CHAPTER 7 YEREVAN PILOT PROJECT

7.1 Social and Economic Situation

7.1.1 Location and Area

Yerevan City is situated in northeastern of the RA postponed from northeast to the southeast, on the north-eastern part of Ararat valley, on concavity, on two riversides of Hrazdan, 900-1200 meters above sea level. This capital city adjoins Aragatsotn, Kotayk, Ararat, and Aramavia Marz (regional administration) with it's administration boundaries. Only 20km is in to a Turkish boundary in the southeast.

Figure 7.1.1 Location of Yerevan City

It is about at the same latitude as Washington, Madrid, Beijing.

Territory 227 square km	
Agricultural land	6413 ha
including arable rand	1506 ha

7.1.2. History and Urban Development

Yerevan City is the largest city not only among the present-day 48 cities of RA but also among the capitals of historical Armenia. Yerevan is one of the oldest cities in the world and has a history of 2784 years (of the same age as Eternal City of Rome, Kartagen, Nineveh and Damascus).

Name of Yerevan comes from Urartian period (It is B.C.9 to 6 century.)and derivers from Erebuni. It is known from Urartology that Urartian sound "B" in Armenian sounds like "V". Therefore name Erebuni has been changes into Eerevan then Erevan, Yerevan.

In the Soviet period modern Yerevan from the provincial city (number of population was less than 30,000 in 1920) turned into a big industrial (nearly half of industrial potential), cultural and scientific center as well as the most important transport junction (the railway connected Black Sea with Persian Gulf and the railroad (Yerevan - Hrazdan- Ijevan-Aghstava) connecting it with Baku- Tbilisi are intersected in Yerevan); Yerevan- Sevan basin-Stock railway is of local importance. Yerevan- Sevan basin –Stock railway is of local importance. RA general air gateway with its two international airports "Zvartnots" and

“Erebuni”: a number of highways run through.

7.1.3. Climate of Yerevan

The climate of the city is strongly continental, summer is long, hot and dry, and winter is comparatively inclement, mainly with unstable snow cover. Spring is short and weather is very changeable. Autumn is mild and pleasant, sunny and warm. Annual number of precipitations fluctuates within the limits of 300-350mm. The annual mean temperature is 10-11 degree.

Table 7.1 1 Climate of the Yerevan City (mean during 1994 -2003)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average highest temperature	1	4	11	19	24	29	33	32	28	21	12	4
Monthly average lowest temperature	-8	-6	0	6	10	14	17	17	12	7	1	-4
Average of precipitation per month	22	25	30	37	44	21	9	8	8	27	23	23

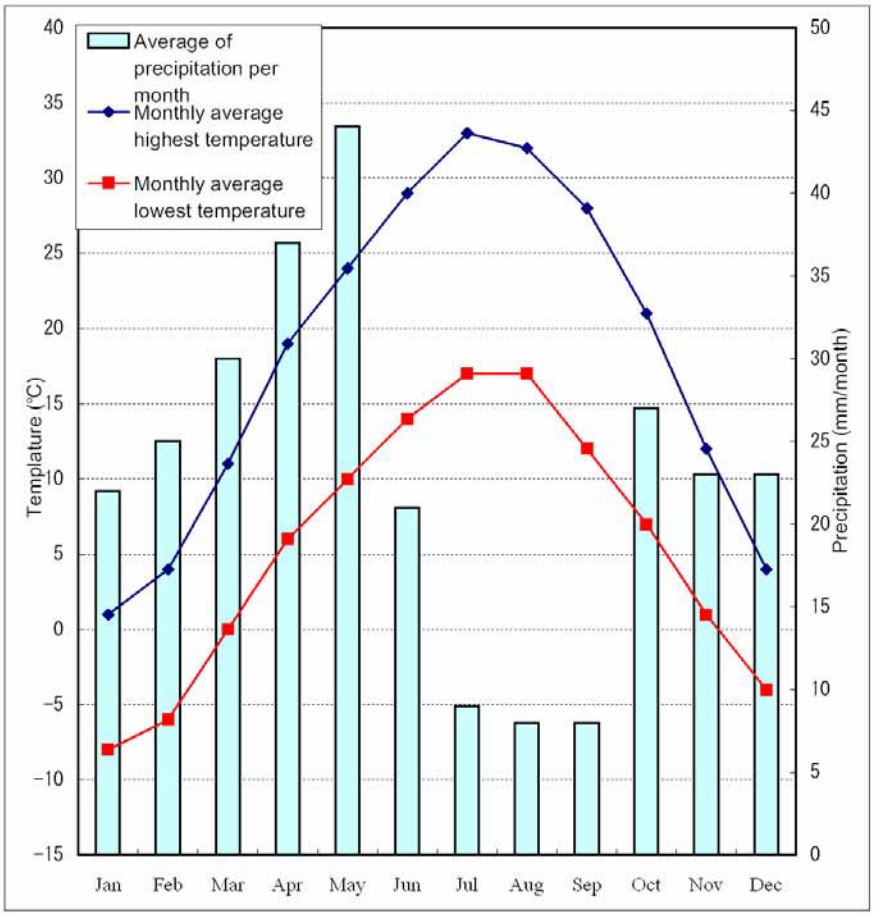


Figure 7.1.2 Climate of the Yerevan City (mean during 1994 -2003)

7.1.3. Population and Settling Characteristics

(1) Population

The population of Yerevan City in 2004 amounted 1.1 million, it is 34.4% of population of RA.

Table 7.1.2 the Number of Population of Yerevan City on January 1, 2004

Gender	Under age 0-16 years old	Working age 16-63 years old	Old 63 –and older	Total
Female	124,100	372,400	53,500	550,000
Male	121,300	333,700	97,600	552,000
Total	245,400	706,100	15,100	1,102,600

Statistical Yearbook of Armenia 2004 explain that population break down in the urban and rural population is considerate by their place of residence: urban settlements are considered those determined the status by law. All other settlements are considered rural.

There are 48 urban settlements (cities and towns). These settlements have more than 10,000 person scales in general. There are 871 rural settlements (villages). These settlements have less than 10,000 person scales in general.

Table 7.1.3 Population Number in Yerevan City and RA

	Unit	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total in the RA	1000 persons	3,766	3,781	3,791	3,798	3,803	3,215	3,213	3,210	3,212
Yerevan	1000 persons	1,249	1,250	1,250	1,249	1,248	1,103	1,103	1,102	1,102
population percentage Yerevan	%	33.1	33.0	33.0	32.8	32.8	34.3	34.3	34.3	34.3
Population percentage Urban	%	67.3	67.0	66.9	66.8	66.7	64.6	64.3	64.2	64.2
Population percentage Rural	%	32.7	33.0	33.1	33.2	33.3	35.4	35.7	35.8	35.8

Source: 1. Ministry of Nature Protection of the Republic of Armenia, 2002, national action programme to combat desertification in Armenia
2. Statistical Yearbook of Armenia 2004
After 2001, populations are calculated on the basis of RA 2001 population Census

The data of 2000 shows, the most populated cities/towns (having 100 thousand residents and above) are the following: Yerevan, Gyumri, Vanadzor inhabited 1,633 thousand people of 64% of the total population in the country (in 1999). Almost half (49%) of the urban population in the country is concentrated in the Yerevan City

As a result of rapid development in Armenia within the recent 80 years an essential discrepancy raises between the central and backcountry districts. 2/3rds of the republic's

population, most of the cities/ towns, more than half of the labor resources are concentrated on the 20% of the so-called Central agglomeration (Yerevan and its influence zone).

Table 7.1.4 Births, Deaths and Natural Growth of Population in Yerevan City and RA

		Birth		Deaths		Natural growth	
		2001	2003	2001	2003	2001	2003
Natural growth	1000persons	32.1	35.8	24.0	26.0	8.1	9.8
	per 1000 population	10.0	11.2	7.5	8.1	2.5	3.1
Yerevan	1000 persons	10.3	11.2	8.5	9.0	1.8	2.2
	per 1000 population	9.3	10.2	7.7	8.2	1.6	2.0
Urban	1000 persons	20.3	22.6	15.6	16.9	4.7	5.7
	per 1000 population	9.8	11.0	7.5	8.2	2.3	2.8
Rural	1000 persons	11.8	13.2	8.4	9.1	3.4	4.1
	per 1000 population	10.3	11.5	7.3	8.0	3.0	3.5

2. Statistical Yearbook of Armenia 2004
After 2001, populations are calculated on the basis of RA 2001 population Census

(2) Policy of Settling of RA and Yerevan City Situation

Demographic and socio-economic characteristics: Formation and development of the overall settling system on the territories of cities, as well as country are conditioned by:

- peculiarities and traditions of historical development;
- the level of economic development;
-economic and territorial development policy conducted in the country;
-prevailing production orientation of population residing in a certain settlement;
-military purposes.

Given the real conditions, purposeful and functional significance of the areas, as well as location of settlements and profile of the areas in the RA, the Yerevan City might have following functions.

The capital city of Yerevan. State governance of bodies of republic-wide significance, mostly important cultural and educational institutions are concentrated here. An estimated evaluation of the people engaged in the registered economy sector (under the conditions of concealed unemployment and self-employment) is above 60%.

