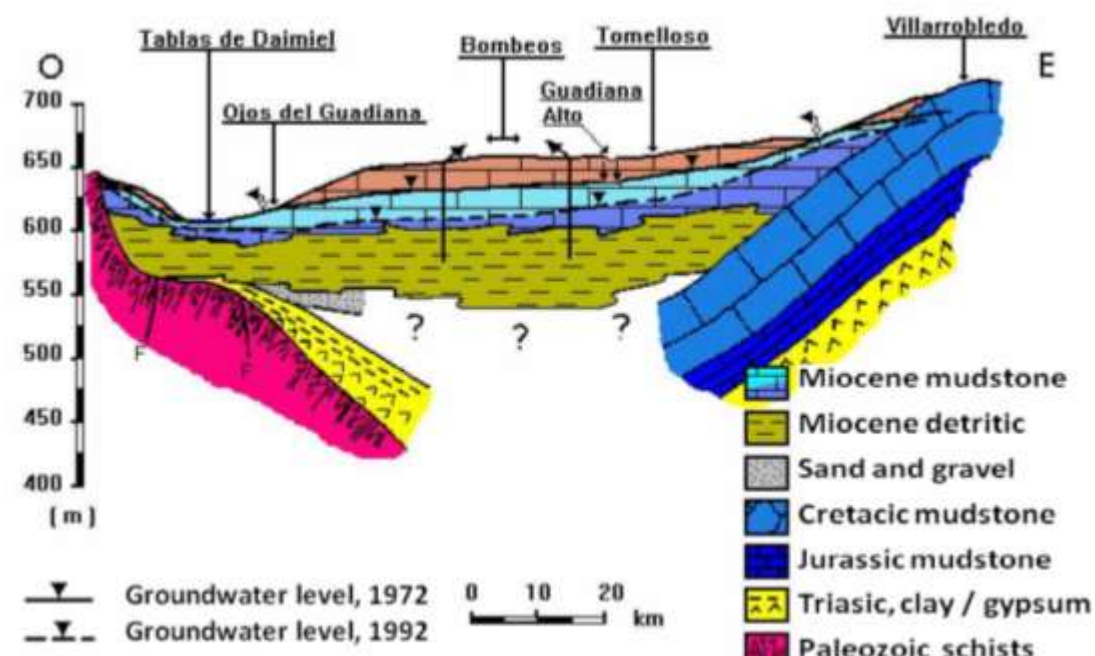


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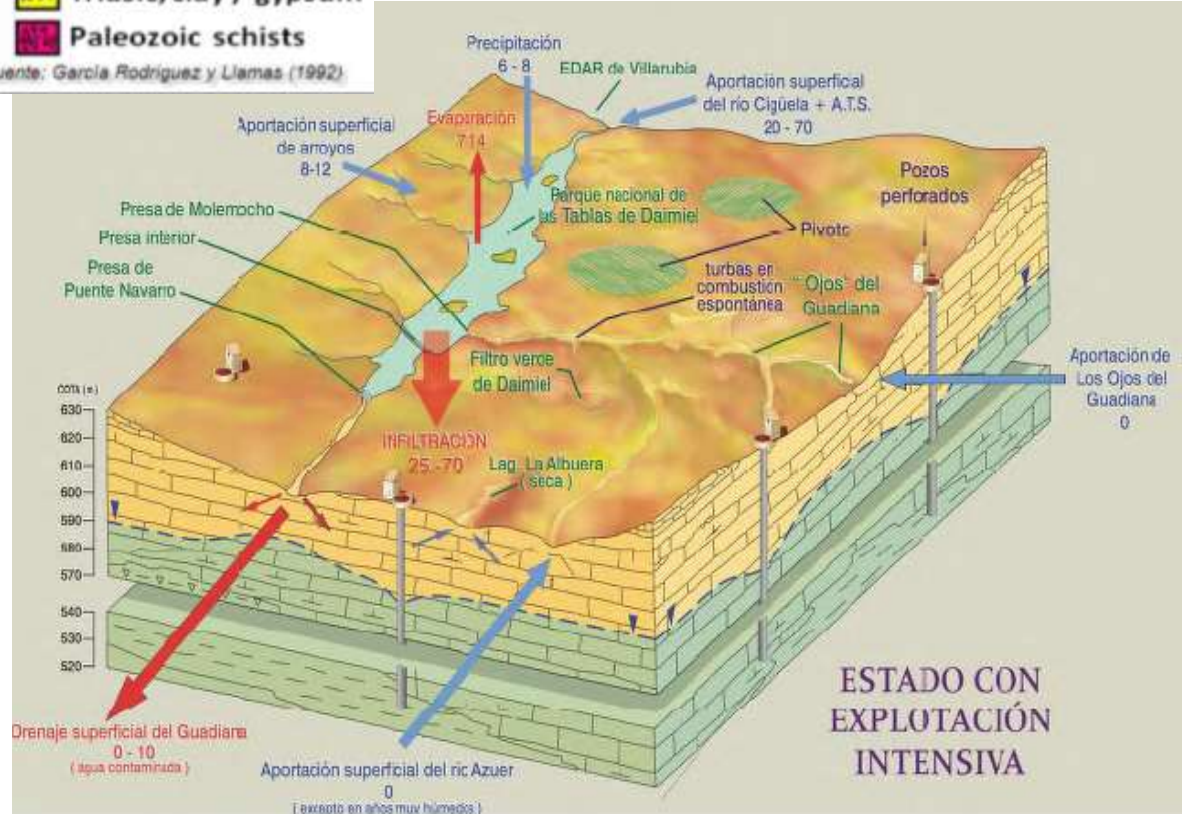
DAIMIEL

