B.6.10.3 Groundwater Resources

(1) Quaternary Aquifer

The surface area and the average thickness of the Quaternary sediments are estimated to be 12 m and 99 km^2, and the porosity of the aquifer is assumed to be 0.22. The static amount of groundwater resources in the Quaternary sediments of the Veles valley is calculated to be 261 million m^3. The average hydraulic conductivity is assumed to be $4.76x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.035 along the flowpath of 1.5 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Veles valley is calculated to be 0.3 m^3/sec.

(2) Karst Aquifer

Regarding determination of the amount of karst groundwater resources in the karst aquifer of the Babuna valley, the infiltration area is estimated to be 80 km^2 and the average coefficient of infiltration and hydraulic head gradient are 0.43 m/sec and 0.6, respectively. Therefore, the amount of karst groundwater resources in the Babuna valley is calculated to be 0.65 m^3/sec.

In the case of karst groundwater resources in the karst aquifer of the Topolka valley, the infiltration area is estimated to be 45 km^2 and the average coefficient of infiltration and hydraulic head gradient are 0.42 m/sec and 0.6, respectively. Therefore, the amount of karst groundwater resources in the Topolka valley is calculated to be 0.42 m^3/sec.

B.6.11 Gevgelija-Valandovo Valley

B.6.11.1 Geology

The Precambrian rocks in the Vardar zone are presented by porphyroblastic gneiss and fine-grained biotitic gneiss.

The old Paleozoic rocks lie across the Precambrian rocks. Within these rocks, seven layers are separated: amphibole-pyroxene schist, sericite-chlorite schist, sandstone, argillo-schist, sandstone, green schist and phyllite. The Paleozoic metamorphosed rocks are gabbro-diabase, green schists, serpentinites, Belasica granite, Furka granite, aplite and pegmatite.

The Mesozoic rocks are presented by quartz monzonite, diabase and spilite of Triassic and Jurassic ages, and orthophyre, karatophyre and quartz karatophyre of Jurassic age.

The Upper Eocene marine sediments are partly presented in comparison with the Paleozoic schist. Two horizons of the Upper Eocene are distinguished: conglomerates and flysch sediments are separated in the lower horizon and light yellow limestone is laid in the upper horizon.

The Quaternary sediments are presented by proluvial and dilluvial deposits and alluvial sediments that are mutually rather mixed, fluvio-glacial deposits, lacustrine sediments, terrace sediments and spring sediments.

Concerning the tectonics in the Gevgelija-Valandovo Valley, three structural stages may be distinguished in the Vardar zone and the Serb-Macedonian massive: Precambrian, Hercynian and Alpine stages.

The rocks of the Precambrian structural stage represent compressive forms. In the Vardar zone, Bogdanska anticline is distinguished and the Belasica anticline is distinguished within the Serb - Macedonian massif.

The rocks of the Hercynian structural stage form the east wing of the Belasica anticline.

The rocks of the alpine structural stage are distinguished into three substages. Within these substages, five large ruptures are distinguished and manifested as overthrusts.

B.6.11.2 Hydrogeology

Within this basin, the following types of aquifers are represented: 1) inter-granular and unconsolidated aquifer, 2) fissured aquifer and 3) karst aquifers

(1) Inter-granular and unconsolidated aquifer

The aquifers are developed in the rocks with inter-granular porosity, i.e. the alluvial sediments, dilluvial and proluvial deposits as well as the terrace, lacustrine and mud sediments. These sediments are composed of a mixture of sandy clay materials as well as sandy gravel debris with a total thickness of 30 m. These sediments present a significant groundwater aquifers. The aquifers are characterized by inter-granular porosity with a hydraulic conductivity of $1x10^{-2}$ to $1x10^{-1}$ cm/sec. The groundwater recharge is being done by precipitation and by flowing through upper aquifers and drainage by river flows and springs. The levels of this aquifer are various, depending on the infiltration degree and the surface water level.

(2) Fissured aquifer

This type of aquifer is represented along the peripheral parts of the Gevgelija-Valandovo valley, but has no great economic role. The aquifer is represented in the rocks with fracture porosity, which percolate through a system of fractures and fissures. The waterbearing of this aquifer depends on the mutual connection of the fractures and the fissures. This aquifer is formed within the schist, granite, argillo-schist, phyllite, serpentinite etc. This aquifer is recharged by precipitation and the drainage of springs with a yield of 0.1 to 1.0 l/sec. The larger part of the fissured aquifer has no great practical importance.

(3) Karst aquifer

The karst aquifer is represented in the marble and the carbonate schist, which are distributed in the Kozuf Mountains from Vladaja, Deribash to the Belasica massif, i.e. in the rocks with cavernous porosity. The circulation and the accumulating of groundwater are being done through systems of fractures and caverns, mutually well connected and 100 m in depth. The aquifer is recharged by precipitation and the drainage by many springs with a yield of over 1 l/sec. This aquifer has practical important role in order to solve the water supply problem of the surroundings and other water economy problems.

(4) Waterless parts of the terrain

This category encompasses the areas composed of Paleozoic gneiss, schists, gabbro-diabase, serpentinite, granite, spilite, orthophyre, keratophyre, as well as Quaternary conglomerate, flysch and calc-sinter. Because of the tectonic compactness they are characterized by small water bearing body and the yield of the springs is up to 0.01 l/sec. From a practical point of view, these parts of the terrain are not significant for water supplying.

B.6.11.3 Groundwater Resources

(1) Quaternary Aquifer

In the Gevgelija-Valandovo valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 15 m and 114 km^2, and the porosity of the aquifer is assumed to be 0.2. The static amount of groundwater resources in the Quaternary sediments of the Gevgelija-Valandovo valley is calculated to be 342 Mm^3. The average hydraulic conductivity is assumed to be $5.49x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.028 along the flowpath of 1.3 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Gevgelija-Valandovo valley is calculated to be 0.3 m^3/sec.

(2) Karst Aquifer

Regarding determination of the amount of karst groundwater resources in the Lukar aquifer of the Kozuf Mountains, the infiltration area is estimated to be 20 km^2 and the average coefficient of infiltration and hydraulic head gradient are 1.57 m/sec and 0.55, respectively. Therefore, the amount of karst groundwater resources in the Lukar aquifer is calculated to be 0.55 m^3/sec.

In the case of karst groundwater resources in the Huma aquifer of the Kozuf

Mountains, the infiltration area is estimated to be 200 km^2 and the average coefficient of infiltration and hydraulic head gradient are 0.06 m/sec and 0.55, respectively. Therefore, the amount of karst groundwater resources in the Huma aquifer is calculated to be 0.18 m^3/sec.

B.6.12 Pcinja River Basin

B.6.12.1 Geology

The Pcinja River basin has been composed of the following rocks:

The Precambrian rocks are the oldest rocks within this basin. They are represented by lepidolite and mica-schist, pegmatite, sericite-chlorite schist. They are mostly represented in the north parts of the area.

Within this basin, the Paleozoic rocks are represented by marble, sericite, phyllite schist, metamorphic sandstone and serpentinite.

The rocks of Jurassic age are Gabbro diabase, diabase, limestone, sandstone, conglomerate, albitite and claystone.

The Cretaceous rocks are represented by granodiorite and are mostly distributed in the northwest part of the basin.

The Paleocene rocks in this basin are presented by extrusive magmatic rocks, rhyolite, the Eocene flysch, sandstone, siltstone, Claystone and limestone.

The Neogene rocks in this basin are represented by claystone, sandstone, calc-sinter limestone, volcanic breccia, augite hornblende-biotitic andesite, ignimbrite and trachybasalt.

The Quaternary rocks in this basin are represented by terrace deposits, dilluvial and proluvial deposits and alluvial sediments. They are mostly represented along the river valleys and in the peripheral parts of the basin.

From viewpoint of tectonics, major parts of the basin belong to the Vardar zone and the Serb-Macedonian mass. In the tectonic structure of the Vardar zone, various formations from Paleozoic to Quaternary rocks exist. In the tectonic structure of the Serb-Macedonian mass, Precambrian rocks present as a crystalline core in this part of the basin. The boundary between the two tectonic units is covered by the Quaternary sediments, and effusive rocks and materials.

The Kumanovo Valley has been formed by the youngest tectonic movement where the massif Skopska Crna Gora was mostly erected. An example for the erection of this terrain is the plate of the Oligocene limestone at a height of 1,178 m. The tectonic movement along the peripheral part of the Skopje-Kumanovo valley is still going on. The activity of earthquakes in this terrain is a clear evidence of the youngest tectonic movement.

B.6.12.2 Hydrogeology

Within this basin, the following types of aquifers are represented: 1) inter-granular aquifer, 2) fissured aquifer and 3) karst aquifer.

(1) Inter-granular and unconsolidated aquifer

The inter-granular and unconsolidated aquifers are represented within the Quaternary sediments and the Pliocene sediments. The Quaternary sediments are represented in the alluvial and terrace sediments of the Pcinja River, Kriva Reka and Konjska River and in the dilluvial and proluvial deposits along the peripheral parts of the valleys. The alluvial sediments are characterized by a thickness of 5 to 10 m, a hydraulic conductivity of $1.6x10^{-2}$ to $5.2x10^{2}$ cm/sec and a yield of 5 to 10 l/sec. Within the Pliocene sediments, this type of aquifer is developed in the sand and gravel layers with a thickness of 1 to 5 m. The sand and gravel layers are characterized by artesian and sub-artesian aquifers with a yield of 3 to 5 l/sec.

(2) Fissured aquifer

The fissured aquifers are represented in the northwestern part of the basin. The aquifers are developed in the layers of granodiorite, gabbro, and diabase, i.e. in the tectonically altered zones. The aquifers have no special importance for practical use. The yields of springs range from 0.1 to 0.3 l/sec.

(3) Karst aquifer

The karst aquifers are developed within the marble and Jurassic limestone. The yields of springs range from 1 to 10 l/sec.

B.6.12.3 Groundwater Resources

(1) Quaternary and Neogene Aquifers

In the Pcinja valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 15.5 m and 110 km^2, and the porosity of the aquifer is assumed to be 0.21. The static amount of groundwater resources in the Quaternary sediments of the Pcinja valley is calculated to be 358 Mm^3. The average hydraulic conductivity is assumed to be $3.69x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.035 along the flowpath of 0.65 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Pcinja valley is calculated to be 0.13 m^3/sec.

Regarding the Neogene sediments in the Ohrid valley, the surface area and the average thickness of the Neogene sediments are estimated to be 10 m and 372 km^2, and the porosity of the aquifer is assumed to be 0.18. The static amount of groundwater resources in the Neogene sediments of the Pcinja valley is calculated to be 670 million m^3. The average hydraulic conductivity is assumed to be 5.26×10^{-3} cm/sec. The hydraulic gradient is estimated to be 0.02 along the flowpath of 19 km. Therefore, the dynamic amount of groundwater resources in the Neogene sediments of the Pcinja valley is calculated to be 0.2 m^3/sec.

B.6.13 Bregalnica River Basin

The Bregalnica River basin is composed of five valleys: 1) Berovo-Delchevo valley, 2) Kochani valley, 3) Zletovo valley, 4) Kriva Lakavica valley, and 5) Ovche Pole valley.

B.6.13.1 Geology

The basin of Bregalnica River has been composed of the following rock masses as shown in Figure B.49:

Within the basin of Bregalnica River, the Precambrian rocks are presented by gneiss, mica-schist, amphibolite, granite and schist. These rocks are presented by gabbro, schist, meta-diabase, quartz porphyry, marble and carbonate schist, phyllite, meta-sandstone, marble and chlorite-amphibole schist.

The Upper Paleozoic rocks are presented by schist, serpentinite and several varieties of granites.

The Triassic rocks are presented by sandstone, sandy clay, conglomerate and limestone.

The Paleocene rocks are represented by conglomerate, sandstone, marl, claystone, yellow sandstone, limestone, quartz latite and quartz monzonite porphyry.

The Neogene rocks are presented by dacite, ignimbrite, marl, tuff, sandstone, claystone, sandy loam, gravel, andesite tuff, hornblende-augite-biotite andesite, andesite breccia, calc-sinter limestone and augite-hornblende-biotite andesite.

The Quaternary sediments are presented by proluvial-dilluvial sediments, terrace, spring sediments and alluvial sediments.

From viewpoint of tectonics, the river basin of the Bregalnica River belongs to two large geotectonic units: Serb-Macedonian mass and the Vardar zone. The Serb-Macedonian mass are surrounded by the Plackovica Mountains, Maleshevski Mountains, Vlaina Mountains, Golak Mountains, Obozna Mountains and the south slopes of Osogovo Mountains, as well as Delcevo-

Pehcevo Mountains ranges and a part of the Vinica valley. The Serb-Macedonian mass are distinguished into the following structural shapes: Bezikovsko-Izvedenski block, Delcevo-Berovo block, Vlainsko-Maleshevo block and Delcevo-Pehcevo trench.

The Vardar zone, in Old Paleozoic age and in Caledonian orogeny phase is distinguished into separate geotectonic units between the Serb-Macedonian mass and the Pelagonian massif. The structure of this zone was formed at the end of Paleozoic age, probably during the Hercyan orogeny. Within this tectonic zone, several tectonic structures are distinguished: horst Bogoslovec, Shtip block, Ovce Pole block, Kratovo-Zletovo block, Kriva Lakavica and Kocani grabens.

B.6.13.2 Hydrogeology

Within the Bregalnica River basin, the following types of aquifers have been represented: 1) inter-granular and unconsolidated aquifer, 2) fissured aquifer and 3) waterless terrain as shown in Figures B.50 and B.51.

(1) Inter-granular and unconsolidated aquifer

The aquifers are developed within the Quaternary, Neogene and Paleocene sediments. Quaternary rocks are the alluvial, terrace, dilluvial and proluvial deposits. In the alluvial and terrace deposits, the aquifers are developed along the valleys of Bregalnica, Zletovska, Kriva Lakavica and Osojnica Rivers. The thickness of these deposits ranges from 2 to 10 m in the alluvium of the Bregalnica River and the thickness at Kochani is up to 50 m in minimum. The sediments are characterized by good water-bearing bodies with yields of 5.0 to 10.0 l/sec and about 25 to 50 l/sec in the alluvium of the Bregalnica River at Shtip and Kochani. The groundwater has a free level from 3 to 6 m.