The build-up part of the Yerevan City amounts to 15,885 ha, or 80% of the total and area. Adjacent cities are also almost exhausted or already exhausted land resources allocated to them and, consequently, possibilities for further development. The most important ones

among them with the above than 90% of built-up areas are Aratashat, 98.9, Echmiadzin, 91.2% (These values are in 2002.).

Yerevan City is in intensively appropriated zones of urban development and economic appropriation level.

Intensively appropriate zones (p44, Ministry of Environmental Protection of the Republic of Armenia, 2002, national action programme to combat desertification in Armenia)
Analysis of the characteristics typical to the status of settlements and other functional areas in the RA on the basis of urban development and economic appropriation level presumes the following division of the area of the RA the following zones:
intensively appropriated
-slightly appropriated
-recreation and environmental
–unfavorable for settling

Intensively appropriated zones include the city of Yerevan, flat parts of the Kotayk, Aragatsotn, Aramavia, Ararat Marts--, in the Syunik Marz – valley of the Vararak river, narrow valleys of the Vorotan, Vokhichi, Meghri rivers. These zones amount to 24.3 per cent of the RA territory, where 88.0% of the population is concentrated (99% of the urban

7.1.4. Administration Structure of the Yerevan City

Figure 7.1.3 shows administration structure of the Yerevan City. The city development planning of Yereban City is conducted by “Yerevan Project” closed joint stock Company, instructing directly by mayor as “Technology management center”.

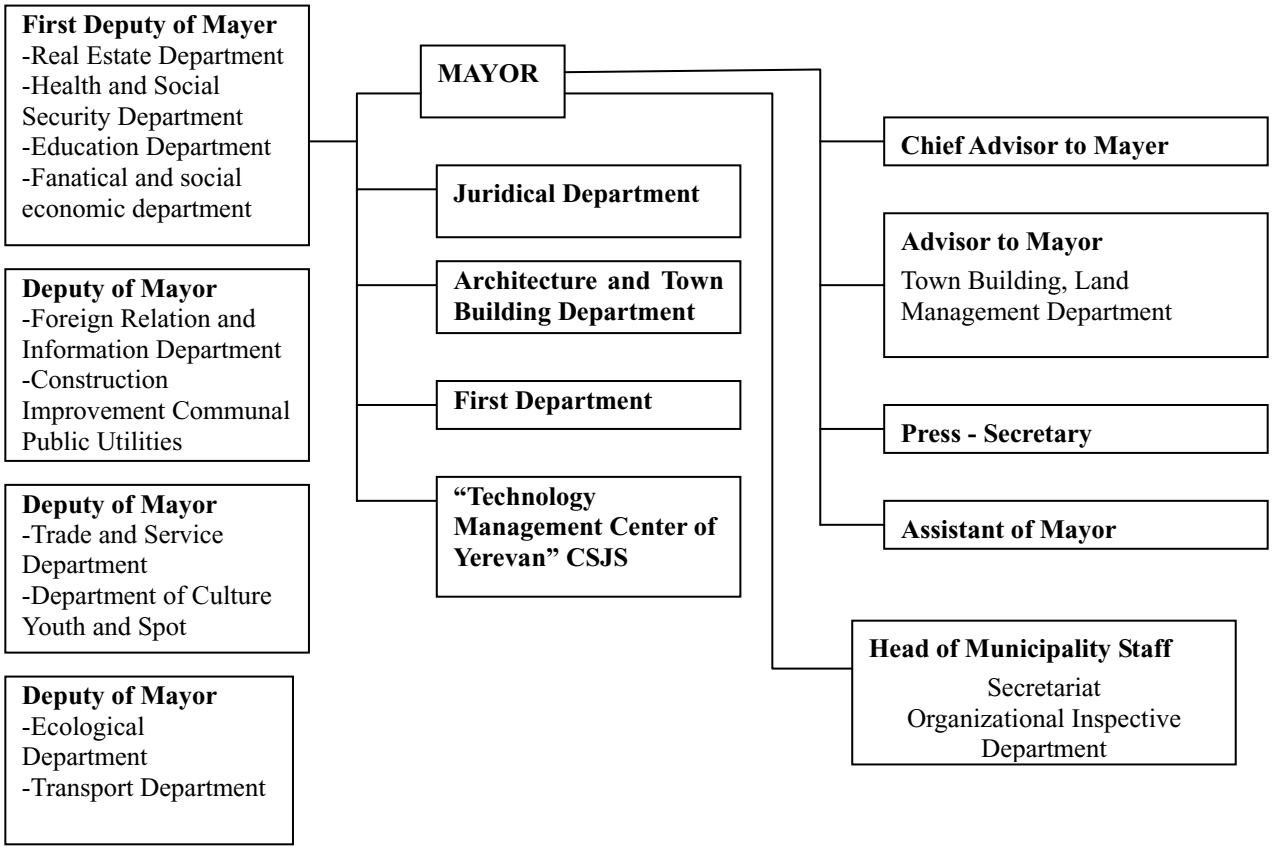


Figure 7.1.3 Administrant Structure in the Yerevan City

7.1.4 Districts in the Yerevan City

Yerevan City is subdivided into 12 district communities shown in Figure 7.1.4. Heads and the assembly members of these community districts are chosen by the election.（Mayor of Yerevan is nominated by the president.）

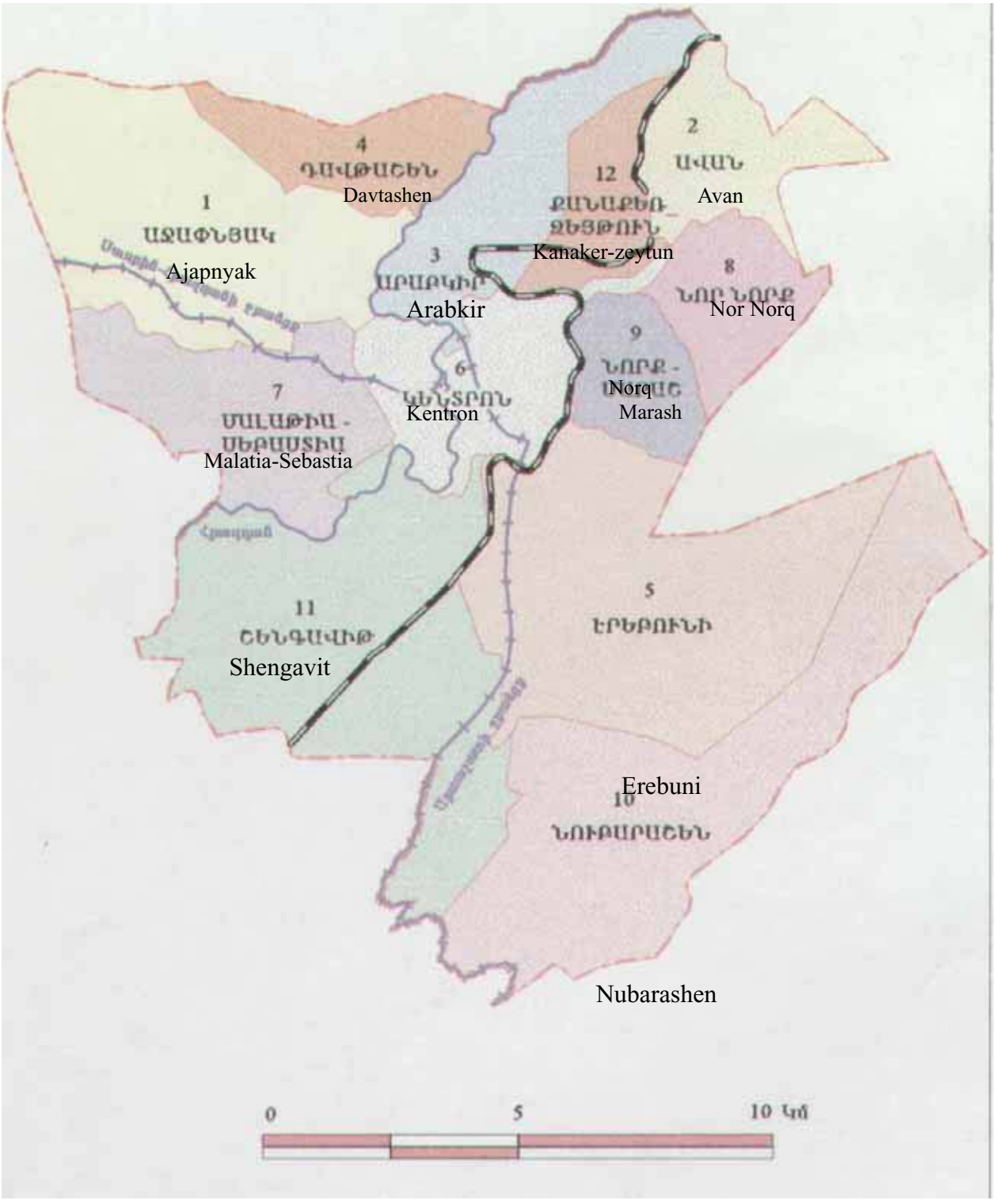


Figure 7.1.4 District Communities in the Yerevan City

Table 7.1.5 Number of population of District Communities

District community name	Number of Population, As of January 1, thousand persons	
	2002	2003
C. Yerevan, total	1,246	1,102
1. Ajapnyak	126	107
2. Avan	50	50
3. Arabakir	151	132
4. Davatshen	51	40
5. Erebuni	126	119
6. Kentron	179	130
7. Malatia - Sebastia	159	142
8. Nor -Nork	132	142
9. Nork -Marash	15	12
10. Nubarashen	9	9
11. Shengavit	146	141
12. Karaker-Zeytun	103	78