710  
19-30

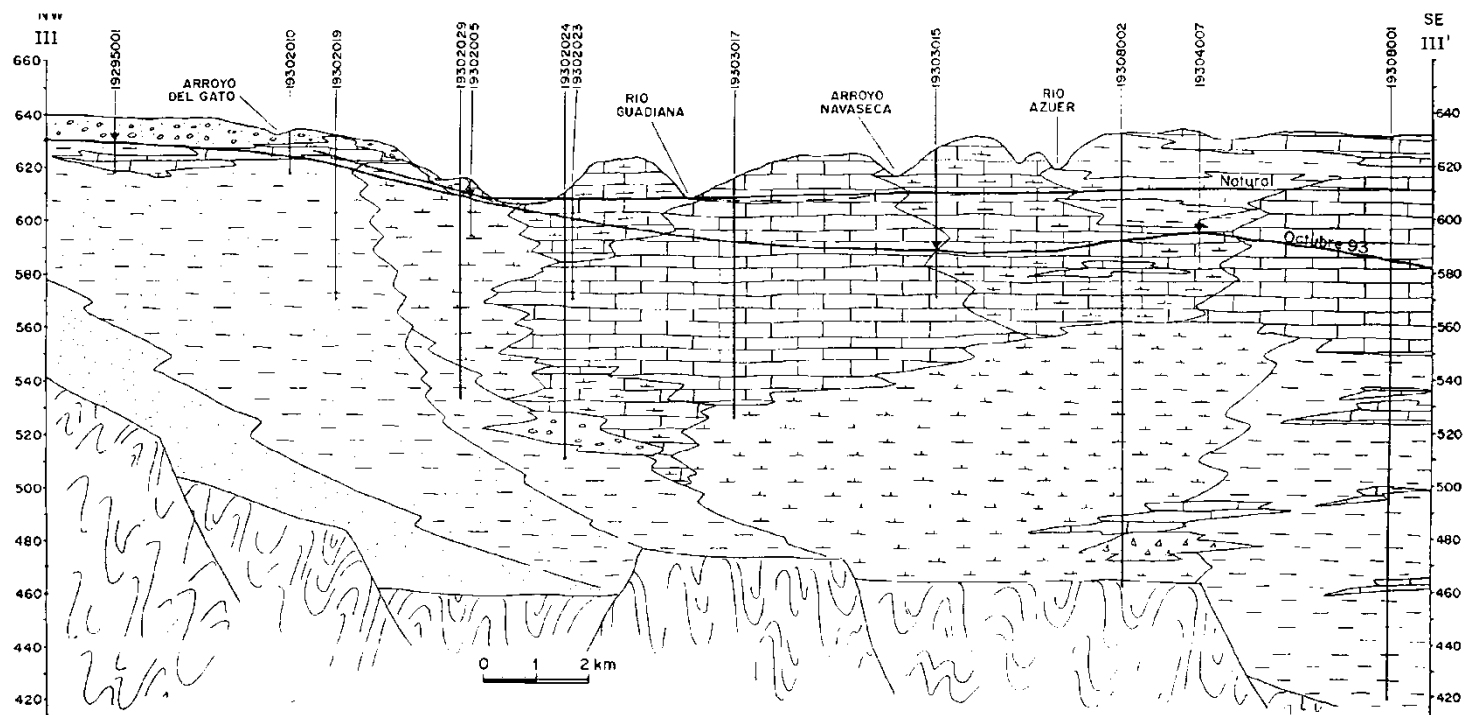
