

#### 14.4.2.2 Natural Environment

##### a. Groundwater

##### a.1 Water Bearing Formation (Aquifers)

The area is a delta plain which is formed by Berdan, Delicay and Efrenk creeks. The plain has materials of various characters because the streams carried and deposited different kinds of materials.

Extension of formation below the ground surface is determined by using geoelectrical methods and well logs. The proposed area extends between subordinate surface water division lines. In the wells opened in this area, the sequence are observed as alternating marl, clay, sandstone, limestone of Miocene aged from surface to deep down.

The water bearing formations of the area are clayey gravel and gravel layers in delta depositions of the Quaternary aged. The thickness and water capacity of aquifers increase southwards. The average thickness of water bearing formation reaches to 100 m in Delicay plane and the aquifer is of unconfined type. The thickness of the water bearing formation is 10-80 m and it is spread over the left side of geological map.

Besides these depositions, a little amount of water is obtained by the caliche. In the area some caisson wells are drilled in the caliche. The thickness of caliche is between 3-30m.

Static level in the wells, generally, is in the range of 10-15m. In the proposed area groundwater level is measured in both three existing (caisson) and three new piezometric boreholes(Figure 14-20). The measured values are shown in Table 14-19. The depth of the groundwater table decreases towards south. The direction of groundwater flow is from north to south (Figure 14-21).