Statistical Yearbook of Armenia 2004
After 2001, populations are calculated on the basis of RA 2001 population Census

Table 7.1.6 Main Indicators of Natural Movement of Yerevan City by District Communities in 2003

District community name	Births	Deaths	Deaths under 1 year	Natural growth (+,-)	Marriages	Divorces
C. Yerevan, total	10,504	8,863	158	+1,642	4,895	911
1. Ajapnyak	940	815	11	+95	411	65
2. Avan	412	323	6	+89	228	37
3. Arabakir	995	1,165	11	-170	565	123
4. Davatshen	232	208	1	+24	135	14
5. Erebuni	1,400	1,161	15	+239	544	125
6. Kentron	1,156	1,190	52	-34	618	126
7. Malatia - Sebastia	1,517	1,170	18	+400	671	109
8. Nor -Nork	1,485	966	10	+519	698	139
9. Nork -Marash	68	140	1	-72	30	2
10. Nubarashen	115	54	-	61	46	3
11. Shengavit	1,531	1,040	21	+491	672	129
12. Karaker-Zeytun	630	631	12	-1	277	39

Statistical Yearbook of Armenia 2004
After 2001, populations are calculated on the basis of RA 2001 population Census

7.1.5 Economical Situation

In the Soviet period modern Yerevan from the provincial city (number of population was less than 30,000 in 1920) turned into a big industrial (nearly half of industrial potential), cultural and scientific center. As well as it was the most important transport junction with RA general air gateway with its two international airports “Zvartonots” and “Erebuni”; and a number of highways run through.

A number of 77 organizations implementing scientific and technical works (the 80.2% of scientific organizations functioning in the republic) functioned in the capital in 2002, of which 28 organizations (36.4%) functioned in the structure of RA National Academy of Science.

Table 7.1.7 Production of Industrial Output by District Communities of Yerevan City for 2002

District community name	Volume of output (work, services). at current prices, million AMD	Realization of finished output, at current prices million AMD	Physical volume index of output (work, services) of 2002 compared to 2001. at comparable prices, in %
C. Yerevan, total	162,374.3	164,550.6	108.2
1. Ajapnyak	3,491.7	3,345.9	99.6
2. Avan	3,960.3	3,672.5	135.9
3. Arabakir	14,663.0	13,767.0	139.3
4. Davatshen	2,209.2	2,195.6	87.6
5. Erebuni	14,723.8	15,331.5	123.6
6. Kentron	58,032.7	59,622.7	94.5
7. Malatia - Sebastia	18,640.5	20,311.9	134.0
8. Nor -Nork	6,710.0	6,659.4	109.9
9. Nork -Marash	327.2	327.2	105.0
10. Nubarashen	267.7	270.4	39.8
11. Shengavit	29,095.6	29,236.6	106.0
12. Karaker-Zeytun	10,252.3	9,809.9	115.9

Statistical Yearbook of Armenia 2004
After 2001, populations are calculated on the basis of RA 2001 population Census

Industrial production of Yerevan City in 2002 belong to Kentron community is 35.7%, to Shengavit is 17.9%, to Malatia-Sebastia is 11.5%, to Erebuni is 9.1%, to Arabakir is 9.0%, to Karaker-Zeytun is 6.3%, to Nor Nork is 4.1%, to Avan is 2.4%, to Ajapnyak is 2.2%, to Davatshen is 1.4%, and to Nork-Marash and Nubarashen are 0.4%.

Volume of goods turnover of Yerevan City in 2002 belong to Kentron and Nork-Marash

communities are 25.7%, to Malatia-Sebastia is 22.8%, to Erebuni and Nubarashen are 17.7%, to Arabakir is 16.7%, to Nor Nork is 5.7%, to Ajapnyak is 4.6%, to Shengavit is 3.8%, to Avan is 1.6%, to Karaker-Zeytun is 1.2%, and to Davatshen is 0.4%

7.1.6 Recognition of the Yereban City to landslide Issue

Figure 7.1.5 Satellite image in the southeast of Yerevan City

(Source; Calendar of 2005 issued from real estate committee, geodesy mapping center).

Following in formations are provided by Yerevan Project CJSC at first advisory committee)

There are active twelve (12) landslides in the Erebuni district communities. These causes are recognized artificial. This region has been used as an orchard for 25 years. Having watered people who broke irrigation restriction attention became victims also, and a lot of houses were toppled. The conclusion of this cause has not gone out. The watering is being done now, but the amount is relatively small. The restriction for the water supply is not made a law.

This landslide problem area can not treat the architectural object region now. Vegetation with an unnecessary irrigation shall be put as a greening region. This area is important in fauna and flora and nature conservation is also necessary. Provisionally calculation of these measures in Soviet Era showed one billion US dollars. This region entered the ledger of the city in 1966, and recognized as necessary land. The government has decided to work on these measures for this landslide problem.

The level of underground water in the Erebuni District goes up and ground is being made soft.

7.1.7 The Administration Concerning Cemetery

(1) Interviewee

Following information are provided by Chief engineer of bureau for citizens special services, Mr. Arutyunyan Razmik.

(2) Formal Name

The Nubarashen cemetery is formally called Arinberd cemetery.

(3) Cemetery Service and Compensation

The graveyard is supposed to be offered free of charge by the government decision No.444on June 30, 1975. Application cannot be put out during alive. The management fee of the cemetery is also unnecessary.

It becomes for a fee in the bill while discussing the new law in the graveyard when three times or more 7.5m2 that is an average graveyard area are needed.

The relative has the property right of the tombstone. There are complaint for breaking of land and the tombstones. A new graveyard is being offered. There is an example of provisionally calculating the compensation. There is no price list for compensation. There is no case of compensation.

(4) Cemetery Maintenance Budget

There is no regular budget donation of the maintenance of the Arinberd cemetery. There is a budget of 90 million AMD in 2006. It is the one including the design and the cost of construction. As for this budget, it is scheduled to be used to asphalt pavement of roads in the cemetery and water supply. The bureau asked the mayor for the budget provision every year and to become it so from next year.

Table 7.1.8 Transition of Budget to Arinberd Cemetery

Year	Arinberd Cemetery	All cemetery (25 cemetery) in Yereban City
1998	13 million AMD	
2004	24 million AMD	
2005	13 million AMD	450 million AMD
2006	90 million AMD	

The management expense of the bureau is financed by the municipal budget. Chief engineer's salary is 100 dollar/month. There is no overtime pay.

(4) Hanjanske Channel

Channel where the southern part of the Arinberd Cemetery is crossed are called Hanjanske Channel. It was made in 1937. It is after as for the first clerk's in Armenian communist party name at that time (1935-1939).

This waterway had aimed at watering to the orchard. It doesn't complete and it has not been passed by water.

The railway (railway where the Azerbaijan territory was not passed) was planned by the channel.

7.1.8. The By-pass Road (M-15)

(1) Interviewee

Following information are provided by MoTA through MoUD.

(2) Purpose and damage of road

The construction of the by-pass road got out from the Arinberd cemetery to Jelbez in Kotayk Marz was 1984 from 1982. The main purpose was a reduction of a traffic jam of Yereban City’s center south-north traffic. It was used at the period from the end of 1984 to first of 90’s. It has decreased by deformation of the road though there was 5,000/the day traffic when it is normal.

7.1.9 Summer House along M-5 by-pass Road

(1) Interviewee

Inhabitants, the chairman in about 100 houses.

(2)Situation of residence district

A tire plant company provided houses to employee as the second house 20 years ago. Interviewee is chair man of the company provides houses. These land was free. The surrounding is land that other enterprises provided. It is necessary to pay the Real Estate Committee for registration (100 dollars).

This region is called Erebuni the second district. Water service fee 500 has been paid to the Garden ministry for one month.

Watering fee to the fruit tree is AMD 3100 per season. The pipeline has come and there is watering two times once a week.

7.2 Activities of Pilot Projects

Table 7.2.1 shows the detail of execution.