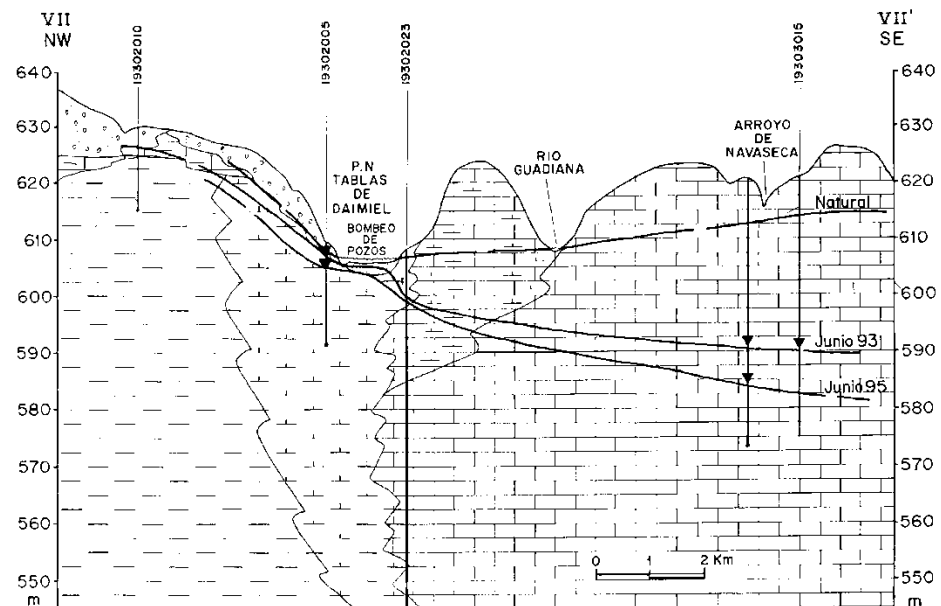
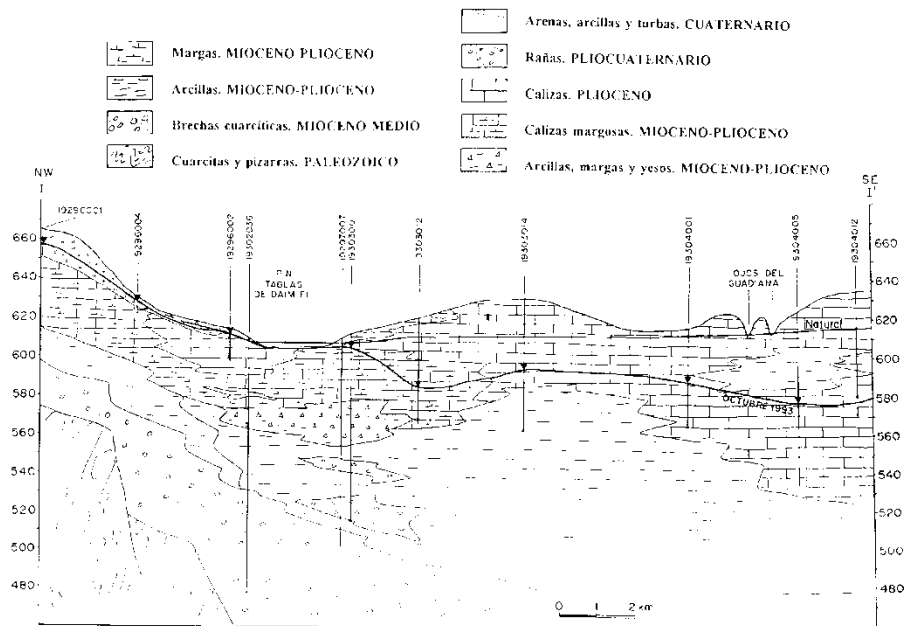