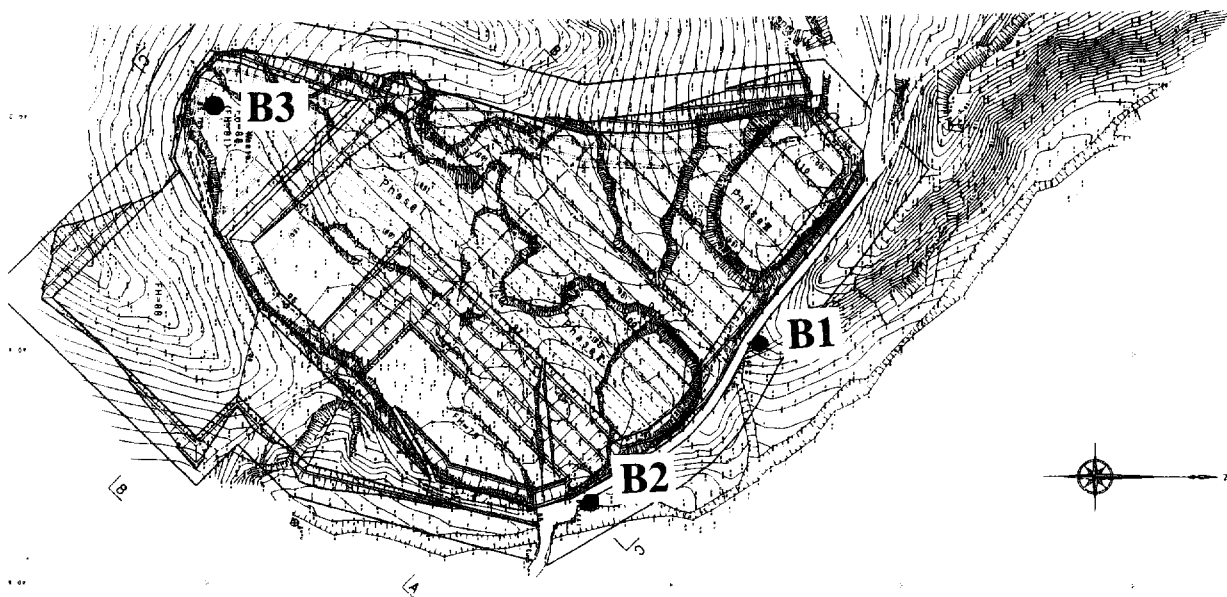


Figure 14-20: Location Map of Existing Wells and Boreholes

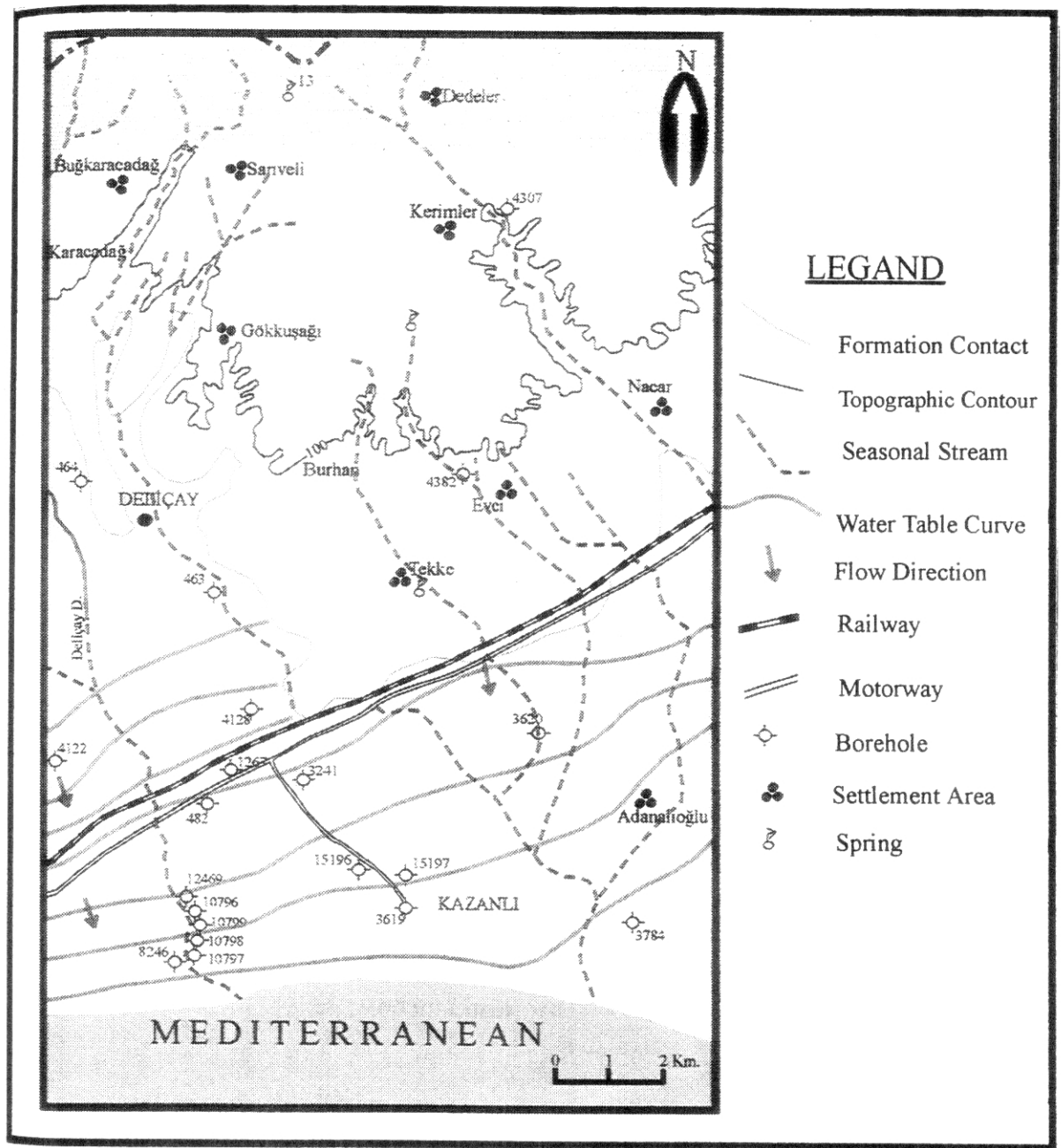


Figure 14-21: Hydrographic and Water Table Map of the Proposed Area

Table 14-19: Measured Ground Water Table Values

Well Number	Watertable Depth From Surface (m)	Watertable Height From Datum (m)
Existing Well 1(Burhan town)	33	-
Existing Well 2 (Broken pump)	10.88	-
Existing Well 3 (Near hut)	4.42	-
Borehole 1	7.90	89.2
Borehole 2	7.95	74.05
Borehole 3	14.68	69.32

The transmissibility coefficient of the aquifer in Delicay area changes between 376-6,550 m<sup>3</sup>/day/m.