Table 7.2.1 Execution History of Nubarashen Pilot Project

Date	Event name	Theme
June 7,2005	Signature of agreement	Purpose, implementation bodies, advisory committee, activities to be carried out
June 23 ,2005	First Advisory committee	Advice for the pilot project implementation
August 17,2005	Second Advisory committee	Advice for the pilot project implementation
December 25,2005	Third Advisory committee	Report on engineering study result

Table 7.2.2 Summary of Advisory Committee

First Advisory committee June 23,2005	Confirmation of Purpose, and Indicators. Confirmation of Inputs of JICA study team and MOUD
Second Advisory Committee August 17th, 2005	Progress report of geological Investigations Site study with advisory members It is confirmed that there will is no conflict in the scheduled drilling site.
Third Advisory Committee	report of engineering study results confirmation to use the Study result to Yerevan city development plan

7.3 Geotechnical Survey and Risk Assessment

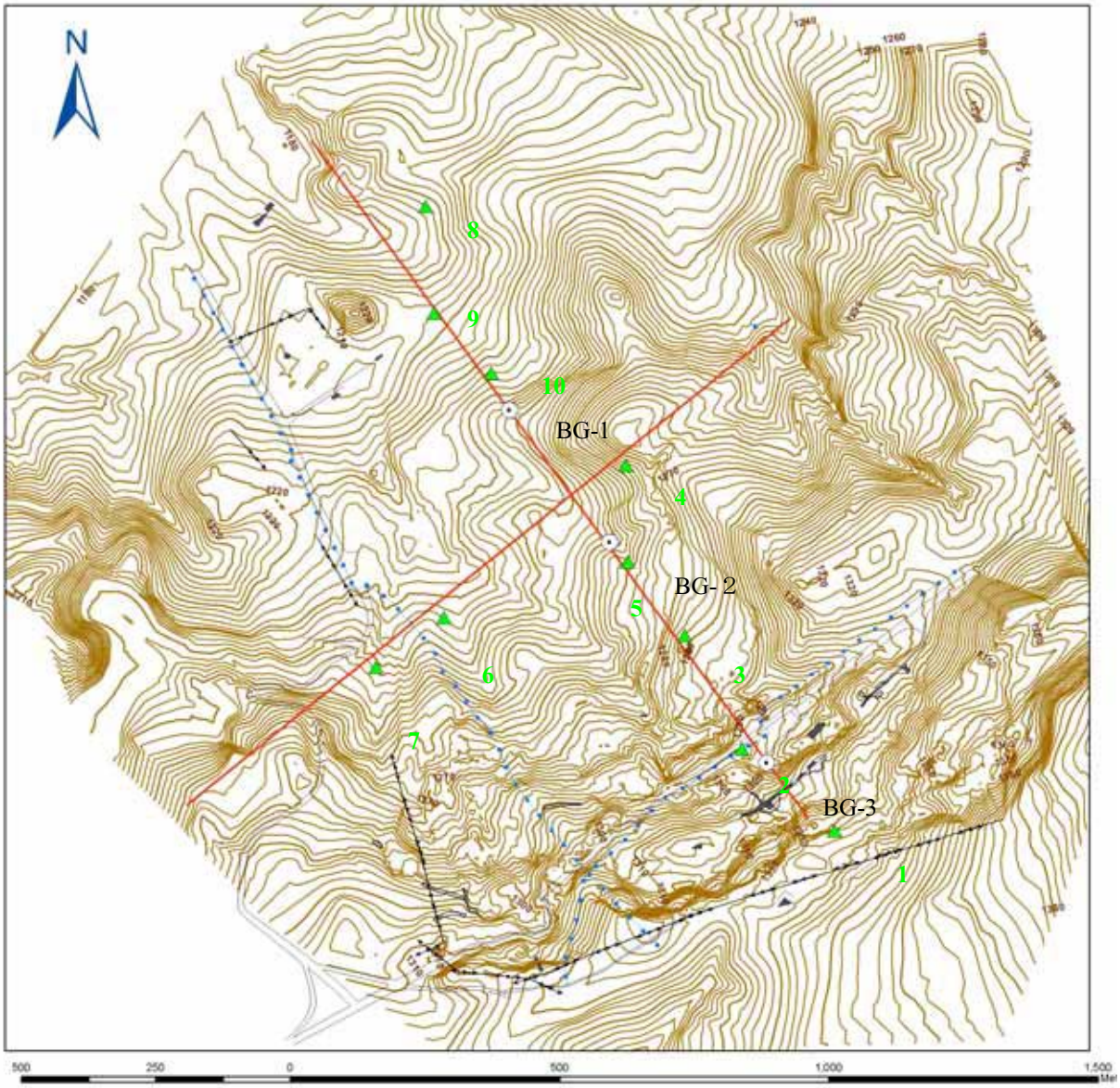
7.3.1 Progress of the Survey

The following geotechnical surveys were conducted in the pilot project.

Table 7.3.1 List of the Geotechnical Survey in Nubarashen Cemetery

Item			Quantity	Description
Survey	Drilling (Vertical)	All core	3 holes 89 m	GB-1 20m, GB-2 36m, GB-3 33m
		Non core	2 holes 35 m	GB-1 20 m, GB-2 15 m
	Standard Penetration Test (SPT)		34 Tests	
	Geo-electrical Prospecting		2 lines	Profile 1 1560m, Profile 2 1440m
	Simple Dynamic Cone Penetration Test		10 Points	
	Groundwater Prospecting		3 holes	
	Soil Laboratory Test		11 samples	
Monitoring	Pipe Strain Gauge		3 hole 76 m	GB-1 20m GB-2 30m GB-3 26 m
	Groundwater Level Observation		3 points	
	Nuki-Ita (Movable Beam)		9 points	

The location of the surveys are shown in Figure 7.3.1



Legend

- Boreholes
- Buildings
- Penetration points
- Geophisical profiles
- Power transmission lines
- Roads
- Sewer channel
- Water pipeline
- Isolines

Figure 7.3.1 Location of Surveys

7.3.2 Technical Geological Features from Yereban City the Southeast to Kotayk Mart South

(1) General Condition

Region of along by-pass road M-15 of the Yerevan City southeast is a concentrate zone of the landslides. Figure 7.3.2 and Figure 7.3.3 shows geotechnical engineering situation of these arias. Table 7.3.2 shows Stratigraphy and facies of these areas. Figure 7.3.4 and 7.3.5 shows geotechnical engineering situation around Arinberd cemetery area.

The landslide in this region has been chiefly generated by the residual soil of the sedimentary rock or tuff origin. The soil that makes from the sedimentary rock an origin is in the situation in which the landslide or more is caused easily among the original rocks of this both. “Terrace deposit”, “Pyroclastics” and “Mudflow” are distributed the head of the landslide or near. These materials are pervious or partially pervious. And those materials should supply underground water to the landslides.

Table 7.3.2 Stratigraphy and Facies

Age	Symbol /color	Name	Facies
Holocene	g/c	Alluvial deposit	Gravels, cobbles, sands, fines,
	c3	Embankment soil	Fine-grained soil
	k/c	Colluvial deposit	Cobbles, garbles, fines
	c2	Residual soil , partially colluvial deposit (hard weathered tuff, tuff breccia)	Fine-grained soil with some sands, gravels
	c1	Residual soil , partially colluvial deposit (hard weathered sedimentary rock)	Fine-grained soil, reddish brown in general.
	k/b	Terrace deposit	Cobbles, gravels, sands with some fines
Pleistocene	BA	Basalt	Hard rock
	TU	Tuff	Moderate hard rock
	TB	Tuff breccia	Moderate hard rock
	PY	Pyroclastics	pyroclastics, loose
Tertiary	SE	Sedimentary rock	Siltstone, sandstone, conglomerate

(2) The clay soil of hard weathered sedimentary rock

The clay of hard weathered sedimentary rock is widely distributed around subsurface of the cemetery landslide. This soil is erodable, and some big piping halls are admitted.

Outcrops of sedimentary rock (tuffaceous sandstone) The east of the cemetery

Piping hole, 1 meter diameter which was admitted in the clay soil of hard weathered sedimentary rock

(3) The clay soil of hard weathered tuff

The feature is to present the reddish brown. It is stronger than the clay soil of hard weathered sedimentary rock in erosion. The distribution of the landslide is also comparatively little than the soil of hard weathered sedimentary rock area.

The clay soil of hard weathered tuff distributed east of the Arinberd cemetery

(4) Terrace deposit / mud flow deposit / pyroclastics

They are pervious or partially pervious material. This material should supply sources of underground water to the cemetery landslide. The Scarps of the landslide is admitted in the vicinity of the boundary of these gravely soil and the clay soil of hard weathered sedimentary rock.