Within the Neogene and Paleocene sediments, this type of aquifer is developed in the sandy and gravely layers in the Ovce Pole, Berovo-Delcevo and Kocani-Vinica basin. The environments are characterized by a poor water-bearing body and yields of well range from 3 to 5 l/sec. The yields of wells in the Ovche Pole basin are up to 10 l/sec. The groundwater forms sub-artesian or artesian aquifers.

(2) Fissured aquifer

The aquifers are developed within the fractured granite, marble schist and etc. and have no significant importance for practical use. Springs occur with a yield mostly from 0.1 to 0.5 l/sec except for several springs with a yield that exceeds 1 l/sec.

(3) Waterless terrain

The rocks are very represented by schist, mica-schist, tuff, Paleocene and

Neogene clay and claystone, marl and etc. The well yields in these rocks have a yield of about 0.1 l/sec.

B.6.13.3 Groundwater Resources

(1) Quaternary Aquifer

In the Berovo-Delchevo valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 15 m and 86 km^2, and the porosity of the aquifer is assumed to be 0.194. The static amount of groundwater resources in the Quaternary sediments of the Berovo-Delchevo valley is calculated to be 250 million m^3. The average hydraulic conductivity is assumed to be $2x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.009 along the flowpath of 8.5 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Berovo-Delchevo valley is calculated to be 0.23 m^3/sec.

In the Kocani-Shtip valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 12 m and 150 km^2, and the porosity of the aquifer is assumed to be 0.2. The static amount of groundwater resources in the Quaternary sediments of the Kocani-Shtip valley is calculated to be 360 million m^3. The average hydraulic conductivity is assumed to be $2.31x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.009 along the flowpath of 26 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Kocani-Shtip valley is calculated to be 0.649 m^3/sec.

In the Zletovo valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 14.7 m and 34 km^2, and the porosity of the aquifer is assumed to be 0.3. The static amount of groundwater resources in the Quaternary sediments of the Zletovo valley is calculated to be 150 million m^3. The average hydraulic conductivity is assumed to be $2.22x10^{-1}$ cm/sec. The hydraulic gradient is estimated to be 0.0031 along the flowpath of 1.5 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Zletovo valley is calculated to be 0.152 m^3/sec.

In the Kriva Lakavica valley, the average hydraulic conductivity is assumed to be $1.15x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.01 along the flowpath of 6.5 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Kriva Lakavica valley is calculated to be 0.045 m^3/sec.

In the Ovce Pole valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 15 m and 95 km^2, and the porosity of the aquifer is assumed to be 0.18. The static amount of groundwater resources in the Quaternary sediments of the Ovce Pole valley is calculated to be 257 million m^3. The average hydraulic conductivity is assumed to be $9.52x10^{-3}$ cm/sec. The hydraulic gradient is estimated to be 0.0075 along the flowpath of 14 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Ovce Pole valley is calculated to be 0.15 m^3/sec.

B.6.14 Strumica River Basin

The Strumica River basin is composed of two valleys: 1) Strumica valley in the lower part, and 2) Radovis valley in the upper part.

B.6.14.1 Geology

The basin of Strumica River has been composed of the following rock masses as shown in Figure B.52.

The Precambrian rock is the oldest rock in this basin. The Precambrian rocks are divided into bimica-banded gneiss, pegmatite, biotite gneiss, muscovite gneiss, amphibole schist, amphibole, mica-schist, lepidolite and marble according to the genetic and mineralogical characteristics. They are distributed in the Ograzden, Maleshevo, Belasica and Plackovica Mountains.

Rifean-Cambrian rocks are presented by various kinds of schists, gabbro-amphibolite, meta-diabase, phyllite and phyllitic mica-schist. These rocks are known as green series exposed in the vicinity of Gubener, east of Radovish.

The Paleozoic rocks are presented by metamorphic rocks and pegmatite. The metamorphic rocks are presented by phyllite, carbonate schist, marble, quartz-sericite-chlorite schist, meta-rhyolite, series of chlorite schist, meta-diabase, tuff, carbonate schist and tuff, carbonate schist, meta-gabbro, thin platy marble and phyllite. These rocks occur in the Veljusa village of the eastern slope of the Smrdesh Mountains and Strumica Valley of the northern slope of the Belasica Mountains.

The Mesozoic rocks are presented by the sediments of Jurassic age (diabase - hornstone formation), dark-gray claystone, siltstone, claystone, argillo-schist and sericite-clay schist. These sediments are encountered at Kosturino village. The Jurassic pegmatites are presented by gabbro, diabase and granite, which are encountered at Kosturino Village.

The Tertiary rocks are presented by upper Eocene sediments, dacite and andesite and Pliocene sediments, which are represented in the peripheral and central parts of Radovish-Strumica valley.

The Quaternary rocks are presented by calc-sinter, alluvial and proluvial sediments, which are distributed along river valleys and in the peripheral parts of the valley.

The Strumica River basin is situated in the southeast part of the Republic of Macedonia and belongs to the Serb-Macedonian massif except for a small part which belongs to the Vardar zone. The Radovish-Strumica valley is enclosed by the mountain ranges of Plackovica, Ograzden and Maleshevo Mountains in the north and Belasica and Smrdes Mountains in the south. The Radovish-Strumica valley is a typical tectonic trench, which was formed by subsidence of a part of the terrain between two large parallel faults: Belasica fault and Ograzden fault. The trench has a strike direction of east–west and cuts the structures of the Serb-Macedonian mass and the Vardar zone horizontally.

B.6.14.2 Hydrogeology

Within the basin of Strumica River, the following types of aquifers are represented: 1) inter-granular and unconsolidated aquifer, 2) fissured aquifer and 3) karst aquifer as shown in Figures B.53 and B.54.

(1) Inter-granular and unconsolidated aquifer

The inter-granular and unconsolidated aquifers are developed within the alluvial, proluvial and Pliocene sediments. Within the alluvial sediments, the inter-granular and unconsolidated aquifers are developed in the alluvium of Strumica, Turija, Trkanja and Plavaja Rivers. The thickness of these sediments ranges from 5 to 15 m. The hydraulic conductivity of the alluvial sediments $K = 1x10^{-2}$ to $1x10^{-3}$ m/sec. Phreatic aquifers are formed in the alluvial sediments, which the groundwater level is from 4 to 8 m below the ground surface.

Within the proluvial sediments, the inter-granular and unconsolidated aquifers are formed in the peripheral parts of the valley and are characterized by small waterbearing bodies with unconfined groundwater.

Within the Pliocene sediments, the inter-granular aquifers are developed in sandy sediments. The Pliocene sediments have a thickness of 9 to 160 m and are characterized by sub-artesian and artesian groundwater aquifers with a yield of the drillholes from 0.1-8.0 l/sec.

(2) Fissured aquifer

The fissured aquifers are mostly developed in the granite of Ograzden and Belasica Mountains and are characterized by springs and thermal water with a yield of 0.1 - 10.0 l/sec.

(3) Karst aquifer

The karst aquifers are represented in the carbonate rocks and marble at Veljusa village of the eastern slope of the Smrdesh Mountains and at Raklesh in

Radovish. The aquifer is characterized by springs with a yield of 0.2 to 2.0 l/sec and the spring in Veljusa village ranges from 20 to 50 l/sec. Thermal water was obtained from the aquifer in Raklesh village.

B.6.14.3 Groundwater Resources

(1) Quaternary and Neogene Aquifers

In the Strumica valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 18 m and 265 km^2, and the porosity of the aquifer is assumed to be 0.21. The static amount of groundwater resources in the Quaternary sediments of the Strumica valley is calculated to be 1000 million m^3.

Regarding the Neogene sediments in the Strumica valley, the surface area and the average thickness of the Neogene sediments are estimated to be 25 m and 200 km^2, and the porosity of the aquifer is assumed to be 0.17. The static amount of groundwater resources in the Neogene sediments of the Strumica valley is calculated to be 850 million m^3. The average hydraulic conductivity is assumed to be $4x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.006 along the flowpath of 25 km. Therefore, the dynamic amount of groundwater resources in the Neogene sediments of the Strumica valley is calculated to be 1.5 m^3/sec.

In the Radovis valley, the surface area and the average thickness of the Quaternary sediments are estimated to be 16.7 m and 80 km^2, and the porosity of the aquifer is assumed to be 0.15. The static amount of groundwater resources in the Quaternary sediments of the Radovis valley is calculated to be 200 million m^3. The average hydraulic conductivity is assumed to be $3.69x10^{-2}$ cm/sec. The hydraulic gradient is estimated to be 0.01 along the flowpath of 8 km. Therefore, the dynamic amount of groundwater resources in the Quaternary sediments of the Radovish valley is calculated to be 0.1 m^3/sec.

B.7 Groundwater Monitoring

B.7.1 Existing Monitoring Systems and Current Problems

B.7.1.1 Groundwater Level Monitoring

Evaluation, development and management of groundwater resources are often handicapped by non-availability of historic water level data which are required for assessing changes in storage of groundwater in response to rainfall, evaporation, pumping, irrigation, drying due to urbanization and other causes. Historic water level data are essential for forecasting future trends of water levels. Groundwater resources assessment requires the following knowledge of suitable water resources and then groundwater monitoring is indispensable to assess groundwater resources.

- Evaluation of existing hydrogeological data including groundwater quality based on the database of wells and hydrogeological data including water quality
- Identification and execution periodical and additional field investigations required
- Improvement and preparation of hydrogeological maps
- Evaluation of existing data collection system and propose improvement of the system
- Evaluation of groundwater recharge by field investigation and computer simulation

Groundwater level data are acquired by establishing groundwater observation wells at critical locations. The criteria to be adopted for selecting a well as an observation well are:

- Aquifers tapped in the wells should be identifiable for each aquifer
- Static water levels should be available for monitoring
- Fixed point for measurement of water levels should be in good condition
- The wells should be approachable at any time

Regarding groundwater monitoring in Macedonia, the Republic Hydro-Meteorological Institute (HMI) is the responsible agency. The contents of the groundwater monitoring performed by HMI are measurement of groundwater levels for the first (shallowest) aquifer and groundwater quality analysis

There are 108 groundwater level monitoring stations, but only 63 stations are operated as shown in Table B.25. Out of 63 stations, only 47 stations are recorded continuously as shown in the following table and Figure B.55.

Valley	Number of monitoring stations	Continuous recording stations
Polog (Poloshko Pole)	18	10
Skopje (Skopsko Pole)	14	5
Ovche Pole(Sveti Nicole)	9	4
Kochani (Kochansko Pole)	15	9
Strumica & Radovish (Strumichko Pole)	25	5
Bitola (Bitolsko Pole)	17	6
Struga & Ohrid (Strushko Pole)	10	8
Total	108	47

The groundwater levels are measured every 5 days and in the last day of the month. The measured data are compiled and analyzed, and are reported on the annual reports of the HMI.

The relationships between groundwater levels and rainfalls are analyzed for all stations, which are being recorded continuously. The analyses of the relationships between groundwater levels and rainfalls for groundwater monitoring stations are shown in Annex 2.

The groundwater levels of the first (shallowest) aquifer are being measured, but piezometers in deeper aquifers, which are exploited mainly, are not installed. Therefore, monitoring wells for deeper aquifers are also required to measure the groundwater levels.

The diameters of the monitoring wells are generally 50 mm. This diameter is too small to measure groundwater level inside of the observation wells. Therefore, the HMI intends to install piezometers in wells with a big diameter of 200 mm.

B.7.1.2 Groundwater Quality Monitoring

Groundwater quality monitoring has not been conducted since 1992 due to budget constraint of the HMI.

Regarding health aspect of drinking water, the Ministry of Health and the Republic Institute for Health Protection (RIHP) has responsibility of water quality test for drinking water including groundwater and spring water. There are ten (10) regional institutes of health protection and twenty (20) local units under the ministry as shown in Figure B.56. The regional institute of health protection can carry out basic water quality analysis, which is equivalent to regular water quality analysis, for drinking water and the RIHP has responsibility of full analysis of chemical components including radiology and pesticides, which is equivalent to periodical water quality analysis.

According to the regulation for quality and pollution of drinking water (Official Gazette No. 5, 1984), the regular and periodical water quality analyses should be required. The regular water quality analysis is composed of the following components;

- Micro-biological component: total coliform bacteria, coliform bacteria of faecal origin and total aerobic mezophile bacteria
- Physical and chemical components: temperature, color, taste, odor, pH, ammonia, nitrate, nitrite, chloride, iron, manganese, $KMnO_4$, and residual chloride

The sampling interval for the regular water quality analysis should depend on the size of population within the water supply system as follows,

Number of population	Sampling interval	Minimum number of samples for each sampling	Minimum number of samples for each month
Less than 5,000	30 days	3	2
5,000 – 10,000	30 days	4	4
10,000 – 20,000	15 days	4	8
20,000 – 50,000	7 days	5	20
50,000 – 100,000	4 days	6	45
100,000 – 200,000	2 days	7	105
200,000 – 400,000	1 day	8	240
More than 400,000	1 day	10	300

The periodical water quality analysis is composed of the following components and should be done at least twice a year,

- Same components for the regular water quality analysis
- Calcium, magnesium, fluoride, lead, zinc, copper, selenium, sulphate, and total and carbonate hardness
- Pesticides

In the case of newly established water supply systems, the periodical analysis should be done four times a year and radiological components should be examined twice a year for acquirement of scientific evidence.