### a.2 Boreholes

A total number of three boreholes named B1, B2, B3 were drilled in the proposed area. Extension of formation below the ground surface is shown in Figure 14-22, Figure 14-23 according to geoelectrical methods and well logs. Location of B-B' and C-C' section is shown in Figure 14-20. The variation of lithological profile in the logs of the borehole are presented below :

#### Borehole No: B1

Depth: 15.00m  
 Static Level: 7.15m  
 Lithology: 0-3.00 m Limestone gravel with clay  
 3.00-4.50 m Sandstone-conglomerate  
 4.50-13.50 m Silty clay  
 13.50-15.00 m Limestone

#### Borehole No: B2

Depth: 16.00 m  
 Static Level: 2.15 m  
 Lithology: 0-4.50 m Red limestone gravel with clay  
 4.50-15.00 m Silty clay  
 15.00-16.00 m Limestone

#### Borehole No: B3

Depth: 15.00m  
 Static Level: - m  
 Lithology: 0-2.00 m Silty, sandy, clay  
 2.00-3.50 m Sandy  
 3.50-12.80 m Silty clay  
 12.80-15.00 m Limestone

The stratification, and some engineering properties of soil have been determined from visual inspection and standard penetration test done in the boreholes. Soil samples were collected from the borings for laboratory testing. Filling materials taken from nearby soil pits were also brought to the laboratory.