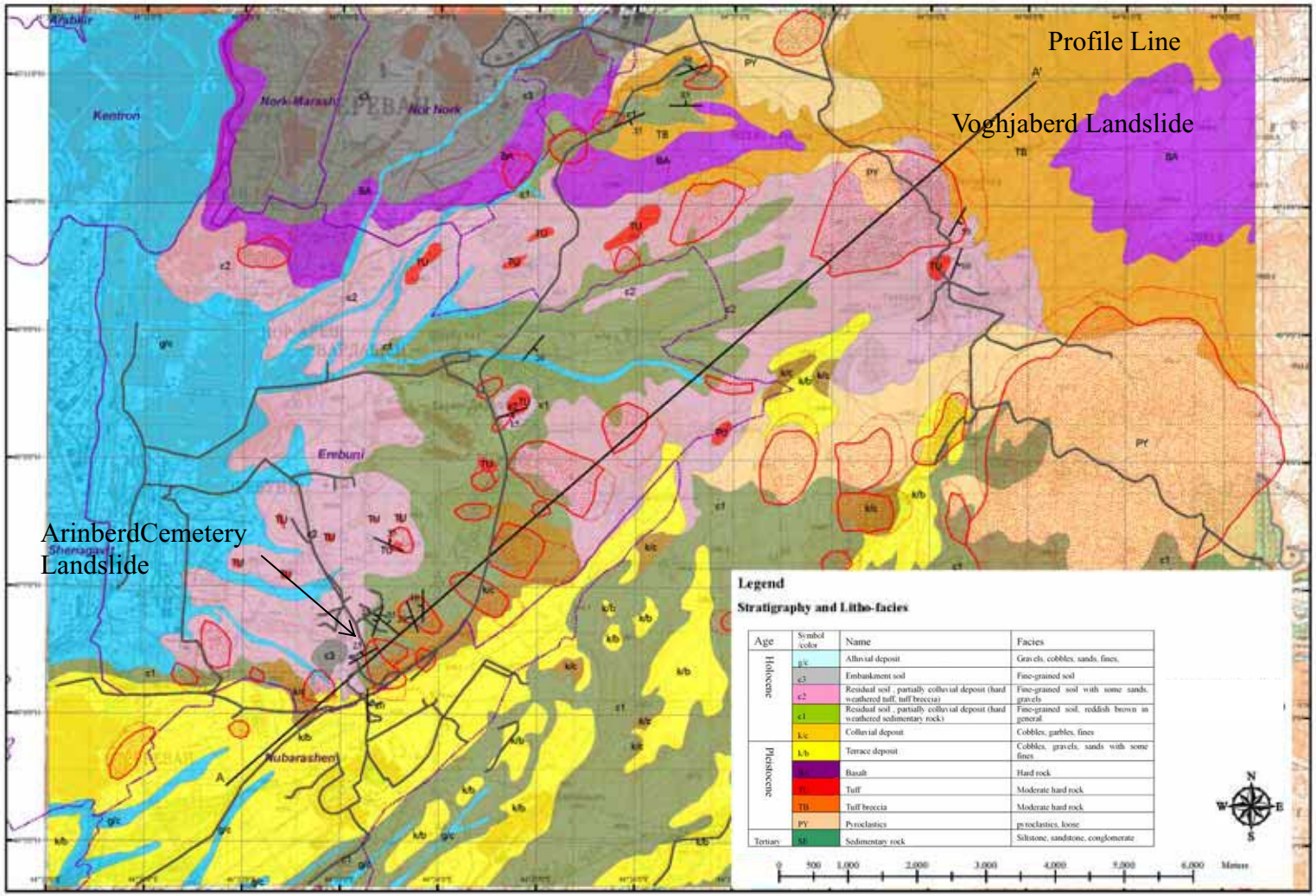
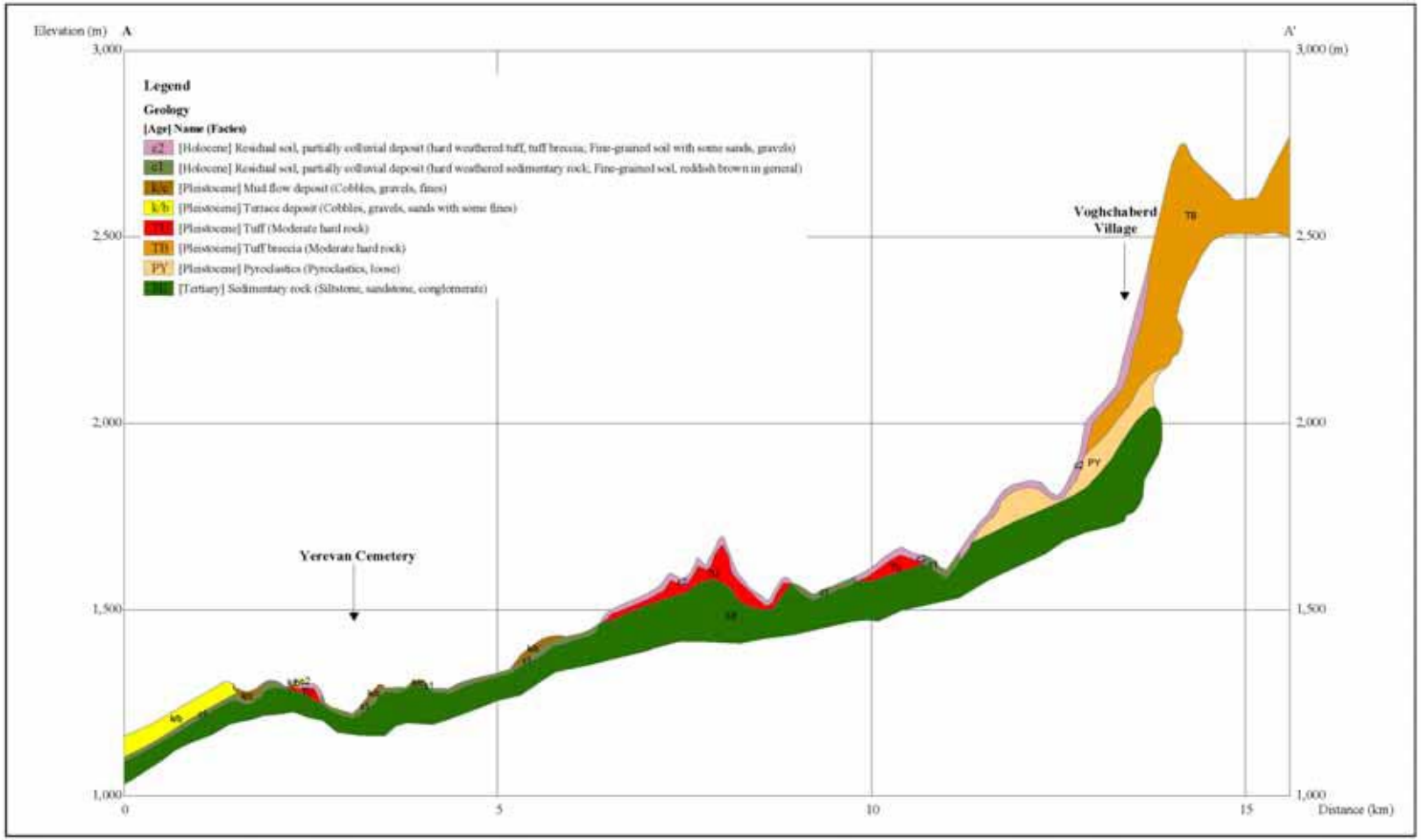


Figure 7.3.2 Engineering Geological Map (Yerevan - Kotayk)



Engineering Geological Profile (Yerevan - Voghchaberd Village)
by JICA Study Team