B.7.1.3 Land Subsidence Monitoring

The Institute of Geodesy has responsibility of surveying the territory in Macedonia and the following network systems are established as shown in Table B.26 and Figure B.57:

- First class landmark: 25 points
- Second class landmark: 225 points
- Third and forth landmarks: 18000 to 20000 points

Regarding the first and second classes' landmarks are generally surveyed once a year, but the surveying has not been carried out since the latest in 1996 due to financial problem. The landmark density can be calculated to be approximately 1 point per 100 km^2. Therefore, the landmarks should be increased especially in the major valleys for detection of land subsidence and the surveying should be conducted once a year.

The international project "Expert Assessment of Land Subsidence Related to Hydrogeological and Engineering Geological Conditions in the Regions of Sofia, Skopje and Tirana" was organized under sponsor of UNESCO by mainly researchers of Institute of Earthquake Engineering and Engineering Seismology, Univ. of St. Cyril and Methodius, in order to clarify phenomena of land subsidence in the Balkan Peninsula. However, lowering phenomena of groundwater level and ground surface have not yet besen clarified due to lack of groundwater monitoring systems. Therefore, groundwater and land subsidence monitoring systems should be established as soon as possible.

B.7.1.4 Groundwater-Related Institute

The former Republic Geological Institute had responsibility of all kinds of groundwater and hydrogeology including drilling except for groundwater monitoring. At the present, however, there is no responsible public agency of hydrogeology and groundwater in Macedonia. The Republic Hydrometeorological Institute (HMI) has not any hydrogeologist in spite of responsibility of groundwater monitoring and the Department of Geology and Mines, Ministry of Economy has not any capability of hydrogeological works due to manpower constraint. At the present, Geohydroproject-Skopje, as a succession of the former Republic Geological Institute, is working for the preparation of hydrogeological maps with Department of Geology and Mines, Ministry of Economy, and intends to be a public institute of hydrogeology/groundwater.

Hydrogeological maps should be prepared by a public institute, which has capability of hydrogeological works. Hydrogeological maps should be periodically improved in order to integrate all information on groundwater including wells, springs, water quality and etc. and to provide effective information on groundwater potentiality, risk of water quality, availability of new wells and springs and etc. The hydrogeological maps should be composed of the following information based on the International Legend for Hydrogeological Maps published by UNESCO in 1983: 1) climatological, topographical and geological features, 2) aquifer classification, 3) existing boreholes, 4) existing springs, 5) groundwater quality classification, 6) groundwater level, 7) groundwater potential classification, and 8) geological logging data.

In the case of Macedonia, hydrogeological Map of Macedonia at a scale of 1:200,000 was published in 1977 as the results of the hydrogeological activities of the former Republic Geological Institute, which conducted the regional explorations during 1963 to 1975. After that, exploration-level hydrogeological maps of Macedonia were published in a scale of 1:100,000 and compiling of the well inventory was also conducted in 1982. However, a database of wells and hydrogeology had not yet been filed on the computer. At the present, Geohydroproject-Skopje, as a succession of the former Republic Geological Institute, is preparing hydrogeological maps in a scale of 1:100,000 by request of the Department of Geology and Mines, Ministry of Economy. The hydrogeological map of Bitola area has already been compiled and is ready for publication.

B.7.2 Improvement and Development Plans for Groundwater Monitoring

B.7.2.1 Plans for Monitoring System of Groundwater

As discussed in Sub-section B.7.1, there are 108 existing groundwater monitoring stations in Macedonia. Out of 108 stations, 63 stations are basically operated and only 47 stations are recorded continuously. Groundwater and land subsidence monitoring wells and piezometers should be installed in order to detect continuous lowering phenomena of groundwater level and land subsidence. At the same time, groundwater quality monitoring system, which regular monitoring stations and existing production wells will be utilized to take water samples, should be arranged in order to detect pollutants, to evaluate environmental quality and to estimate geo-chemical characteristics.

The following plans of groundwater monitoring shall be proposed:

- Groundwater monitoring station improvement project
- Groundwater and land subsidence monitoring project
- Groundwater quality monitoring project

Project	Monitoring stations	Diameter of wells (mm)	Well depth (m)
Groundwater monitoring station improvement project	61	200	100
Groundwater and land subsidence monitoring project*	10	500	350
Groundwater quality monitoring project**	150		

*: One station includes 3 piezometers, i.e., 50, 100 and 200 m

**: 108 groundwater monitoring stations and 42 existing wells.

B.7.2.2 Plan for Groundwater-related Institute

As mentioned in Sub-section B.7.1.1, the former Republic Geological Institute had responsibility of all kinds of groundwater and hydrogeology including drilling except for groundwater monitoring. At the present, however, there is no responsible public agency of hydrogeology and groundwater in Macedonia. The Republic Hydrometeorological Institute (HMI) has not any hydrogeologist in spite of responsibility of groundwater monitoring and the Department of Geology and Mines, Ministry of Economy has not any capability of hydrogeological works due to manpower constraint. At the present, Geohydroproject-Skopje, as a succession of the former Republic Geological Institute, is working for the preparation of hydrogeological maps with Department of Geology and Mines, Ministry of Economy, and intends to be a public institute of hydrogeology/groundwater.

Therefore, a public institute of hydrogeology/groundwater should be a succession of the former Republic Geological Institute. The public institute should have responsibility of all aspects of hydrogeology/groundwater, especially preparation of hydrogeological maps and groundwater and land subsidence monitoring systems.

Table B.1 Characteristics of Boreholes/Wells by Well Type

Borehole/Well type	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water temperature (°C)	pH
Artesian borehole No. of wells:102)	No. of samples	88	78	77	100	22	30	8	9	7	65	44
	Average	98.8	129.1	4.8	3.0	7.18E-04	17.8	3.1	11.1	400.2	14.3	7.0
	Maximum	360	501	19.8	30	5.40E-03	59	4	22.2	1230	23	7.6
	Minimum	12	50.8	-3.1	0.05	1.00E-06	3	2	2.5	7.5	4.5	6
Drilled borehole No. of wells:321)	No. of samples	311	208	251	231	167	203	40	158	93	64	101
	Average	48.7	403.6	-7.4	23.9	2.25E-03	15.2	3.5	6.7	227.9	12.2	7.2
	Maximum	450	4000	-0.2	921	8.80E-02	155	9	36	3140	17.5	8.7
	Minimum	3	34	-282	0.1	6.00E-07	0.3	2	0.2	5	5.2	6
Dug well (No. of wells:70)	No. of samples	69	65	61	68	46	15	3	46	7	48	15
	Average	7.6	1259.4	-5.1	8.1	4.57E-03	4.4	2.3	1.9	167.8	12.7	7.3
	Maximum	17	5000	-1	90	7.00E-02	12	3	9.3	621.9	17	12
	Minimum	2.4	400	-20.5	0.1	2.20E-05	0.3	2	0.15	12.1	4.5	6.4
Radial well (No. of wells:9)	No. of samples	8	9	6	8	1			7	0	1	2
	Average	19.2	2988.9	-6.2	150.6	5.90E-04	-	-	5.4	-	12.0	7.3
	Maximum	51	4000	-2	890	5.90E-04	-	-	10	-	12	7.52
	Minimum	6	350	-12	4	5.90E-04	-	-	2	-	12	7.12
Observation well (piezometer (No. of wells:85)	No. of samples	85	64	80	0	50	53	9	0	0	13	20
	Average	71.4	61.7	-16.3	-	1.29E-03	18.7	2.8	-	-	12.1	7.3
	Maximum	370.13	76.2	-0.53	-	2.40E-02	144	7	-	-	16	7.8
	Minimum	8	50.8	-195.8	-	2.80E-10	1.3	2	-	-	8	6.5
Thermo-mineral (No. of wells:18)	No. of samples	18	14	5	8	0	0	0	0	0	15	6
	Average	336.4	375.5	-11.0	35.0	-	-	-	-	-	47.3	7.1
	Maximum	738	2000	-0.5	200	-	-	-	-	-	79	8.1
	Minimum	65	76	-39.5	0.2	-	-	-	-	-	19	6.2
All wells (Total wells:605)	Total number of samples	579	438	480	415	286	301	60	220	107	206	188
	Average	63.3	484.0	-6.6	18.9	2.33E-03	15.6	3.3	5.8	235.2	15.5	7.2
	Maximum	738.0	5000.0	19.8	921.0	8.80E-02	155.0	9.0	36.0	3140.0	79.0	12.0
	Minimum	2.4	34.0	-282.0	0.05	2.80E-10	0.3	2.00	0.15	5.0	4.5	6.0

Table B.2 Characteristics of Boreholes/Wells by Use

Borehole/Well use	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	No. of aquifers	Draw-down (s)	Radius of influence (m)	Water tempe-rature (°C)	pH
Water supply	No of samples	117	120	103	125	74	76	8	83	42	31	47
o. of wells: 127)	Average	43.8	733.6	-5.0	22.7	1.20E-03	19.0	2.8	7.0	303.0	11.5	7.2
	Maximum	450	4000	10	180	1.00E-02	155	4	36	3140	17	8.6
	Minimum	3	34	-39.8	0.1	6.00E-07	1.5	2	0.3	5	6	6.5
Agriculture	No of samples	36	35	32	32	12	20	2	11	5	21	23
No. of wells: 36)	Average	28.6	860.9	-4.5	9.7	1.33E-03	9.0	3.5	6.6	214.0	11.1	7.0
	Maximum	302	5000	3	50	9.00E-03	26.2	5	15	458	16.4	7.74
	Minimum	4	51	-20.5	0.1	5.00E-05	0.5	2	1.25	31.8	4.5	6.4
Industry	No of samples	85	64	70	74	55	60	14	51	39	26	40
No. of wells: 86)	Average	41.7	449.3	-6.8	30.2	4.89E-03	12.4	2.5	7.4	207.4	13.1	7.2
	Maximum	302	2700	10.2	921	8.80E-02	113.6	5	27.7	1000	17.5	8.4
	Minimum	4	50.8	-99.1	0.23	1.00E-06	0.3	2	0.25	10.5	5.2	6.4
Observation	No of samples	86	65	81	1	50	53	9	0	0	14	21
No. of wells: 86)	Average	74.1	61.5	-16.0	1.2	1.30E-03	18.7	2.8	-	-	12.1	7.3
	Maximum	370.13	76.2	9	1.2	2.40E-02	144	7	-	-	16	7.8
	Minimum	8	50.8	-195.8	1.2	2.80E-10	1.3	2	-	-	8	6.5
Others	No of samples	237	140	189	175	95	92	27	75	21	99	51
o. of wells: 252)	Average	61.3	398.6	-3.7	12.5	2.59E-03	14.4	3.9	3.4	156.5	14.1	7.2
	Maximum	450	4000	19.8	890	5.00E-02	64.4	9	16.6	1360	25	12
	Minimum	2.4	50.8	-282	0.05	1.00E-05	0.5	2	0.15	6.8	4.5	6
Thermo-mineral	No of samples	18	14	5	8	0	0	0	0	0	15	6
No. of wells: 18)	Average	336.4	375.5	-11.0	35.0	-	-	-	-	-	47.3	7.1
	Maximum	738	2000	-0.5	200	-	-	-	-	-	79	8.1
	Minimum	65	76	-39.5	0.2	-	-	-	-	-	19	6.2
Total	Total number of samples	579	438	480	415	286	301	60	220	107	206	188
o. of wells: 605)	Average	63.3	484.0	-6.6	18.9	2.39E-03	15.6	3.3	5.8	235.2	15.5	7.2
	Maximum	738	5000	19.8	921	8.80E-02	155	9	36	3140	79	12
	Minimum	2.4	34	-282	0.05	2.80E-10	0.3	2	0.15	5	4.5	6

Table B.3 Characteristics of Boreholes/Wells by Geology

Geology	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water temperature (C)	pH
Alluvial (No. of wells: 174)	No. of samples	170	149	145	144	107	119	7	101	52	49	63
	Average	33.6	699.0	-5.7	28.7	3.65E-03	16.8	2.9	6.2	184.4	11.7	7.2
	Maximum	235.0	5000.0	-0.5	921.0	8.80E-02	144.0	5.0	36.0	1132.0	16.1	8.6
	Minimum	4.0	50.8	-39.8	0.2	3.00E-07	0.3	2.0	0.3	5.0	4.5	6.4
Pleistocene (No. of wells: 24)	No. of samples	24	17	21	11	13	13	3	4	1	6	3
	Average	37.4	459.9	-6.3	4.1	1.76E-03	11.0	2.7	1.4	15.0	11.9	7.3
	Maximum	210.0	3000.0	-1.5	16.5	1.50E-02	28.0	3.0	3.0	15.0	13.0	7.7
	Minimum	3.5	50.8	-16.3	0.2	1.70E-06	2.0	2.0	0.2	15.0	6.8	7.0
Quaternary (No. of wells: 85)	No. of samples	79	53	74	57	43	39	14	37	15	32	16
	Average	27.0	594.5	-3.1	7.6	1.59E-03	10.6	2.9	4.1	152.0	13.8	7.5
	Maximum	136.0	3000.0	4.0	80.0	1.80E-02	55.6	6.0	18.0	450.0	16.0	8.7
	Minimum	2.4	50.8	-12.0	0.1	1.00E-06	1.0	2.0	0.3	26.9	12.0	6.9
Quaternary-Pliocene (No. of wells: 5)	No. of samples	5	5	5	2	4	4	1	1	1	3	4
	Average	41.0	185.6	-2.8	16.3	2.47E-03	11.1	2.0	11.3	90.0	11.7	7.2
	Maximum	81.0	400.0	-1.5	20.0	9.00E-03	18.3	2.0	11.3	90.0	13.0	7.6
	Minimum	28.0	50.8	-4.2	12.6	1.00E-05	4.4	2.0	11.3	90.0	9.0	6.5
Pliocene (No. of wells: 139)	No. of samples	130	98	112	111	43	57	23	26	15	64	53
	Average	87.1	186.2	-0.3	4.8	7.47E-04	16.5	3.7	6.2	205.8	14.1	7.1
	Maximum	312.0	1300.0	19.8	56.0	5.40E-03	64.4	9.0	17.2	900.0	23.0	12.0
	Minimum	5.0	50.8	-40.5	0.1	1.00E-06	2.4	2.0	0.2	7.5	4.5	6.0
Neogene (No. of wells: 104)	No. of samples	103	76	82	60	62	61	10	41	18	25	25
	Average	47.6	473.3	-4.0	33.3	2.05E-03	11.9	3.4	6.8	362.1	17.6	7.2
	Maximum	380.0	4000.0	5.0	890.0	5.00E-02	50.0	9.0	24.6	3140.0	62.0	8.4
	Minimum	3.0	50.8	-40.0	0.2	2.80E-10	0.3	2.0	0.2	18.6	7.3	6.6
Fractured (No. of wells: 21)	No. of samples	21	12	6	7	0	0	0	0	0	8	6
	Average	275.7	358.4	-9.4	39.6	-	-	-	-	-	54.3	7.2
	Maximum	738.0	2000.0	-0.5	200.0	-	-	-	-	-	79.0	8.1
	Minimum	60.0	50.8	-22.4	0.2	-	-	-	-	-	19.0	6.2
Karst limestone (No. of wells: 43)	No. of samples	38	22	29	20	14	8	2	10	5	11	13
	Average	108.7	258.5	-52.2	19.6	1.18E-03	51.8	2.5	4.6	718.7	15.6	7.1
	Maximum	450.0	700.0	5.0	100.0	4.00E-03	155.0	3.0	15.2	1725.0	40.0	7.8
	Minimum	8.0	34.0	-282.0	0.1	6.00E-07	8.0	2.0	0.2	18.6	9.0	6.0
Others (No. of wells: 10)	No. of samples	9	6	6	3	0	0	0	0	0	8	5
	Average	173.4	562.3	-10.4	3.3	-	-	-	-	-	16.3	6.9
	Maximum	25.0	1000.0	-4.0	5.5	-	-	-	-	-	31.4	7.4
	Minimum	5.0	128.0	-39.5	1.5	-	-	-	-	-	5.2	6.4
Total	Total number of samples	579	438	480	415	286	301	60	220	107	206	188
	Average	63.3	484.0	-6.6	18.9	2.33E-03	15.6	3.3	5.8	235.2	15.5	7.2
	Maximum	738.0	5000.0	19.8	921.0	8.80E-02	155.0	9.0	36.0	3140.0	79.0	12.0
	Minimum	2.4	34.0	-282.0	0.1	2.80E-10	0.3	2.0	0.2	5.0	4.5	6.0