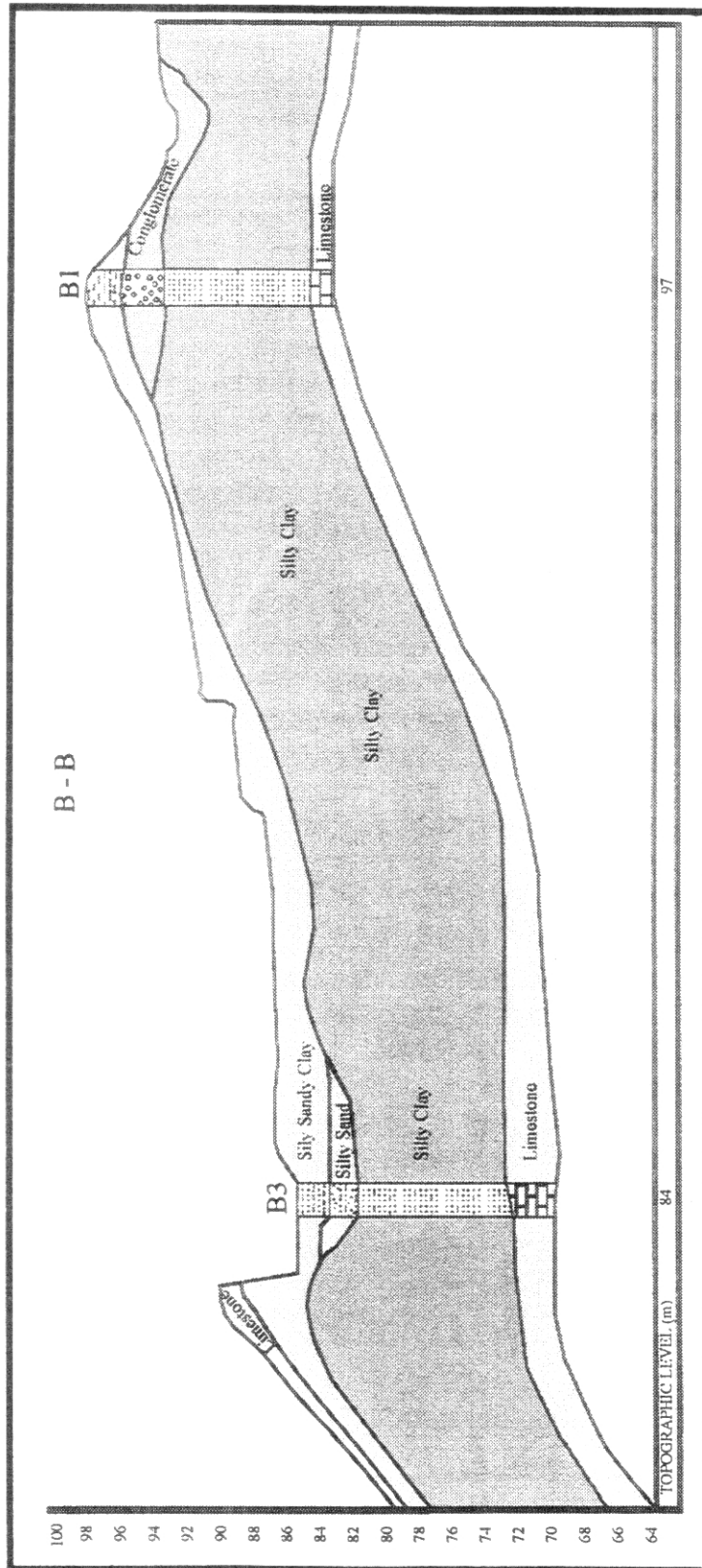


Figure 14-22: The Section Showing Extension of Formation Under Ground (B - B')