Figure 7.3.3 Engineering Geological Profile

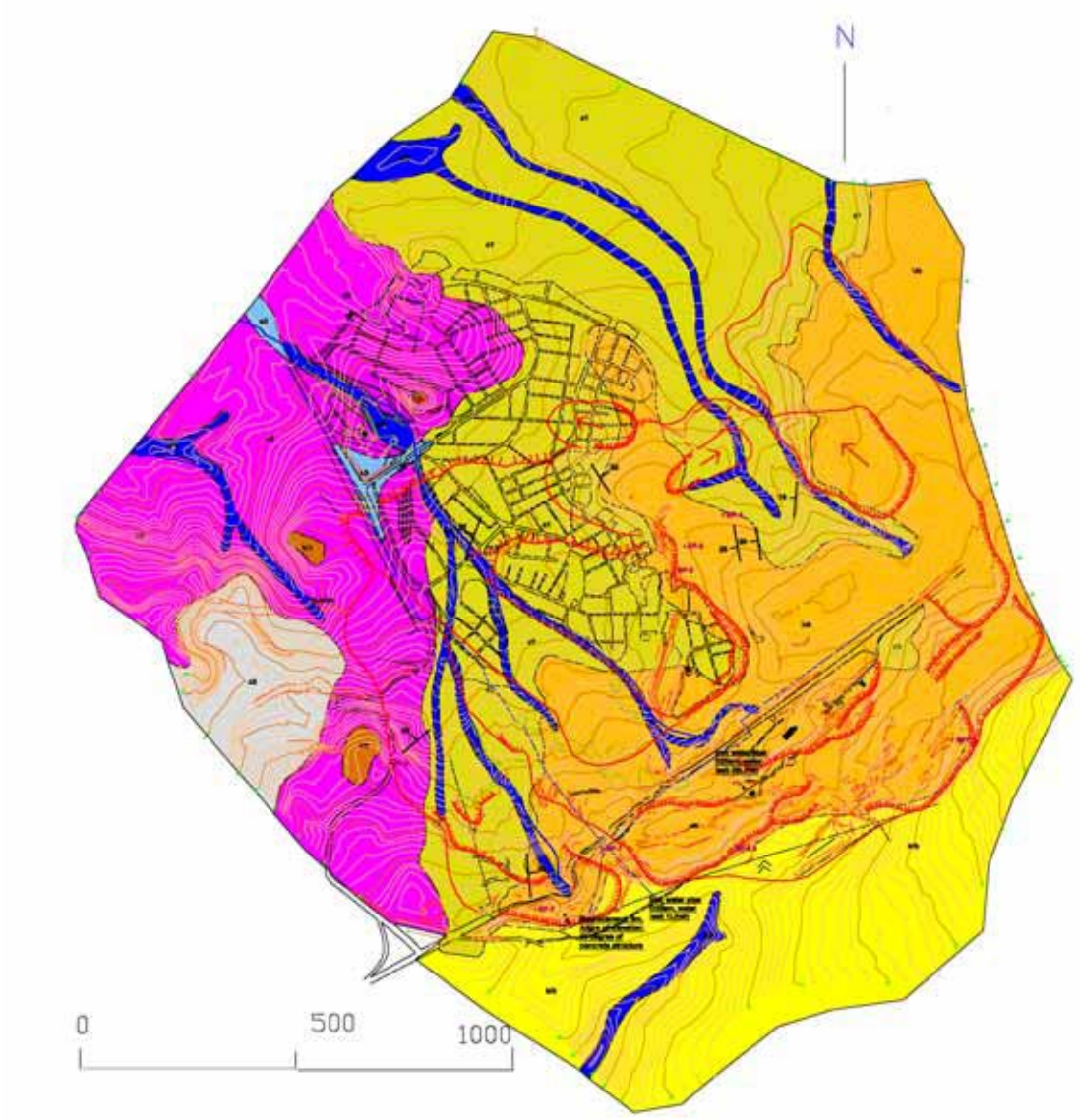


Figure 7.3.4 Configurations of the Cemetery Landslides

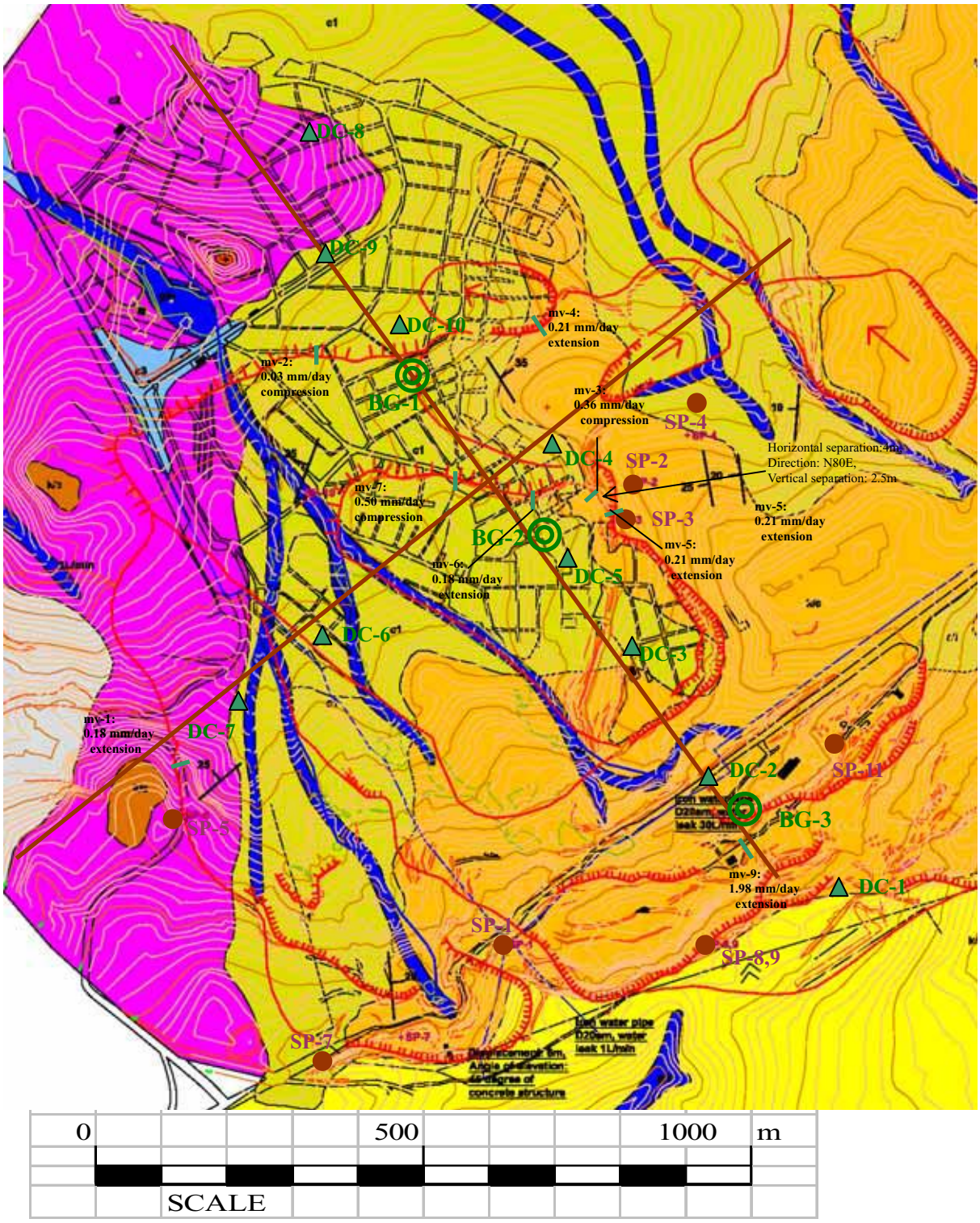


Figure 7.3.5 Engineering Geological Map of the Cemetery Landslide

LEGEND

Dip and strike	N50E 30	Scarp	
Compression Ridge		Water Spring	20L/min
Surface Water	20L/min	Movable beam Displacement speed (Aug-Oct, 2005)	mv-1
Drilling	BG-1	Sampling	SP-1
Dynamic Cone Penetration Test	DC-1		

Age	Symbol /color	Name	Facies
Holocene	g/c	Alluvial deposit	Gravels, cobbles, sands, fines,
	c3	Embankment soil	Fine-grained soil
	c2	Residual soil , partially colluvial deposit (hard weathered tuff, tuff breccia)	Fine-grained soil with some sands, gravels
	c1	Residual soil , partially colluvial deposit (hard weathered sedimentary rock)	Fine-grained soil, reddish brown in general.
	k/c	Colluvial deposit	Cobbles, garbles, fines
Pleistocene	k/b	Terrace deposit	Cobbles, gravels, sands with some fines
	BA	Basalt	Hard rock
	TU	Tuff	Moderate hard rock
	TB	Tuff breccia	Moderate hard rock
	PY	Pyroclastics	pyroclastics, loose
Tertiary	SE	Sedimentary rock	Siltstone, sandstone, conglomerate

Figure 7.3.6 Legend of Engineering Geological Map of Cemetery Landslide

Figure 7.3.7
Water leak from pipe near by drilling BG-3 point (30 L/min)