Table B.4 Characteristics of Boreholes/Wells by Municipality (1/4)

Municipality	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water tempe-rature (°C)	pH
Berovo	No. of samples	4	2	4	2	0	2	0	1	0	2	2
(No. of wells: 4)	Average	33.6	650.0	-2.9	4.8	-	3.5	-	3.2	-	9.6	6.715
	Maximum	107.4	1000.0	-2.0	7.5	-	4.0	-	3.2	-	12.7	6.93
	Minimum	7.0	300.0	-4.0	2.0	-	3.0	-	3.2	-	6.5	6.5
Bitola	No. of samples	39	24	20	31	10	16	1	13	4	14	15
(No. of wells: 40)	Average	67.8	221.3	2.0	12.0	8.20E-05	17.8	4.0	10.5	226.4	14.6	7.034
	Maximum	204.1	600.0	19.8	140.0	1.80E-04	46.0	4	27.7	444.0	22.0	7.53
	Minimum	17.2	50.8	-26.9	0.2	1.00E-06	5.8	4	2.7	7.5	10.0	6.5
M. Brod	No. of samples	5	5	5	4	1	1	0	2	0	0	0
(No. of wells: 5)	Average	16.4	196.7	-3.4	2.9	5.70E-04	4.5	-	9.0	-	-	-
	Maximum	30.0	230.0	-0.3	8.7	5.70E-04	4.5	-	12.0	-	-	-
	Minimum	10.0	63.5	-9.7	0.3	5.70E-04	4.5	-	6.0	-	-	-
Valandovo	No. of samples	2	0	1	1	0	1	1	1	0	0	0
(No. of wells: 2)	Average	252.5	-	-4.3	1.4	-	20.9	6.0	5.0	-	-	-
	Maximum	380.0	-	-4.3	1.4	-	20.9	6.0	5.0	-	-	-
	Minimum	125.0	-	-4.3	1.4	-	20.9	6.0	5.0	-	-	-
Vinica	No. of samples	8	6	2	8	0	0	0	0	0	2	2
(No. of wells: 8)	Average	107.1	1095.0	-3.9	13.8	-	-	-	-	-	37.5	7.2
	Maximum	353.0	2000.0	-3.0	49.5	-	-	-	-	-	62.0	7.3
	Minimum	4.0	76.2	-4.8	1.0	-	-	-	-	-	13.0	7.0
Gevgelija	No. of samples	23	21	18	15	10	10	1	11	5	15	10
(No. of wells: 23)	Average	71.0	647.2	-4.8	37.0	1.12E-03	19.6	4.0	6.9	992.4	28.5	7.192
	Maximum	350.0	4000.0	5.0	205.0	5.12E-03	38.0	4.0	22.2	3140.0	68.0	7.8
	Minimum	4.9	50.8	-17.5	0.2	1.00E-05	4.0	4.0	1.1	30.0	12.1	6.2
Gostivar	No. of samples	20	10	17	6	9	6	0	6	1	8	5
(No. of wells: 20)	Average	47.5	274.8	-12.2	4.1	6.20E-03	26.9	-	3.8	450.0	11.6	6.9
	Maximum	171.0	700.0	-0.8	8.0	5.00E-02	113.6	-	14.3	450.0	14.0	7.4
	Minimum	5.0	50.8	-71.5	0.6	1.00E-05	3.0	-	0.2	450.0	9.0	6.6
Debar	No. of samples	8	7	8	8	5	1	0	6	0	3	2
(No. of wells: 8)	Average	28.1	685.7	-6.0	15.7	2.79E-04	14.5	-	8.53	-	11.8	9.4
	Maximum	92.0	1000.0	-1.8	52.0	1.00E-03	14.5	-	17.2	-	14.0	12.0
	Minimum	5.1	400.0	-11.2	0.1	1.00E-05	14.5	-	0.18	-	8.3	6.9

Table B.4 Characteristics of Boreholes/Wells by Municipality (2/4)

Municipality	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water tempe-rature (°C)	pH
Delcevo (No. of wells: 10)	No. of samples	10	8	7	7	6	6	0	3	5	2	2
	Average	13.1	1978.9	-2.4	24.4	2.90E-03	4.2	-	1.1	316.4	12.9	6.9
	Maximum	40.0	4000.0	-1.2	90.0	7.80E-03	6.0	-	1.7	1000.0	13.0	7.4
	Minimum	5.4	131.0	-3.8	0.2	7.00E-05	2.5	-	0.6	26.9	12.7	6.4
Demir Hisar (No. of wells: 3)	No. of samples	3	2	3	3	2	2	0	1	2	1	2
	Average	35.7	800.0	-1.9	17.7	2.06E-04	13.7	-	4.6	123.5	11.8	6.6
	Maximum	72.0	1300.0	-1.5	30.0	3.12E-04	17.4	-	4.6	143.0	11.8	6.8
	Minimum	10.0	300.0	-2.3	8.0	1.00E-04	10.0	-	4.6	104.0	11.8	6.5
Kavadarci (No. of wells: 5)	No. of samples	5	4	5	3	3	2	2	3	1	3	2
	Average	99.3	495.2	-63.1	1.7	3.08E-04	4.0	2.0	4.1	10.0	15.7	7.3
	Maximum	398.4	800.0	-3.0	4.5	6.00E-04	4.0	2.0	10.7	10.0	17.0	7.6
	Minimum	7.3	50.8	-282.0	0.3	3.50E-05	4.0	2.0	0.7	10.0	15.0	7.0
Kicevo (No. of wells: 12)	No. of samples	10	9	11	7	4	8	3	3	3	1	4
	Average	20.8	267.0	-5.0	1.1	2.59E-04	9.7	2.7	8.9	49.7	10.1	7.1
	Maximum	30.0	1000.0	-1.5	2.0	1.00E-03	27.0	3.0	16.6	57.6	10.1	7.3
	Minimum	8.0	50.8	-11.0	0.2	5.60E-06	3.1	2.0	5.0	40.6	10.1	7.0
Kocani (No. of wells: 8)	No. of samples	7	8	5	6	5	4	0	3	3	4	3
	Average	172.7	535.3	-3.7	72.9	2.84E-03	18.05	-	6.0	115.7	38.0	7.2
	Maximum	570.0	2000.0	-1.5	200.0	1.00E-02	40.2	-	9.4	197.0	79.0	7.4
	Minimum	10.0	116.0	-7.0	4.0	5.70E-05	5	-	1.0	70.0	6.8	7.0
Kratovo (No. of wells: 2)	No. of samples	2	0	1	1	0	2	0	0	0	0	0
	Average	7.0	-	-3.0	5.0	-	3.5	-	-	-	-	-
	Maximum	10.0	-	-3.0	5.0	-	4	-	-	-	-	-
	Minimum	4.0	-	-3.0	5.0	-	3	-	-	-	-	-
Kriva Palanka (No. of wells: 11)	No. of samples	11	4	9	3	2	8	4	2	2	1	2
	Average	64.5	441.5	-2.6	6.5	2.60E-04	8.9	2.5	3.6	174.9	9.5	7.0
	Maximum	450.0	1000.0	-0.8	8.4	4.30E-04	21.0	4.0	3.6	185.7	9.5	7.1
	Minimum	9.0	50.8	-7.0	3.0	8.90E-05	1.0	2.0	3.5	164.0	9.5	6.9
Krusevo (No. of wells: 4)	No. of samples	4	3	4	3	1	1	0	3	1	1	1
	Average	18.5	253.6	-1.4	9.5	6.13E-05	23.0	-	8.1	42.5	10.0	7.2
	Maximum	42.0	480.0	-0.6	15.0	6.13E-05	23.0	-	15.0	42.5	10.0	7.2
	Minimum	10.0	50.8	-2.7	1.2	6.13E-05	23.0	-	4.5	42.5	10.0	7.2

Table B.4 Characteristics of Boreholes/Wells by Municipality (3/4)

Municipality	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water tempe-rature (°C)	pH
Kumanovo (No. of wells: 28)	No. of samples	28	7	27	8	3	19	1	3	2	4	5
	Average	35.7	621.4	-6.1	5.8	1.95E-04	7.8	2.0	4.8	81.9	11.4	6.8
	Maximum	142.0	1000.0	-1.2	30.0	4.00E-04	80.0	2.0	8.0	149.8	14.5	7.2
	Minimum	4.0	350.0	-40.0	0.3	8.60E-05	0.5	2.0	2.3	14.0	7.5	6.4
Negotino (No. of wells: 12)	No. of samples	12	11	11	13	8	7	0	6	6	3	5
	Average	29.4	630.9	-1.3	21.4	1.04E-03	7.8	-	5.4	113.2	14.5	7.5
	Maximum	113.0	3000.0	1.0	107.0	3.00E-03	13.0	-	8.5	300.0	15.5	7.8
	Minimum	3.0	50.8	-5.5	0.1	1.00E-04	1.3	-	2.1	15.0	14.0	7.0
Ohrid (No. of wells: 37)	No. of samples	29	29	30	35	27	13	9	24	7	14	10
	Average	27.7	544.0	-4.5	14.9	2.52E-03	17.9	2.7	4.0	286.8	13.2	7.6
	Maximum	100.0	1500.0	2.8	100.0	1.80E-02	55.6	5.0	20.0	1725.0	14.0	8.7
	Minimum	3.5	50.8	-21.0	0.1	1.00E-05	3.6	2.0	0.3	30.4	10.3	6.9
Prilep (No. of wells: 29) Total : 29	No. of samples	29	24	25	23	3	6	0	4	1	16	19
	Average	107.3	124.0	-0.7	4.0	1.04E-04	15.9	-	11.7	100.0	13.9	6.9
	Maximum	235.0	400.0	16.4	50.0	2.50E-04	50.0	-	23.0	100.0	16.4	7.5
	Minimum	12.0	50.8	-40.5	0.1	1.16E-05	1.5	-	2.7	100.0	4.5	6.0
Probistip (No. of wells: 4)	No. of samples	4	2	4	3	1	2	0	2	1	1	3
	Average	50.0	1600.0	-2.6	22.7	7.00E-02	3.6	-	4.0	12.1	8.0	7.2
	Maximum	180.0	2700.0	-0.7	38.0	7.00E-02	4.2	-	5.7	12.1	8.0	7.5
	Minimum	4.5	500.0	-5.7	5.0	7.00E-02	3.0	-	2.3	12.1	8.0	6.9
Radovis (No. of wells: 12) Total : 12	No. of samples	11	9	11	10	11	9	2	7	6	6	7
	Average	36.2	341.2	-3.3	22.4	5.43E-04	15.3	3.0	3.3	328.1	12.3	7.2
	Maximum	68.0	500.0	-1.6	74.0	2.00E-03	23.5	3.0	6.9	1132.0	14.5	7.6
	Minimum	8.2	50.8	-6.5	0.4	1.80E-05	10.0	3.0	1.7	30.0	6.0	6.7
Resen (No. of wells: 33)	No. of samples	31	30	31	30	16	14	1	19	4	12	5
	Average	55.3	556.7	-3.9	7.5	1.75E-03	29.2	2.0	4.7	11.6	12.9	7.0
	Maximum	450.0	2000.0	8.0	30.0	1.50E-02	155.0	2.0	10.0	15.0	14.0	7.4
	Minimum	2.4	34.0	-12.0	0.2	6.00E-07	12.0	2.0	0.2	10.5	9.0	6.4
Sveti Nikole (No. of wells: 26)	No. of samples	25	16	18	16	13	18	11	13	7	7	5
	Average	47.9	480.8	-2.5	8.7	9.70E-04	17.0	3.6	6.5	380.9	13.4	7.3
	Maximum	120.0	3000.0	0.5	22.0	1.00E-02	54.0	9.0	14.5	900.0	17.5	7.5
	Minimum	4.5	101.0	-8.0	1.0	5.00E-06	0.3	2.0	1.5	100.0	7.0	7.0