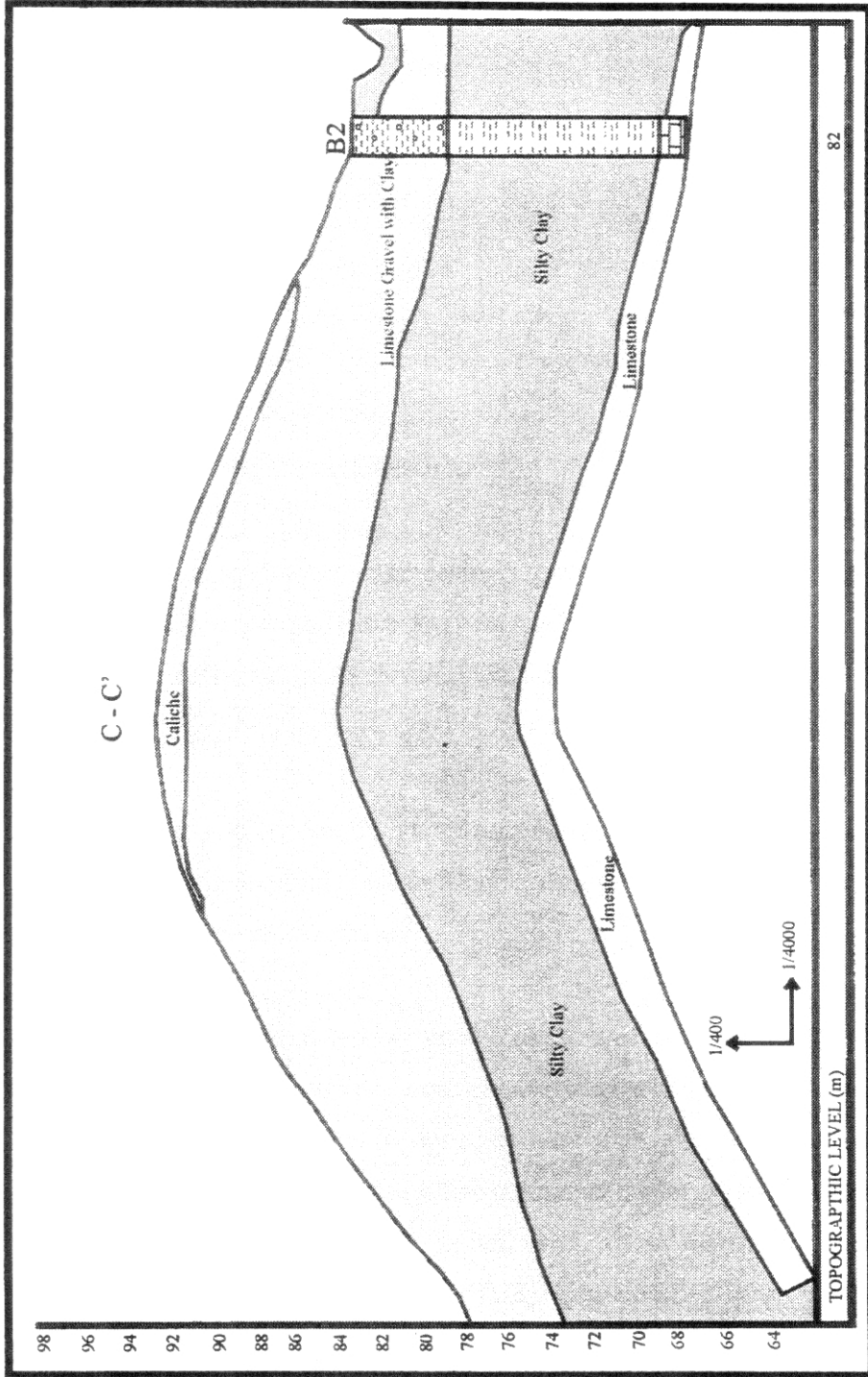


Figure 14-23: The Section Showing Extension of Formation Under Ground (C - C')

The dominating geology of the proposed area is outcropping as clay, sandstone and marl. In the proposed area, 13 geo-electrical readings in harmonic positioning along with the 3 boreholes are conducted.

As a general expression, it can be stated that the area is based on silty clay over the dominating part of the survey area, representing a thickness about 7-9 meters (Figure 14-22, Figure 14-23). The silty clay is topped by a layer varying from 2 m to around 7 m outcropping mainly clay dominating formations on the larger part. These formations consist of various caliche, gravel, silt and sand. These two layers are placed over limestone. The limestone outcropping in the geo-electrical profile is fissured and therefore it is permeable. However, it is quite deep and positioned below an impermeable layer.

The silty clay has proven itself to be highly impermeable because of the low percentage and fine grain size of the silt content. The laboratory test results are evidently confirming this. Scatteredly laying sandy clay is showing a similar character with very fine grains in low percentage.

The undisturbed and disturbed soil samples from different soils at various depths from the investigation site and filling material were subjected to tests in the soil mechanics laboratory.

Table 14-20: The Laboratory Test Results

Laboratory Test		Boreholes	Fill material
Moisture content	W <sub>n</sub> (%)	19 - 35	10 - 27
Bulk density	$\rho_n$ ton/m <sup>3</sup>	1.81-1.89	1.65-1.79
Unit weights	$\rho_s$ ton/m <sup>3</sup>	2.69-2.74	2.71-2.73
Consistency limits	W <sub>l</sub> (%)	58 - 68,	52 - 58
	W <sub>p</sub> (%)	17 - 38	20 - 27

Table 14-21: The Values of permeability coefficient -k (cm/sec)

Borehole No.	B1	B1	B2	B2	B3	B3
Depth (m)	7.50-7.95	12.0-12.2	4.50-6.0	9.0-10.5	7.50-7.75	9.0-9.20
k(cm/sec)	3.51x10 <sup>-7</sup>	8.20x10 <sup>-8</sup>	6.22x10 <sup>-7</sup>	1.60x10 <sup>-7</sup>	7.13x10 <sup>-7</sup>	9.03x10 <sup>-7</sup>

Hydraulic conductivity of clayey soil were found in order of 1x10<sup>-7</sup> cm/sec according to the compaction test.

Grain size distribution of soils named as clay or claystone in the fields were found to be mainly clay and silt size fine materials (over 90%) based on the borehole soil samples. Gravel-sand size coarse materials are less than about 10%.

It has been found that the soil imported from nearby pits consists of mainly fine materials and, gravel and sand size coarse materials are less than 3%. It can be concluded that these soil samples are highly plastic.

As a conclusion, the soil type in the borehole samples was determined as “high plasticity inorganic silty clay (with the group symbol CH)”. Cemented claystone layer

with calcareous structure are observed below these soils. The permeability of borehole soils are very low.

The soil type for filling material was determined as medium to high plasticity inorganic silty clay. This type of soils has high compressibility and expansion properties.

## **b. Hydrological Situation**

In the study area there are no significant surface waters like stream, lake and spring, wet land which are wet every season.

### **b.1 Streams**

Surface water is observed as small flows in bed of creeks in the proposed area. It permits the flow of water for only two or three months in winter time. It has very low flow rate. On the other hand, there is only one stream called Delicay out of the proposed area (at the west). This stream also gets dry in hot season.