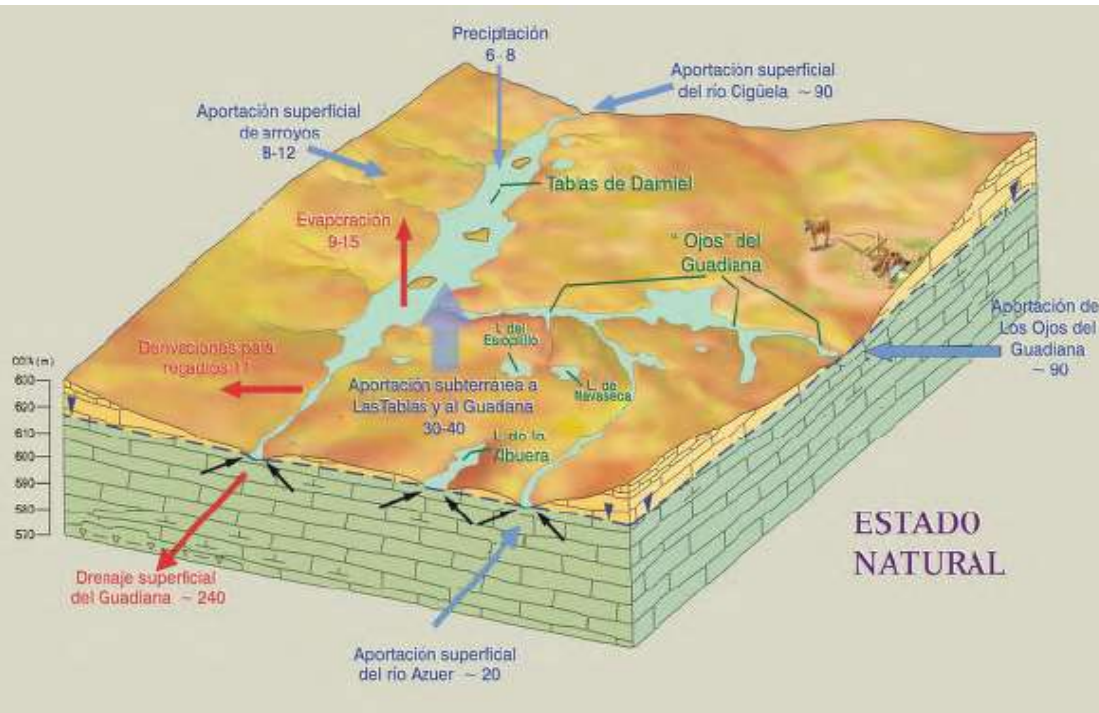
Fuente: García Rodríguez y Llamas (1992)







# P.N. Tablas de Daimiel





# Environmental sustainability

- These two MAR systems have been very important to support local rural development, and, at the same time, they have helped to restore a key wetland.
- With an area of about 3,000 ha, Tablas de Daimiel National Park is the smallest of Spain's fifteen national parks. The protected area (Ramsar, SPA, Man & biosphere) is in the process of being expanded outside the original nature reserve to include neighbouring dryland farming areas. The expansion is part of efforts to improve the condition of the wetland, which has been damaged by over-exploitation of water resources. It is one of the most important aquatic ecosystems of Spain (Mancha Húmeda) and probably the main inland wetland of the Iberian Peninsula. It is capital for migratory birds that pass by the zone from Africa to North Western Europe.
- In recent years demand for water for agriculture in the area surrounding the park has reduced the amount of wetland. Overexploitation of water resources has caused the water-table to drop. The key aquifer ("aquifer 23") has not been able to refill because of the overuse of water created by the "Badajoz Plan" (a huge irrigation extension Plan) started in 1952, and of the administrative apathy and lack of suppleness faced with cereal farmers lobbies. The quotas assigned to water-users (about 590 hm<sup>3</sup>/year attributed) correspond to nearly twice the amount of renewable water (about 320 hm<sup>3</sup>/year available).
- Faced with a possible fine from the EU, the Spanish Environment Ministry presented in 1995 a transfer project (an aqueduct and miles of pipes between the Tagus and the Mancha Húmeda Wetland) to bring water to the upper Guadiana basin. This extra water was to be used strictly for urban water provision and for the protected ecological zones, not for agriculture.
- The Special Upper Guadiana Plan gives scope to use water for the benefit of the national park and also to reassign water quotas in favour of more efficient use than cereal production, essentially small producers of vines and horticulture which have been found more efficient in water use and generate more income per cubic meter of water used.

# Economic and Social sustainability

- 7,842 ha of irrigated plots are served by the Guadiana Canal from the Peñarroya Dam. 2,000 farmers are grouped in the Irrigation Community (*Comunidad de Regantes del Pantano Estrecho de Peñarroya*) from 1963. Population of the villages of Argamasilla de Alba (6,901 inhabitants), Campo de Criptana (13,600) y Tomelloso (36,090) is mainly dedicated to agriculture and its associated services and agro-industries. Main cultures are maize, wheat, vineyard, melon, watermelon, garlic, onion, alfalfa, pepper... Irrigation has suffered a high modernization for the last two decades and most of cultures are sustained by sprinkler, pivot or drip irrigation.
- The availability of water during the hot summer in La Mancha plays a key role in the support of agriculture. The change from furrow to pressurized irrigation techniques has allowed the extension of automatized systems where consumption is automatically controlled. An annual save of 15.36 hm<sup>3</sup> has been calculated thanks to modernization works within an officially over-exploited aquifer area.
- The development of other local economic sources such as solar electricity production, ecotourism, better quality agricultural products, and environmental services is widening the economic landscape of the region.