Table B.4 Characteristics of Boreholes/Wells by Municipality (4/4)

Municipality	Statistics	Well depth (m)	Diameter (mm)	Water level (m)	Yield (l/sec)	Hydraulic conductivity (cm/sec)	Aquifer thickness (m)	Number of aquifers	Draw-down (m)	Radius of influence (m)	Water tempe-rature (°C)	pH
Skopje (No. of wells: 130)	No. of samples	128	92	96	72	84	84	11	47	27	22	35
	Average	64.6	316.5	-10.1	46.1	3.07E-03	16.3	2.3	5.7	198.4	14.4	7.3
	Maximum	370.1	4000.0	5.0	921.0	8.80E-02	144.0	3.0	26.6	1360.0	40.0	8.6
	Minimum	4.4	50.8	-195.8	0.1	2.80E-10	0.3	2.0	0.2	5.0	4.5	6.0
Struga (No. of wells: 15)	No. of samples	14	14	15	15	5	2	1	6	0	12	2
	Average	34.2	454.6	-1.2	1.0	8.00E-04	30.0	4.0	3.7	-	12.2	7.2
	Maximum	120.0	1000.0	10.0	5.5	1.60E-03	31.0	4.0	14.0	-	14.0	7.4
	Minimum	3.4	50.8	-11.1	0.2	2.40E-04	29.0	4.0	0.3	-	5.2	7.0
Strumica (No. of wells: 34)	No. of samples	31	29	22	31	9	12	3	3	3	22	7
	Average	146.1	217.9	1.9	8.9	9.50E-04	22.0	2.7	8.3	96.7	18.3	7.3
	Maximum	738.0	800.0	7.7	60.0	3.60E-03	59.0	3.0	13.0	160.0	70.5	8.1
	Minimum	15.0	75.0	-10.0	0.1	5.30E-06	6.0	2.0	2.5	30.0	13.0	7.0
Tetovo (No. of wells: 48)	No. of samples	45	32	42	24	26	23	6	10	4	22	19
	Average	81.1	237.6	-18.8	7.0	2.17E-03	19.6	6.0	6.6	278.0	11.5	7.1
	Maximum	312.0	1000.0	10.2	42.0	2.40E-02	64.4	9.0	36.0	390.0	14.0	7.8
	Minimum	5.2	50.8	-180.0	0.1	1.00E-06	2.2	2.0	0.3	100.0	6.9	6.0
T. Veles (No. of wells: 18)	No. of samples	18	16	18	17	9	13	1	10	5	6	8
	Average	43.2	1286.9	-5.3	16.3	1.65E-03	5.9	2.0	5.6	103.7	18.0	7.1
	Maximum	300.0	4000.0	-1.0	65.0	6.00E-03	12.0	2.0	10.0	300.0	31.4	7.8
	Minimum	7.0	66.0	-39.5	1.0	1.20E-05	2.0	2.0	1.1	6.8	10.8	6.5
Shtip (No. of wells: 12)	No. of samples	11	12	9	8	12	8	2	7	6	2	5
	Average	15.3	1301.9	-2.0	32.3	2.26E-03	8.3	5.0	4.5	97.1	14.3	7.3
	Maximum	30.0	5000.0	-1.1	95.0	8.80E-03	11.0	5.0	8.0	318.0	14.5	7.5
	Minimum	9.4	50.8	-3.7	4.2	2.30E-05	5.5	5.0	1.6	31.8	14.0	7.2
Others (No. of wells: 2)	No. of samples	2	2	1	2	1	1	0	1	1	0	1
	Average	14.0	865.0	-3.4	3.5	3.00E-04	5.0	-	12.0	621.9	-	7.2
	Maximum	20.0	1500.0	-3.4	5.4	3.00E-04	5.0	-	12.0	621.9	-	7.2
	Minimum	8.0	230.0	-3.4	1.5	3.00E-04	5.0	-	12.0	621.9	-	7.2
All wells (Total wells: 605)	Total number of samples	579	438	480	415	286	301	60	220	107	206	188
	Average	63.2	484.0	-6.6	18.9	2.33E-03	15.6	3.3	5.8	235.2	15.5	7.2
	Maximum	738.0	5000.0	19.8	921.0	8.80E-02	155.0	9.0	36.0	3140.0	79.0	12.0
	Minimum	2.4	34.0	-282.0	0.1	2.80E-10	0.3	2.0	0.2	5.0	4.5	6.0

Table B.5 **Bacteriological Quality of Drinking Water**

Organisms	Guideline value
All water intended for drinking	
E.coli or thermotolerant coliform bacteria[b,c]	Must not be detectable in any 100-ml sample
Treated water entering the distribution system	
E.coli or thermotolerant coliform bacteria[b]	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system	
E.coli or thermotolerant coliform bacteria[b]	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period

Note:

[a] Immediate investigative action must be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause must be determined by immediate further investigation.

[b] Although *E.coil* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria
is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[c] It is recognized that, in the great majority of rural water supplies in developing counties, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for the progressive improvement of water supplies, as recommended in Volume 3 of *Guidelines for drinking-water quality.*

Table B.6 Chemicals of Health Significance in Drinking Water (1/5)

A. Inorganic constituents

	Guideline value (mg / liter)	Remarks
antimony (Sb)	0.005 (P)[a]	
arsenic (As)	0.01[b] (P)	For excess skin cancer risk of $6x10^{-4}$
barium (Ba)	0.7	
beryllium (Be)		NAD[c]
boron (B)	0.3	
cadmium (Cd)	0.003	
chromium (Cr)	0.05 (P)	
copper (Cu)	2 (P)	ATO[d]
cyanide	0.07	
fluoride (F)	1.5	Climatic conditions, volume of water consumed, and intake from other sources should be considered when setting national standards
lead (Pb)	0.01	It is recognised that not all water will meet the guideline value immediately; meanwhile, all other recommended measures to reduce the total exposure to lead should be implemented
manganese (Mm)	0.5 (P)	ATO
mercury (total) (Hg)	0.001	
molybdenum (Mo)	0.07	
nickel (Ni)	0.02	
nitrate (as NO_3^-)	50	The sum of the ratio of the concetration of each to its respective guideline value should not exceed 1
nitrite (as NO_2^-)	3 (P) }	
selenium (Se)	0.01	
uranium (U)		NAD

[a] (P) - Provisional guideline value. This term is used for constituents for which there is some evidence of a potential hazard but where the available information on health effects is limited; or where an uncertainty factor greater than 1000 has been used in the derivation of the tolerable daily intake (TDI). Provisional guideline values are also recommended: (1) for substances for which the calculated guideline value would be below the practical quantification level, or below the level that can be achieved through practical treatment methods; or (2) where disinfection is likely to result in the guideline value being exceeded.

[b] For substances that are considered to be carcinogenic, the guideline value is the concetration in drinking-water associated with an excess lifetime cancer risk of 10^{-5} (one additional cancer per 100 000 of the population ingesting drinking-water containing the substance at the guideline value for 70 years). Concetrations associated with estimated excess lifetime cancer risks of 10^{-4} and 10^{-6} can be calculated by multiplying and dividing, respectively, the guideline value by 10.

In cases in which the concetration associated with an excess lifetime cancer risk of 10^{-5} is not feasible as a result inadequate analytical or treatment technology, a provisional guideline value is recommended at a practicable level and the estimated associated excess lifetime cancer risk presented.

It should be emphasized that the guideline values for carcinogenic substances have been computed from hypothetical mathematical models that cannot be verified experimentally and that the values should be interpreted differently than TDI-based values because of the lack of precision of the models. At best, these values must be regarded as rough estimates of cancer risk. However, the models used are conservative and probably err on the side of caution. Moderate short-term exposure to levels exceeding the guideline value for cancerogens does not significantly affect the risk.

[c] NAD- No adequate data to permit recommendation of a health-based guideline value.

[d] ATO- Concentrations of the substance at or below the health-based guideline value may affect the appearence, taste, or odour of the water.

Table B.6 Chemicals of Health Significance in Drinking Water (2/5)

B. Organic constituents

	Guideline value (μg / liter)	Remarks
Chlorinated alkanes		
carbon tetra-chloride	2	
di-chloromethane	20	
1,1-di-chloroethane		NAD
1,2-di-chloroethane	30[b]	for excess risk of 10^{-5}
1,1,1-tri-chloroethane	2000 (P)	
Chlorinated ethenes		
vinyl chloride	5[b]	for excess risk of 10^{-5}
1,1-di-chloroethene	30	
1,2-di-chloroethene	50	
tri-chloroethene	70 (P)	
tetra-chloroethene	40	
Aromatic hydrocarbons		
benzene	10[b]	for excess risk of 10^{-5}
toluene	700	ATO
xylenes	500	ATO
ethylbenzene	300	ATO
styrene	20	ATO
benzo[a]pyrene	0.7[b]	for excess risk of 10^{-5}
Chlorinated benzenes		
mono-chlorobenzene	300	ATO
1,2-di-chlorobenzene	1000	ATO
1,3-di-chlorobenzene		NAD
1,4-di-chlorobenzene	300	ATO
tri-chlorobenzenes (total)	20	ATO
Miscellaneous		
di(2-ethylhexyl)adipate	80	
di(2-ethylhexy)phthalate	8	
arcylamide	0.5[b]	for excess risk of 10^{-5}
epichlorohydrin	0.4 (P)	
hexachlorobutadiene	0.6	
edetic acid (EDTA)	200 (P)	
nitrilotriacetic acid	200	
dialkyltins		NAD
tri-butyltin oxide	2	

Table B.6 Chemicals of Health Significance in Drinking Water (3/5)

C. Pesticides

	Guideline value (μg / liter)	Remarks
alachlor	20[b]	for excess risk of 10^{-5}
aldicarb	10	
aldrin / dieldrin	0.03	
atrazine	2	
bentazone	30	
carbofuran	5	
chlordane	0.2	
chlorotoluron	30	
DDT	2	
1,2-dibromo-3-chloropropane	1[b]	for excess risk of 10^{-5}
2,4-D	30	
1,2-dichloropropane	20 (P)	
1,3-dichloropropane		NAD
1,3-dichloropropane	20[b]	for excess risk of 10^{-5}
ethylene dibromide		NAD
heptachlor and heptachlor epoxide	0.03	
hexachlorobenzene	1[b]	for excess risk of 10^{-5}
isoproturon	9	
lindane	2	
MCPA	2	
methoxychlor	20	
metolachlor	10	
molinate	6	
pendimethalin	20	
pentachlorophenol	9 (P)	
permethrin	20	
propanil	20	
pyridate	100	
simazine	2	
trifluralin	20	
chlorophenoxy herbicides other than 2,4-D and MCPA		
2,4-DB	90	
dichlorprop	100	
fenoprop	9	
MCPB		NAD
mecoprop	10	
2,4,5-T	9	

Table B.6 Chemicals of Health Significance in Drinking Water (4/5)

D. Disinfectants and disinfectant by-products

Disinfectants	Guideline value (mg / liter)	Remarks
monochloramine	3	
di- and trichloramine		NAD
chlorine	5	ATO. For effective disinfection there should be a residual concentration of free chlorine of 0.5 mg/liter after at least 30 minutes contact time at pH<8.0
chlorine dioxide		A guideline value has not been established because of the rapid breakdown of chlorine dioxide and because the chlorite guideline value is adequately protective for potential toxicity from chlorine dioxide
iodine		NAD

Disinfectant by-products	Guideline value (mg / liter)	Remarks
bromate	25[b] (P)	for 7×10^{-5} excess risk
chlorate		NAD
chlorite	200 (P)	
chlorophenols		
2-chlorophenol		NAD
2,4-dichlorophenol		NAD
2,4,6-trichlorophenol	200[b]	for excess risk of 10^{-5}, ATO
formaldehyde	900	
MX		NAD
trihalomethanes		The sum of the ratio of the concetration of each to its respective guideline value should not exceed 1
bromoform	100	
dibromochloromethane	100	
bromodichloromethane	60[b]	for excess risk of 10^{-5},
chloroform	200[b]	for excess risk of 10^{-5},
chlorinated acetic acids		
monochloroacetic acid		NAD
dichloroacetic acid	50 (P)	
trichloroacetic acid	100 (P)	
chloral hydrate (trichloroacetaldehyde)	10 (P)	
chloroacetone		NAD

Table B.6 Chemicals of Health Significance in Drinking Water (5/5)

Disinfectant by-products	Guideline value (μg / liter)	Remarks
halogenated acetonitriles		
dichloroacetonitrile	90 (P)	
dibromoacetonitrile	100 (P)	
bromochloroacetonitrile		NAD
trichloroacetonitrile	1 (P)	
cyanogen chloride (as CN)	70	
chloropicrin		NAD

[a] (P) - Provisional guideline value. This term is used for constituents for which there is some evidence of a potential hazard but where the available information on health effects is limited; or where an uncertainty factor greater than 1000 has been used in the derivation of the tolerable daily intake (TDI). Provisional guideline values are also recommended: (1) for substances for which the calculated guideline value would be below the practical quantification level, or below the level that can be achieved through practical treatment methods; or (2) where disinfection is likely to result in the guideline value being exceeded.

[b] For substances that are considered to be carcinogenic, the guideline value is the concetration in drinking-water associated with an excess lifetime cancer risk of 10^{-5} (one additional cancer per 100 000 of the population ingesting drinking-water containing the substance at the guideline value for 70 years). Concetrations associated with estimated excess lifetime cancer risks of 10^{-4} and 10^{-6} can be calculated by multiplying and dividing, respectively, the guideline value by 10.

In cases in which the concetration associated with an excess lifetime cancer risk of 10^{-5} is not feasible as a result inadequate analytical or treatment technology, a provisional guideline value is recommended at a practicable level and the estimated associated excess lifetime cancer risk presented.