### **b.2 Springs**

There is no spring in the proposed area but a few of them are located in the north of the proposed area.

## **c. Fauna and Flora**

### **c.1 Fauna**

Fauna of the area was classified in five groups (mammals, birds, reptiles, amphibians and insects) and investigation took place in and around Cimsa site. According to the research 8 mammal, 31 bird, 8 reptile and 3 amphibian species were identified in the area.

#### **c.1.1 Mammals**

Fire pine stands located in dry stream beds and slopes, and macchie thickets are abound in mammals. This habitat helps to enrich the biological diversity in the area. According to the field observations and interview performed in the site, following list was formed.

Turkce Adi	Bilimsel Adi
Common Fox	<i>Vulpes flavescens</i>
Rabbit	<i>Lepus europeus</i>
Pipistrelle	<i>Pipistrellus nathusii</i>
Shrew	<i>Crocidura leucodon</i>
Mole	<i>Talpa levantis</i>
Porcupine	<i>Erinaceus europeus</i>
Indian Crested Porcupine	<i>Hystrix indica</i>
Wild Boar	<i>Sus scrofa</i>

### c.1.2 Birds

Fire pine stands, macchie thickets and cultivated lands are very rich in bird fauna. A significant number of birds including natives and migratory, enrich the wild life potential of the proposed site. 31 bird species were recorded in the site. 18 are migratory and 13 are native among these species. 6 of the migratory species breed in the region. Bird species identified in the proposed site are shown in Table 14-22.

Table 14-22: Birds Species Recorded in and Around Cimsa Site

English name	Latin name	Migratory	Native	Summer visitor	Winter visitor	Breeding
Jay	<i>Garrulus glandarius</i>		*			*
White Wagtail	<i>Motacilla alba</i>	*			*	
Yellow-vented Bulbul	<i>Pycnonotus barbatus</i>		*			*
Bee-eater	<i>Merops apiaster</i>	*		*		*
Sparrow Hawk	<i>Accipiter nisus</i>		*			*
Common Quail	<i>Coturnix coturnix</i>	*		*		*
Great Tit	<i>Parus major</i>	*		*		*
Little Stint	<i>Calidris minuta</i>		*			*
Jackdaw	<i>Corvus monedula</i>		*			*
Green finch	<i>Carduelis chloris</i>	*			*	
Roller	<i>Coracias garrulus</i>	*		*		*
Hoopoe	<i>Upupa epops</i>	*		*		
Chaffinch	<i>Fringilla coelebs</i>	*			*	
Black-headed Bunting	<i>Emberiza melanocephala</i>	*		*		
Swift	<i>Apus apus</i>	*		*		
Black Bird	<i>Turdus merula</i>	*			*	
Kestrel	<i>Falco tinnunculus</i>		*			*
Swallow	<i>Hirundo rustica</i>	*		*		*
Little Owl	<i>Athena noctua</i>		*			*
Collared Dove	<i>Streptopelia decaocto</i>		*			*
Northern Weather	<i>Oenanthe oenanthe</i>	*		*		*
Raven	<i>Corvus corax</i>		*			*
Carrion Crow	<i>Corvus corone cornix</i>		*			*
White Stork	<i>Ciconia ciconia</i>	*		*		
Mistle Thrush	<i>Turdus viscivorus</i>	*			*	
Goldfinch	<i>Carduelis carduelis</i>		*			*
House Sparrow	<i>Parus domesticus</i>		*			*
Wood pigeon	<i>Columba palumbus</i>	*			*	
Corn Bunting	<i>Miliaria calandra</i>	*		*		
Tree Sparrow	<i>Passer montanus</i>		*			*
Crested Lark	<i>Gallerida cristata</i>		*			*

The colonies of *Corvus corax*, *Merops apiaster*, *Calidris minuta*, *Hirundo rustica* and *Oenanthe oenanthe* adopted to the site due to changed site conditions as a result of excavation work (Figure 14-24 to Figure 14-26).

*Upupa epops*, an endangered species, also inhabit in the proposed site (Figure 14-27). Only four individuals have been observed during the field work performed in the proposed site.