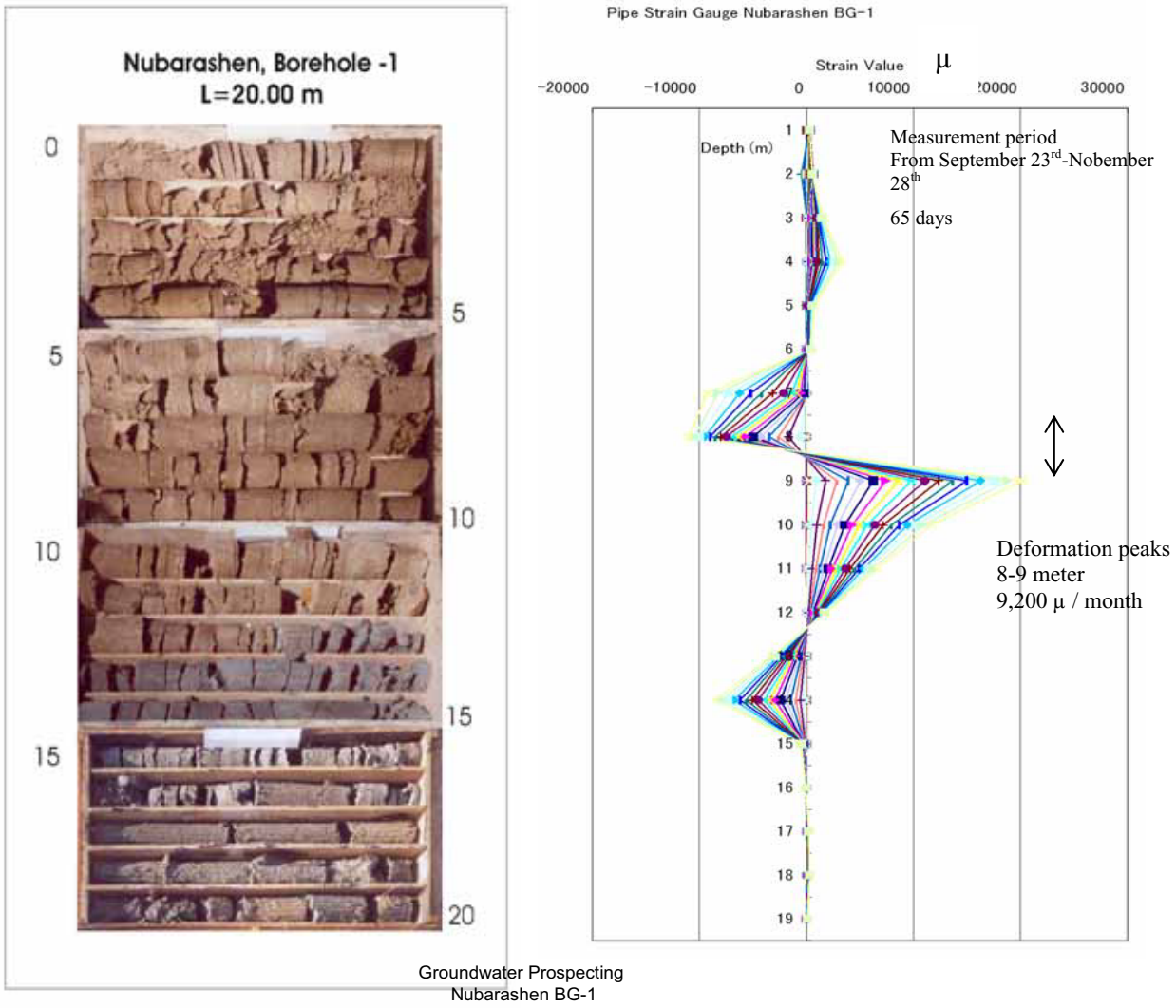


Figure 7.3.8 Photo of Drilling Core of "BG-1" and Results of in Site Tests

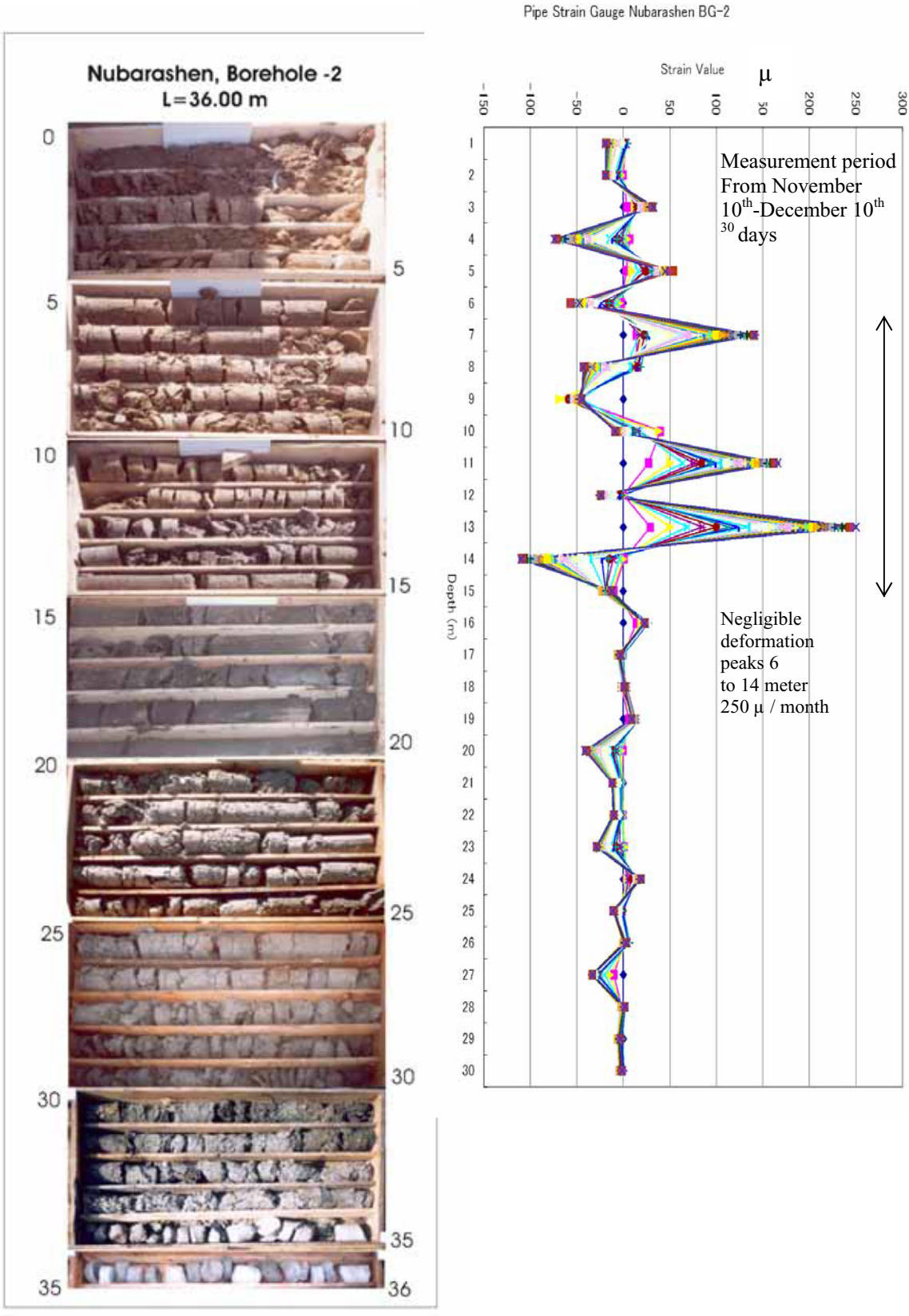


Figure 7.3.9 Photo of Drilling Core of "BG-2" and Pipe Strain Gauge Monitoring

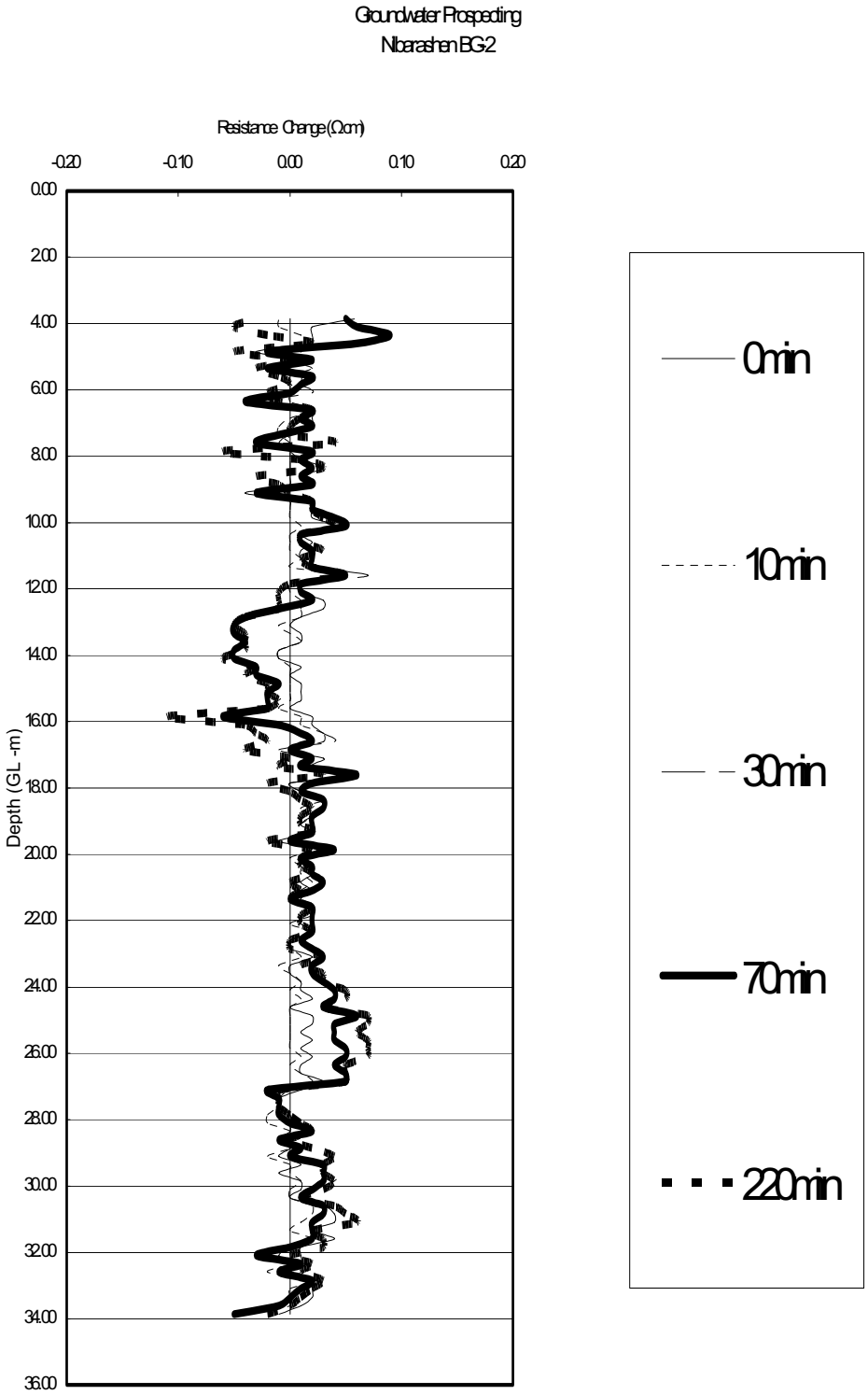


Figure 7.3.10 Ground Water Prospecting Results of "BG-2"