It should be emphasized that the guideline values for carcinogenic substances have been computed from hypothetical mathematical models that cannot be verified experimentally and that the values should be interpreted differently than TDI-based values because of the lack of precision of the models. At best, these values must be regarded as rough estimates of cancer risk. However, the models used are conservative and probably err on the side of caution. Moderate short-term exposure to levels exceeding the guideline value for cancerogens does not significantly affect the risk.

[c] NAD- No adequate data to permit recommendation of a health-based guideline value.

[d] ATO- Concentrations of the substance at or below the health-based guideline value may affect the appearence, taste, or odour of the water.

Chemicals not of health significance at concetrations normally found in drinking-water

Chemical	**Remarks**
asbestos	U
silver	U
tin	U

U - It is unnecessary to recomend a health-based guideline value for these compounds because they are not hazardous to human health at concetrations normally found in drinking-water.

Table B.7 Radioactive Constituents of Drinking Water

	Screening value (Bq/liter)	Remarks
gross alpha activity	0.1	If a screening value is exceeded, more detailed radionuclide analysis is necessary. Higher values do not necessarily imply that the water is unsuitable for human consumption
gross beta activity	1	

Table B.8 **Substances and Parameters in Drinking Water That May Give Rise to Complaints from Consumers (1/2).**

	Levels	Reasons for consumer complaints
Physical parameters		
colour	15 TCU[b]	appearance
taste and odour	-	should be acceptable
temperature	-	should be acceptable
turbidity	5 NTU[c]	appearance; for effective terminal disinfection, median turbidity 1 NTU, single sample 5 NTU
Inorganic constituents		
aluminium (Al)	0.2 mg/l	depositions, discoloration
ammonia (NH_4)	1.5 mg/l	odour and taste
chloride (Cl_2)	250 mg/l	taste, corrosion
copper (Cu)	1 mg/l	staining of laundry and sanitary ware (health-based provisional guideline value 2 mg/liter)
hardness	-	high hardness: scale deposition, scum formation low hardness: possible corrosion
hydrogen sulfide (H_2S)	0.05 mg/l	odour and taste
iron (Fe)	0.3 mg/l	staining of laundry and sanitary ware
manganese (Mn)	0.1 mg/l	staining of laundry and sanitary ware (health-based provisional guideline value 0.5 mg/liter)
dissolved oxygen (O_2)	-	indirect effects
pH	-	low pH: corrosion high pH: taste, soapy feel preferably <8.0 for effective disinfection with chlorine
sodium (Na)	200 mg/l	taste
sulfayte (SO_4)	250 mg/l	taste, corrosion
total dissolved solids	1000 mg/l	taste
zinc (Zn)	3 mg/l	appearance, taste
Organic constituents		
toluene	24-170 µg/l	odour, taste (health-based guideline value 700 µg/l)
xylene	20-1800 µg/l	odour, taste (health-based guideline value 500 µg/l)
ethylbenzene	2-200 µg/l	odour, taste (health-based guideline value 300 µg/l)
styrene	4-2600 µg/l	odour, taste (health-based guideline value 20 µg/l)

Table B.8 Substances and Parameters in Drinking Water That May Give Rise to Complaints from Consumers (2/2)

	Levels	Reasons for consumer complaints
monochlorobenzene	10-120 μg/l	odour, taste (health-based guideline value 300 μg/l)
1,2-dichlorobenzene	1-10 μg/l	odour, taste (health-based guideline value 1000 μg/l)
1,4-dichlorobenzene	0.3-30 μg/l	odour, taste (health-based guideline value 300 μg/l)
trichlorobenzenes (total)	5-50 μg/l	odour, taste (health-based guideline value 20 μg/l)
synthetic detergents	-	foaming, taste, odour
Disinfectants and disinfectant by-products		
chlorine	600-1000 μg/l	taste and odour (health-based guidelin value 5 mg/l)
chlorophenols		
2-chlorophenol	0.1-10 μg/l	taste, odour
2,4-dichlorophenol	0.3-40 μg/l	taste, odour
2,4,6-trichlorophenol	2-300 μg/l	taste, odour (health-based guideline value 200 μg/l)

note:

[a] The levels indicated are not precise numbers. Problems may occur at lower or higher values according to local circumstances. A range of taste and odour treshold concetrations is given for organic constituents.

[b] TCU, time colour unit

[c] NTU, nephelometric turbidity unit

Table B.9 Guidelines for Irrigation Water

Potential Irrigation Problem	Units	Degree of Restriction on Use: None	Slight to Moderate	Severe
Salinity *(affects crop water* availability)[a]				
EC_w	dS/m	< 0.7	0.7 - 3.0	> 3.0
(or)				
TDS	mg/l	< 450	450 - 2000	> 2000
Infiltration *(affects infiltration rate of water into the soil)*				
SAR = 0 - 3 and **EC_w** =		> 0.7	0.7 - 0.2	< 0.2
SAR = 3 - 6 and **EC_w** =		> 1.2	1.2 - 0.3	< 0.3
SAR = 6 - 12 and **EC_w** =		> 1.9	1.9 - 0.5	< 0.5
SAR = 12 - 20 and **EC_w** =		> 2.9	2.9 - 1.3	< 1.3
SAR = 20 - 40 and **EC_w** =		> 5.0	5.0 - 2.9	< 2.9
Specific Ion Toxicity *(affects sensitive crops)*				
Sodium (Na)[c]				
surface irrigation	SAR	< 3	3.0 - 9.0	> 9
sprinkler irrigation	me/l	< 3	> 3	
Chloride (Cl)[c]				
surface irrigation	me/l	< 4	4.0 - 10.0	> 10
sprinkler irrigation	me/l	< 3	> 3	
Boron (B)[d]	mg/l	< 0.7	0.7 - 3.0	> 3.0
Trace Elements (see Table 21)				
Miscellaneous Effects *(affects susceptible crops)*				
Nitrogen (NO_3 - N)[e]	mg/l	< 5	5.0 - 30.0	> 30
Bicarbonate (HCO_3)				
(overhead sprinkling only)	me/l	< 1.5	1.5 - 8.5	> 8.5
pH		Normal Range : 6.5 - 8.4		

[a] EC_w means electrical conductivity, a measure of the water salinity, reported in deciSiemens per meter at 25 C (dS/m) or in units millimhos per centimetre (mmho/cm). Both are equivalent. TDS means total dissolved solids, reported in milligrams per liter (mg/l).

[b] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RN_a. See figure 1 for the SAR calculation procedure. At a given SAR, infiltration rate increases as water salinity increases. Evaluate the potential infiltration problem by SAR as modified by EC_w. Adapted from Rhoades 1977, and Oster and Schroer 1979.

[c] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride; use the values shown. Most annual crops are not sensitive; use the salinity tolerance tables (Tables 4 and 5). For chloride tolerance of selected fruit crops, see Table 14. With overhead sprinkler irrigation and low humidity (< 30 percent), sodium and chloride may be absorbed through the leaves of sensitive crops. For crop sensitivity to absorption, see Tables 18, 19 and 20.

[d] For boron tolerances, see Table 16 and 17.

[e] NO_3 -N means nitrate nitrogen reported in terms of elemental nitrogen (NH_4 -N and Organic-N should be included when wastewater is being tested).

Table B.10 Laboratory Determinations of Irrigation Water

Water parameter	Symbol	Unit [a]	Usual range in irrigation water
SALINITY			
Salt Content			
Electrical Conductivity	EC_w	dS/m	0 - 3 dS/m
(or)			
Total Dissolved Solids	TDS	mg/l	0 - 2000mg/l
Cations and Anions			
Calcium	Ca^{++}	me/l	0 - 20 me/l
Magnesium	Mg^{++}	me/l	0 - 5 me/l
Sodium	Na^{+}	me/l	0 - 40 me/l
Carbonate	CO_3^{--}	me/l	0 - 1 me/l
Bicarbonate	HCO_3^{-}	me/l	0 - 10 me/l
Chloride	Cl^{-}	me/l	0 - 30 me/l
Sulphate	SO_4^{--}	me/l	0 - 20 me/l
NUTRIENTS[b]			
Nitrate-Nitrogen	NO_3-N	mg/l	0 - 10 mg/l
Ammonium-Nitrogen	NH_4-N	mg/l	0 - 5 mg/l
Phosphate-Phosphorus	PO_4-P	mg/l	0 - 2 mg/l
Pottasium	K^{+}	mg/l	0 - 2 mg/l
MISCELLANEOUS			
Boron	B	mg/l	0 - 2 mg/l
Acid/Basicity	pH	1.0-14.0	6.0 - 8.5
Sodium Adsorption Ratio[c]	SAR	$(me/l)^{1,2}$	0 - 15

Note: [a] dS / m = deciSiemen / meter in S.I. units (equivalent to 1 mmho / cm = 1 millimmho / centimeter)
mg / l = milligram per liter ≅ parts per million (ppm).
me / l = milliequivalent per liter (mg / l equivalent weight = me / l); in SI units, 1 me / l = millimol / liter adjusted for electron charge.

[b] NO_3 -N means the laboratory will analyse for NO_3 but will report the NO_3 in terms of chemically equivalent nitrogen. Similarly, for NH_4 -N, the laboratory will analyse for NH_4 but report in terms of chemically equivalent elemental nitrogen. The total nitrogen available to the plant will be the sum of the equivalent elemental nitrogen. The same reporting method is used for phosphorus.

[c] SAR is calculated from the Na, Ca and Mg reported in me / l.

Table B.11 Geo-Chemical Characteristics (Groundwater Quality Survey(1)) (1/2)

N°	Sampling well	River basin /Valley	Geologic time	Geology of aquifer	Geo-chemical type
A1	Well Gas station Tetovo	Polog	Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A2	Well Miletino village		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A3	Well Fer{ped Tetovo		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A4	Borehole Raotince village		Neogene	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A5	Borehole Jegunovce village		Alluvial	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
A6	Borehole OHIS Gostivar		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A7	Well Piskupstina	Debar	Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A8	Well exit Kicevo-Ohrid	Treska	Pliocene	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A9	Well St. Naum	Ohrid	Triassic	Limestone	Calicium-Bicarbonate ($Ca-HCO_3$)
A10	Well in factory "Bratstvo" Ohrid		Quaternary	Sand	Calicium-Bicarbonate ($Ca-HCO_3$)
A11	Drillhole (artesian) Struga		Quaternary	Sand	Calicium-Bicarbonate ($Ca-HCO_3$)
A12	Well Asamati village	Prespa	Pliocene	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A13	Well Carev Dvor village		Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A14	Well Krusje village		Triassic	Limestone	Calicium-Bicarbonate ($Ca-HCO_3$)
A15	Well Sopotnica village	Pelagonija	Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A16	Well Bucin village		Pliocene	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A17	Drillhole (artesian) Kruseani village		Pliocene	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A18	Well "Pivara" Prilep		Pliocene	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A19	Well Aglarci village		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A20	Well "Kvasara" Bitola		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A21	Drillhole (artesian) Egri village		Pliocene	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A22	Drillhole near the Bardovci hospital	Skopje	Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A23	Drillhole Volkovo village		Pleistocene	Sands & gravels	Sodium-Bicarbonate ($Na-HCO_3$)
A24	Drillhole Saraj village		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A25	Well Pobozje		Proluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A26	Well "Kozara"		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
B1G	Dug well, Zelenikovo		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
B2G	Drilled well, Makedonijapat		Neogene	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A27	Radial wells Veles	Veles	Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A28	~~Well in the factory "Porcelanka" Veles~~		Alluvial	Sands & gravels	Sodium-Bicarbonate ($Na-HCO_3$)
B3G	HIV-Veles spring		Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
B4G	Well - Gradsko		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A29	Drillhole Negorci health spa	Gevgelija	Proluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A30	Well Gevgelija		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)
A31	Well Toplec Nov Dojran		Neogene	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A32	Well Chelopek village	Pcinja	Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A33	Well Ginovci village		Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A34	Well Dragomance village		Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A35	Well Pcinja village		Diluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A36	Well Sredno Konjare village		Alluvial	Sands & gravels	Calicium-Bicarbonate ($Ca-HCO_3$)
A37	Well Katlanovo village		Alluvial	Gravels & sands	Calicium-Bicarbonate ($Ca-HCO_3$)

Table B.11 Geo-Chemical Characteristics (Groundwater Quality Survey(1)) (2/2)

N°	Sampling well	River basin /Valley	Geologic time	Geology of aquifer	Geo-chemical type
A38	Well Trboteviste village	Bregalnica	Alluvial	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
A39	Well Delchevo		Alluvial	Gravels & sands	
A40	Well Alkaloid Berovo		Pliocene	Sands & gravels	Sodium-Bicarbonate (Na-HCO_3)
A41	Well Star Bunar, Berovo		Alluvial	Sands & gravels	Calicium-Bicarbonate (Ca-HCO_3)
A42	Well Osojnica village, Vinica		Alluvial	Sands & gravels	Calicium-Bicarbonate (Ca-HCO_3)
A43	Well Burilcevo village		Proluvial	Sands & gravels	Calicium-Bicarbonate (Ca-HCO_3)
A44	Well Ratavica village		Alluvial	Sands & gravels	Calicium-Bicarbonate (Ca-HCO_3)
A45	Well meat industry Sveti Nikole		Alluvial	Gravels & sands	Sodium-Bicarbonate (Na-HCO_3)
A46	Well Lakavica village		Alluvial	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
B5G	Well Grdovski Orman, Kocani		Alluvial	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
B6G	Well, Shtip		Alluvial	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
A47	Well plumbing Radovis	Strumica	Neogene	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
A48	Well Edrenikovo village		Neogene	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
A49	Well Susica village		Neogene	Gravels & sands	Sodium-Bicarbonate (Na-HCO_3)
A50	Drillhole Monospitovo village		Neogene	Gravels & sands	Calicium-Bicarbonate (Ca-HCO_3)
A51	Spring Vrutok village	Polog			Calicium-Bicarbonate (Ca-HCO_3)
A52	Spring Cegrane village				Calicium-Bicarbonate (Ca-HCO_3)
A53	Spring Proshevacka Jurija				Sodium-Bicarbonate (Na-HCO_3)
A54	Spring St. Jovan Bigorski	Debar			Calicium-Bicarbonate (Ca-HCO_3)
A55	Spring Gorna Belica village	Treska			Calicium-Bicarbonate (Ca-HCO_3)
A56	Spring Studencica				Calicium-Bicarbonate (Ca-HCO_3)
A57	Spring at Treska river				Calicium-Bicarbonate (Ca-HCO_3)
A58	Spring Crn Drim river St. Naum	Ohrid			Calicium-Bicarbonate (Ca-HCO_3)
A59	Spring Sum Vevcani village				Calicium-Bicarbonate (Ca-HCO_3)
A60	Spring at Brajcinska river	Prespa			Calicium-Bicarbonate (Ca-HCO_3)
A61	Spring Krusje village				Sodium-Bicarbonate (Na-HCO_3)
A62	Spring Zrze village	Pelagonija			Sodium-Bicarbonate (Na-HCO_3)
A63	Spring Nebregovo village				Calicium-Bicarbonate (Ca-HCO_3)
A64	Spring at Crna river Zeleznec village				Calicium-Bicarbonate (Ca-HCO_3)
A65	Spring Drenovo village				Sodium-Bicarbonate (Na-HCO_3)
A66	Spring St. Petka Crnice village	Skopje			Calicium-Bicarbonate (Ca-HCO_3)
A67	Spring Rasce				Calicium-Bicarbonate (Ca-HCO_3)
A68	Spring Brodec village				Calicium-Bicarbonate (Ca-HCO_3)
A69	Spring at Lisice village	Veles			Sodium-Bicarbonate (Na-HCO_3)
A70	Spring at Sermeninska river	Gevgelija			Calicium-Bicarbonate (Ca-HCO3)
A71	Spring Nikuljane village	Pcinja			Calicium-Bicarbonate (Ca-HCO_3)
A72	Spring Zidilovo village				Calicium-Bicarbonate (Ca-HCO_3)
A73	Spring Kundino village				Calicium-Bicarbonate (Ca-HCO_3)
A74	Spring				
A75	Spring Suslevica, Berovo	Bregalnica			Calicium-Bicarbonate (Ca-HCO_3)
A76	Spring Studenko, Istevnik village				Calicium-Bicarbonate (Ca-HCO_3)
A77	Spring Suvi Laki	Strumica			Sodium-Bicarbonate (Na-HCO_3)
A78	Spring Studenec Dvoriste village				Calicium-Bicarbonate (Ca-HCO_3)

* No analysis : A39 & A74

Table B.12 Summary of Data Analysed (Groundwater Quality Survey(1)) (1/3)

N°	Sampling well	River basin / Valley	t	Ec	pH	$HCO_3 + CO_3$	Cl	SO_4	K	Mn	Na	Ca	Mg	NO_3	NO_2	Fe	Cu	SiO_2	NH_3	F	Hardness
			oC	μS/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
A1	Well Gas station	Polog	-	352.7	7.49	213.5	7.0	7.8	7.8	0.005	13.8	62.8	2.32	2.26	0.0	0.054	0.024	108.5	0.0	0.09	10.1
A2	Well Miletino village	Polog	11.5	678.8	7.19	384.3	26.0	17.3	17.1	0.004	43.1	123.2	6.92	13.6	0.076	0.035	0.023	194.5	0.0	0.10	18.1
A3	Well Fer{ped Tetovo	Polog	6.98	414.8	7.50	250.1	11.0	17.9	11.4	0.014	21.0	70.2	16.1	4.97	0.0	0.050	0.016	123.6	0.0	0.09	13.5
A4	Borehole Raotince	Polog	11.3	750.5	7.08	530.7	14.0	30.9	17.4	0.005	25.3	152.9	14.7	0.90	0.0	0.109	0.007	276.3	0.0	0.20	25.7
A5	Borehole Jegunovce village	Polog	11.2	270.7	6.74	146.4	7.0	12.8	39.4	0.003	69.2	31.6	15.4	1.36	0.0	0.027	0.005	87.07	0.0	0.10	8.1
A6	Borehole OHIS	Polog	10.3	268.3	6.65	153.0	8.0	25.6	7.6	0.002	8.9	50.7	9.2	2.26	0.0	0.019	0.015	98.9	0.0	0.10	9.2
A7	Well Piskupstina	Debar	5.2	355.4	7.43	280.6	8	14.3	16.4	0.076	41.6	72.9	6.44	0	0	0.214	0.033	141.9	0.08	0.1	13.2
A8	Well exit Kicevo-	Treska	10	196.5	7.28	85	10	12.6	9.32	0.003	11.4	17	4.1	4.07	0.001	0.019	0.013	44.07	0	0.1	3.9
A9	Well St. Naum	Ohrid	10.3	260.7	7.8	183.0	0.0	4.5	3.9	0.003	18.9	46.8	6.9	0.0	0.0	0.017	0.014	93.52	0.0	0.10	8.7
A10	Well in factory	Ohrid	12.6	489.7	6.9	105.0	15.5	30.7	6.8	0.004	8.0	107.6	11.7	4.97	0.0	0.027	0.018	190.27	0.0	0.10	17.7
A11	Drillhole (artesian)	Ohrid	12.5	281.9	6.95	95.0	8.0	2.6	5.2	0.088	3.3	51.9	13.1	0.0	0.0	0.066	0.015	110.72	0.24	0.10	10.3
A12	Well Asamati village	Prespa	11.7	414.7	6.87	115.9	20	19.2	16	0.007	10.2	39.4	15.6	11.3	0	0.031	0.013	100.1	0	0.1	9.31
A13	Well Carev Dvor	Prespa	11.2	264.5	7.65	134.2	12	18.6	6	0.012	13.5	49.2	8.1	1.36	0	0.081	0.011	93.53	0	0.1	8.7
A14	Well Krusje village	Prespa	9	295.7	7.38	183	13	7.06	50.3	0.005	20.4	44.9	9.7	4.07	0	0.177	0.003	96.75	0	0.1	9
A15	Well Sopotnica village	Crna	10.6	416.6	7.50	268.4	10.0	18.6	15.2	0.006	23.4	82.3	3.9	1.36	0.0	0.025	0.014	138.6	0.0	0.10	12.9
A16	Well Bucin village	Crna	10	156.0	7.2	54.9	10.0	14.74	9.3	0.018	15.3	15.2	7.8	1.36	0.0	1009.0	0.007	41.92	0.0	0.40	3.9
A17	Drillhole (artesian) Kruseani village	Crna	16.4	544.2	7.48	305.0	44.0	12.8	28.0	0.477	13.0	56.2	29.7	0.0	0.0	0.296	0.013	58.0	0.0	0.10	14.7
A18	Well "Pivara" Prilep	Crna	13.6	534.5	7.2	237.9	30.0	24.3	14.9	0.006	43.5	64.4	16.1	11.3	0.0	0.02	0.014	136.5	0.0	0.10	12.7
A19	Well Aglarci village	Crna	10	669.5	7.53	298.9	30.0	57.6	7.8	0.059	12.9	85.8	28.8	13.6	0.0	0.046	0.012	199.9	0.0	0.70	18.6
A20	Well "Kvasara" Bitola	Crna	16.1	390.2	7.28	219.6	14.0	43.5	10.0	0.332	34.2	51.5	7.6	1.36	0.0	0.035	0.01	153.7	0.0	0.50	14.3
A21	Drillhole (artesian)	Crna	15	2075.0	6.08	1330.0	90.0	233.9	21.68	0.632	97.8	353.0	92.0	0.0	0.0	1924.0	0.012	903.0	0.0	1.1	84.0
A22	Drillhole near the Bardovci hospital	Skopje	10.4	538.8	6.78	366.0	15.0	42.3	36.1	0.006	38.7	99.5	11.84	5.38	0.0	0.041	0.005	184.9	0.0	0.10	17.2
A23	Drillhole Volkovo	Skopje	9	435.4	6.98	354.0	15.0	28.2	36.6	0.010	44.5	29.6	28.9	2.26	0.0	0.158	0.005	189.2	0.0	0.10	17.6
A24	Drillhole Saraj village	Skopje	11.1	1159.7	7.05	573.4	68.0	18.6	157.1	0.006	159.2	206.7	25.3	13.6	0.0	0.170	0.019	371.95	0.0	0.09	34.6
A25	Well Pobozje	Skopje	12.4	565.4	7.74	336.0	14.0	46.8	2.1	0.006	8.8	44.1	17.7	1.36	0.0	0.107	0.022	130.07	0.0	0.10	16.1
A26	Well "Kozara"	Skopje	12.7	535.5	6.42	317.2	17.0	20.5	19.3	0.014	25.5	79.2	28.8	4.07	0.002	0.049	0.006	190.27	0.0	0.30	17.7
A27	Radial wells Veles	Veles	12	643.5	7.12	311	47	30.7	4.68	0.031	13.67	88.1	12.4	5.88	0	0.746	0.025	162.3	0	0.3	15.1
A28	Well in the factory "Porcelanka" Veles	Veles	10.8	275.4	7.12	134.2	17	23.1	26	0.29	59.7	42.5	5.52	0	0	0.047	0.021	77.4	0	0.2	7.2
A29	Drillhole Negorci	Gevgelija	42	773.8	7.63	488	59	282.9	5.6	0.006	14.72	27.3	1.32	0	0	0.017	0.013	40.85	0	1.2	3.8

Table B.12　　Summary of Data Analysed (Groundwater Quality Survey(1)) (2/3)

N°	Sampling well	River basin / Valley	t	Ec	pH	$HCO_3 + CO_3$	Cl	SO_4	K	Mn	Na	Ca	Mg	NO_3	NO_2	Fe	Cu	SiO_2	NH_3	F	Hardness
			oC	μ S/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
A30	Well Gevgelija	Gevgelija	12.1	513.5	6.62	292.8	8	30.7	18.7	0.02	41.8	57.5	33.4	0	0	0.022	0.015	169.9	0	0.1	15.8
A31	Well Toplec Nov	Gevgelija	15.9	669	6.8	281	25	113.3	3.5	0.005	39.6	91.7	18.4	0	0	0.031	0.016	183.8	0	0.1	17.1
A32	Well Chelopek village	Pcinja	7.5	380.0	6.57	232.0	13.0	33.9	2.89	0.063	1.8	55.8	34.5	1.36	0.0	0.053	0.02	169.8	0.0	0.10	15.8
A33	Well Ginovci village	Pcinja	9.5	412.5	6.90	189.1	16.0	54.4	28.0	0.011	39.0	55.8	25.5	0.0	0.0	0.028	0.009	147.27	0.0	0.20	13.7
A34	Well Dragomance	Pcinja		754.1	6.85	268.4	43.0	109.5	18.02	0.023	6.42	92.4	40.9	1.36	0.0	0.036	0.006	240.8	0.0	0.40	22.4
A35	Well Pcinja village	Pcinja	10.9	995.8	6.40	366.0	65.0	151.7	50.313	0.004	6.68	154.1	2.0	13.60	0.0	0.049	0.006	232.2	0.0	0.10	21.6
A36	Well Sredno Konjare village	Pcinja	12.5	1396.0	6.72	390	55.0	140.2	47.2	0.005	9.38	264.1	8.5	13.60	0.0	0.042	0.010	414.95	0.0	0.10	38.6
A37	Well Katlanovo village	Pcinja	10.9	1043.6	7.20	610.0	5.0	146.6	12.4	0.005	25.8	191.1	35.9	5.88	0.0	0.051	0.0	373.03	0.0	0.10	34.7
A38	Well Trboteviste	Bregalnica	12.7	600.5	6.40	335.5	15.0	68.5	1.93	0.007	6.34	85.4	30.2	3.16	0.0	0.051	0.012	203.1	0.0	0.20	18.9
A40	Well Alkaloid Berovo	Bregalnica	13.4	509.5	6.93	231.8	35.0	37.8	39.2	0.235	63.5	55.8	1.98	1.36	0.0	0.132	0.011	133.3	0.8	0.10	12.4
A41	Well Star Bunar,	Bregalnica	5.1	120.4	6.50	427.0	9.0	11.5	9.4	0.007	7.33	141	26.2	0.0	0.0	0.066	0.016	87.0	0.0	0.10	8.1
A42	Well Osojnica village,	Bregalnica	6.8	232.5	7.04	103.7	11.0	19.9	22.8	0.004	27.9	28.9	9.7	1.36	0.0	0.036	0.008	63.72	0.0	0.20	6.3
A43	Well Burilcevo village	Bregalnica	13	1533	7.34	567.3	77.0	266.3	104.8	0.005	102.2	269.9	3.9	13.63	0.0	0.04	0.008	368.7	0.0	2.15	34.3
A44	Well Ratavica village	Bregalnica	8	374.9	6.93	109.8	10.0	94.1	31.3	0.013	27.2	51.9	10.1	1.36	0.0	0.049	0.012	103.3	0.0	0.10	9.61
A45	Well meat industry Sveti Nikole	Bregalnica	156.9	973.9	7.56	397.0	35.0	203.5	119.5	0.006	106.3	62.8	66.5	11.36	0.0	0.037	0.012	203.1	0.0	0.40	18.9
A46	Well Lakavica village	Bregalnica	8.4	1089.	7.35	348	38.0	373.1	96.6	0.021	75.7	140.8	5.6	1.36	0.0	0.023	0.008	194.5	0.0	0.50	18.1
A47	Well plumbing	Strumica	13	632.1	7.38	117.2	40.0	21.1	55.9	0.005	63.0	103.1	2.8	5.81	0.0	0.031	0.007	160.2	0.0	0.20	14.9
A48	Well Edrenikovo	Strumica	13.7	1182.0	7.06	543.0	86.0	101.1	80.0	0.005	82.7	159.1	1.38	13.60	0.0	0.037	0.007	292.4	0.0	0.10	27.2
A49	Well Susica village	Strumica	16	294.5	6.95	128.1	14.0	37.8	36.8	0.008	77.0	23.1	0.5	2.26	0.0	0.038	0.005	65.57	0.0	0.10	6.1
A50	Drillhole Monospitovo village	Strumica	4.6	236.5	7.36	152.5	9.0	2.68	1.74	0.107	4.83	22.6	6.2	0.0	0.0	0.689	0.006	88.15	0.35	0.20	8.2
A51	Spring Vrutok village	Polog	9.2	202.7	7.09	134.2	6.0	3.65	2.5	0.004	5.8	35.1	3.45	1.36	0.0	0.061	0.025	72.03	0.0	0.09	6.7
A52	Spring Cegrane village	Polog	10.8	312.6	7.46	219.6	4.0	4.8	2.31	0.003	2.10	43.7	7.6	1.36	0.0	0.029	0.019	120.4	0.0	0.09	11.2
A53	Spring Proshevacka	Polog	11.1	136.7	6.94	73.2	6.0	7.7	37.15	0.003	78.1	18.7	11.5	1.36	0.0	0.028	0.0	56.97	0.0	0.10	5.3
A54	Spring St. Jovan	Debar	10.5	336.6	7.53	244	5	3.9	7.5	0.003	6.8	59.3	6.4	0	0	0.029	0.014	98.9	0	0.1	11.7
A55	Spring Gorna Belica village	Treska	8.8	237.9	7.12	225.7	5	7.7	5.3	0.008	19.3	60.5	8.1	0	0	0.058	0.018	117.2	0	0.1	10.9
A56	Spring Studencica	Treska	7.3	190.3	7.08	134.2	7	7.7	2.1	0.002	2.7	19.2	12	0	0	0.015	0.013	89.2	0	0.1	8.3
A57	Spring at Treska river	Treska	10.8	350	7.64	237.9	15	5.8	9.85	0.002	11.2	17.5	5.8	0	0	0.025	0.015	120.4	0	0.1	11.2
A58	Spring Crn Drim river	Ohrid	8.5	270.4	6.7	176.9	5.0	3.2	2.2	0.003	4.6	56.2	5.29	4.97	0.0	0.023	0.012	97.82	0.0	0.10	9.1