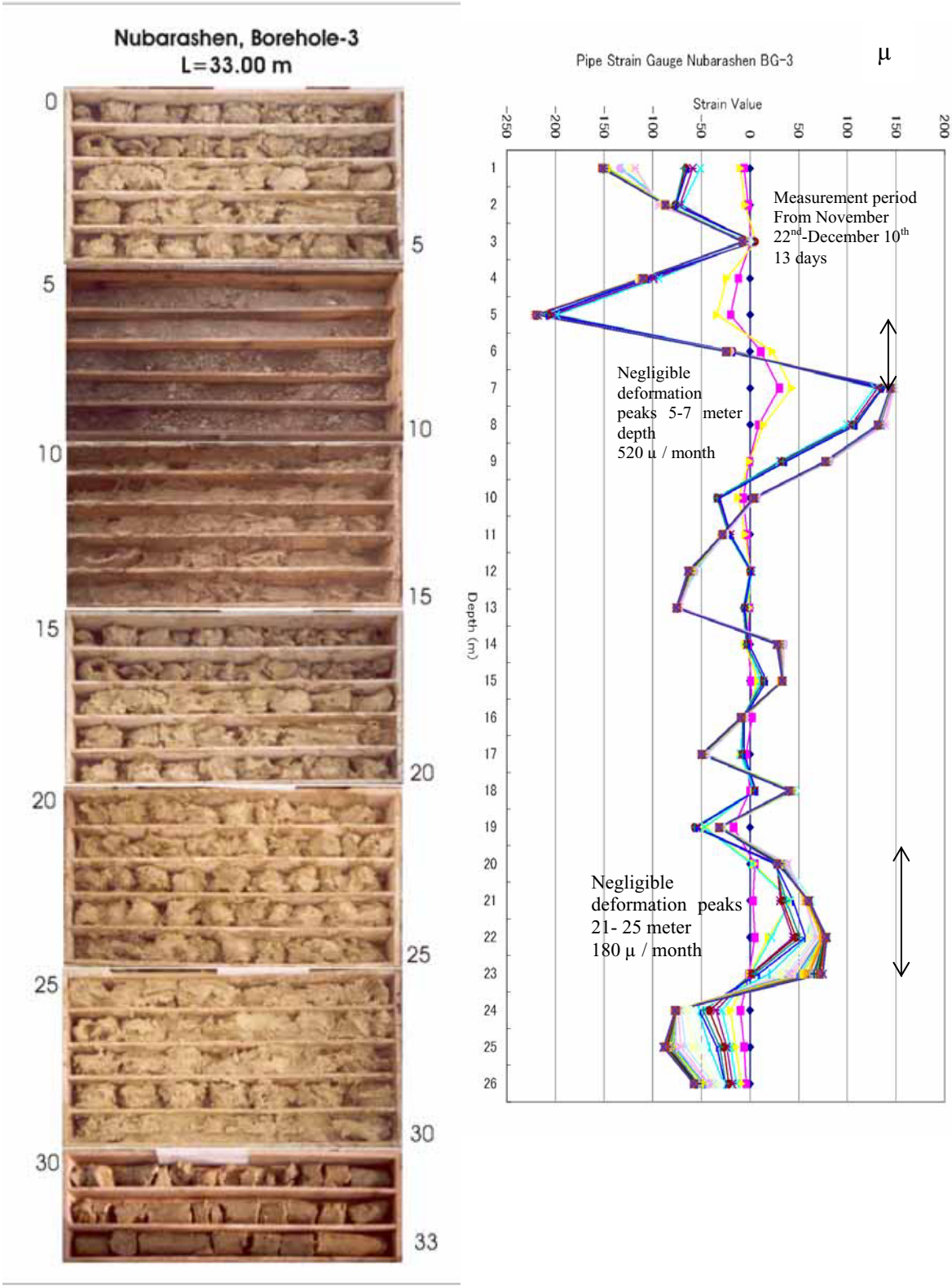


Figure 7.3.11 Groundwater Prospecting Results of Drilling "BG-3"

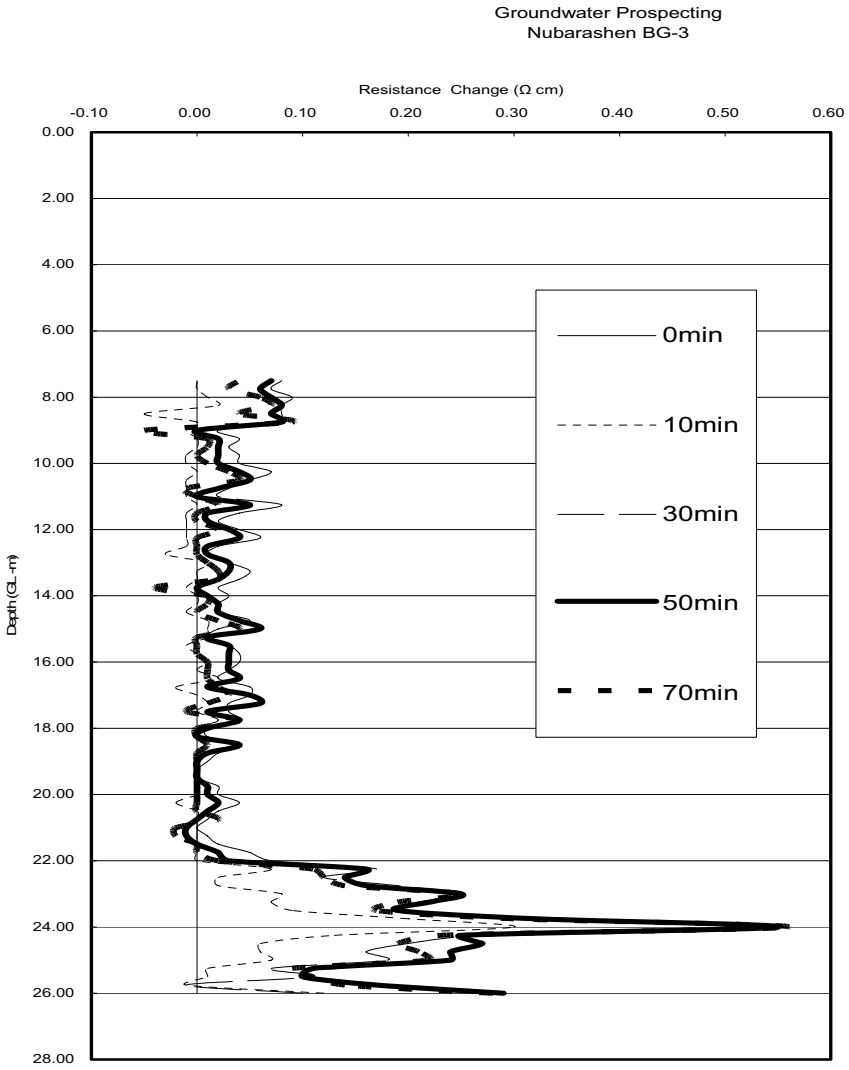


Figure 7.3.12 Results of Groundwater Prospecting of Drilling "BG-3"

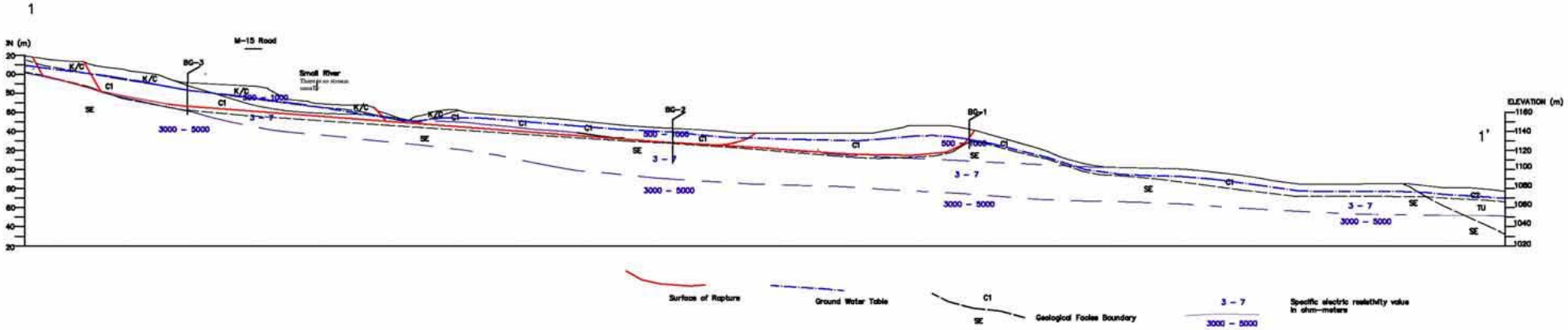


Figure 7.3.12 Engineering Profile 1-1' Line