Table B.12 Summary of Data Analysed (Groundwater Quality Survey(1)) (3/3)

N°	Sampling well	River basin / Valley	t	Ec	pH	$HCO_3 + CO_3$	Cl	SO_4	K	Mn	Na	Ca	Mg	NO_3	NO_2	Fe	Cu	SiO_2	NH_3	F	Hardness
			oC	μS/cm		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
A59	Spring Sum Vevcani village	Ohrid	8.4	201.8	6.99	378.2	5.0	4.1	7.1	0.042	3.37	19.6	3.9	0.0	0.0	0.02	0.012	60.2	0.0	0.10	5.6
A60	Spring at Brajcinska	Prespa	9.12	88.45	7.09	42.7	6	3.9	5.4	0.01	5.92	8.2	7.8	0	0	0.086	0.01	33.33	0	0.1	3.1
A61	Spring Krusje village	Prespa	9.6	390.4	7.36	256.2	12	6.4	5.4	0.031	56.8	21.7	22.8	0	0	0.252	0.013	132.3	0	0.1	12.3
A62	Spring Zrze village	Crna	8.7	390.4	7.46	256.2	12	6.4	5.4	0.031	56.8	21.7	22.8	0.0	0.0	0.253	0.013	145.1	0.0	0.10	12.3
A63	Spring Nebregovo	Crna	9.5	179.4	7.21	97.6	6.0	17.9	10.5	0.025	6.0	23.4	17.1	0.0	0.0	0.321	0.01	78.5	0.0	0.10	7.31
A64	Spring at Crna river	Crna	11.2	364.1	7.05	244.0	7.0	3.9	9.8	0.006	16.7	67.5	11.5	1.36	0.0	0.025	0.011	127.9	0.0	0.10	11.9
A65	Spring Drenovo	Crna	7.9	498.0	7.12	323.3	6.0	13.5	3.1	0.007	79.8	71.0	12.8	1.36	0.0	0.028	0.011	170.9	0.0	0.10	15.9
A66	Spring St. Petka Crnice	Skopje	13.3	690.4	6.87	433.1	20.0	30.7	4.37	0.006	5.81	75.3	40.6	9.04	0.0	0.03	0.005	221.45	0.0	0.10	20.6
A67	Spring Rasce	Skopje	13	533.3	7.20	372.1	8.0	16.6	10.92	0.001	9.95	108.8	9.8	1.36	0.0	0.022	0.019	192.4	0.0	0.10	17.9
A68	Spring Brodec village	Skopje	7.1	176.6	7.90	110	6.0	10.3	14.43	0.002	16.10	33.9	4.83	0.0	0.0	0.025	0.021	62.35	0.0	0.10	5.8
A69	Spring at Lisice village	Veles	10	146.1	7.02	67.1	10	42.9	26.8	0.04	23.7	21.8	2.53	11.3	0	0.11	0.022	39.78	0	0.1	7.3
A70	Spring at Sermeninska	Gevgelija	10.1	463.1	6.8	237.9	5	10.9	2.9	0.006	2.6	25.4	30	13.6	0	0.082	0.015	120.4	0	0.3	11.2
A71	Spring Nikuljane	Pcinja	14.5	396.6	7.38	244.0	7.0	49.3	14.2	0.002	9.80	66.3	19.6	2.26	0.0	0.032	0.001	147.28	0.0	0.09	13.7
A72	Spring Zidilovo village	Pcinja	6.9	361.9	7.12	275.0	6.0	16.7	32.5	0.032	57.8	51.5	29.9	0.0	0.0	0.029	0.003	152.65	0.0	0.10	14.2
A73	Spring Kundino	Pcinja	13.4	902.4	6.90	213.5	60.0	94.1	76.0	0.009	10.4	120.9	23.5	13.60	0.0	0.034	0.015	239.73	0.0	0.20	22.3
A75	Spring Suslevica,	Bregalnica	0.8	309.4	6.25	164.7	16.0	18.6	3.0	0.027	13.7	35.1	1.64	0.0	0.0	0.201	0.014	92.4	0.0	0.10	8.6
A76	Spring Studenko, Istevnik village	Bregalnica	10.5	308.2	6.72	122.0	10.0	34.6	2.2	0.009	8.0	36.7	25.7	1.36	0.0	0.096	0.013	112.8	0.0	0.40	10.5
A77	Spring Suvi Laki	Strumica	7.6	102.69	6.74	42.7	10.0	9.0	19.9	0.003	18.9	11.7	6.4	1.36	0.0	0.038	0.009	39.78	0.0	1.0	3.7
A78	Spring Studenec Dvoriste village	Strumica	5.0	120.4	7.38	42.7	11.0	14.9	10.3	0.029	17.3	19.1	5.1	0.0	0.0	0.248	0.005	40.9	0.0	0.10	3.83
B1G	Dug well, Zelenikovo	Skopje	-	-	6.95	365.9	29	33.9	5.19	0.005	6.51	23.1	37.7	1.36	0	0.139	-	-	0	0.1	-
B2G	Drilled well,	Skopje	-	-	6.72	561.1	188	191.4	68.9	0.011	95.1	274.6	1.4	1.36	0	0.042	-	-	0	0.5	-
B3G	HIV-Veles spring	Veles	14	483	7.27	262.3	19	10.9	11.99	0.01	5.78	6.44	18.2	0	0.001	0.034	0.014	-	0.58	0.2	13.2
B4G	Well - Gradsko	Veles	13.5	1196	6.5	579.5	60	119.7	4.79	0.092	12.31	10.42	65.1	0	0.012	0.029	0.019	-	0.063	0.5	29.7
B5G	Well Grdovski Orman,	Bregalnica	13.6	533.3	7.06	262.3	17	44.2	59.6	0.007	52.2	68.3	25.8	0.0	0.0	0.036	0.006	-	0.0	0.3	15.5
B6G	Well, Shtip	Bregalnica	8.6	480.9	7.45	195.2	15	65.3	5.96	0.133	5.65	55.4	32.5	1.36	0.02	0.071	0.007	-	0.0	0.3	12.2

* No analyses of A39 & A74

Table B.13 Classification of Irrigation Water Based on Sar and Conductivity (Groundwater Quality Survey(1)) (1/3)

N°	Sampling well	River basin/Valley	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	SAR = Na/SQRT((Ca+Mg)/2)	(Ca+Mg)	(pK$_2$'-pKc')	p(Ca+Mg)	(CO_3+HCO_3)	(CO_3+HCO_3)	p(Alk)	Adjusted SAR	Electrical Conductivity	Classification of irrigation water
			(mg/l)	(mg/l)	(mg/l)	(epm)	(epm)	(epm)		(epm)			(mg/l)	(epm)			(μ S/cm)	
A1	Well Gas station Tetovo	Polog	13.80	62.80	2.32	0.600	3.134	0.191	0.466	3.324	2.20	2.80	213.50	3.501	2.45	0.91	352.70	C2-S1
A2	Well Miletino village	Polog	43.10	123.20	6.92	1.875	6.148	0.569	1.023	6.717	2.23	2.47	384.30	6.303	2.11	2.65	678.80	C2-S1
A3	Well Fer{ped Tetovo	Polog	21.00	70.20	16.10	0.914	3.503	1.323	0.588	4.826	2.20	2.60	250.10	4.102	2.4	1.29	414.80	C2-S1
A4	Borehole Raotince village	Polog	25.30	152.90	14.70	1.101	7.630	1.208	0.524	8.838	2.30	2.35	530.70	8.703	2.06	1.41	750.50	C3-S1
A5	Borehole Jegunovce village	Polog	69.20	31.60	15.40	3.010	1.577	1.266	2.525	2.843	2.20	2.80	146.40	2.401	2.6	4.54	270.70	C2-S1
A6	Borehole OHIS Gostivar	Polog	8.90	50.70	9.20	0.387	2.530	0.756	0.302	3.286	2.20	2.80	153.00	2.509	2.6	0.54	268.30	C2-S1
A7	Well Piskupstina	Debar	41.60	72.90	6.44	1.810	3.638	0.529	1.254	4.167	2.20	2.70	280.60	4.602	2.34	2.71	355.40	C2-S1
A8	Well exit Kicevo-Ohrid	Treska	11.40	17.00	4.10	0.496	0.848	0.337	0.644	1.185	2.10	3.30	85.00	1.394	2.8	0.77	196.50	C1-S1
A9	Well St. Naum	Ohrid	18.90	46.80	6.90	0.822	2.335	0.567	0.682	2.903	2.20	2.80	183.00	3.001	2.5	1.30	260.70	C2-S1
A10	Well in factory "Bratstvo" Ohrid	Ohrid	8.00	107.60	11.70	0.348	5.369	0.962	0.196	6.331	2.20	2.50	105.00	1.722	2.75	0.38	489.70	C2-S1
A11	Drillhole (artesian) Struga	Ohrid	3.30	51.90	13.10	0.144	2.590	1.077	0.106	3.667	2.20	2.73	95.00	1.558	2.8	0.18	281.90	C2-S1
A12	Well Asamati village	Prespa	10.20	39.40	15.60	0.444	1.966	1.282	0.348	3.248	2.20	2.77	115.90	1.901	2.72	0.60	414.70	C2-S1
A13	Well Carev Dvor village	Prespa	13.50	49.20	8.10	0.587	2.455	0.666	0.470	3.121	2.20	2.79	134.20	2.201	2.66	0.82	264.50	C2-S1
A14	Well Krusje village	Prespa	20.40	44.90	9.70	0.887	2.241	0.797	0.720	3.038	2.20	2.80	183.00	3.001	2.5	1.37	295.70	C2-S1
A15	Well Sopotnica village	Crna	23.40	82.30	3.90	1.018	4.107	0.321	0.684	4.427	2.20	2.66	268.40	4.402	2.36	1.49	416.60	C2-S1
A16	Well Bucin village	Crna	15.30	15.20	7.80	0.666	0.758	0.641	0.796	1.400	2.10	3.10	54.90	0.900	3.02	0.94	156.00	C1-S1
A17	Drillhole (artesian) Kruseani village	Crna	13.00	56.20	29.70	0.566	2.804	2.441	0.349	5.246	2.20	2.57	305.00	5.002	2.3	0.81	544.20	C2-S1
A18	Well "Pivara" Prilep	Crna	43.50	64.40	16.10	1.892	3.214	1.323	1.256	4.537	2.20	2.65	237.90	3.902	2.42	2.68	534.50	C2-S1
A19	Well Aglarci village	Crna	12.90	85.80	28.80	0.561	4.281	2.367	0.308	6.649	2.23	2.47	298.90	4.902	2.31	0.74	669.50	C2-S1
A20	Well "Kvasara" Bitola	Crna	34.20	51.50	7.60	1.488	2.570	0.625	1.177	3.195	2.20	2.78	219.60	3.601	2.44	2.33	390.20	C2-S1
A21	Drillhole (artesian) Egri village	Crna	97.80	353.00	92.00	4.254	17.615	7.562	1.199	25.177	2.40	1.90	1330.00	21.812	1.66	4.12	2075.00	C3-S1
A22	Drillhole near the Bardovci hospital	Skopje	38.70	99.50	11.84	1.683	4.965	0.973	0.977	5.938	2.20	2.50	366.00	6.002	2.2	2.44	538.80	C2-S1
A23	Drillhole Volkovo village	Skopje	44.50	29.60	28.90	1.936	1.477	2.376	1.395	3.853	2.20	2.72	354.00	5.806	2.22	3.15	435.40	C2-S1
A24	Drillhole Saraj village	Skopje	159.20	206.70	25.30	6.925	10.314	2.080	2.782	12.394	2.30	2.20	573.40	9.404	2.03	7.98	1159.70	C3-S1
A25	Well Pobozje	Skopje	8.80	44.10	17.70	0.383	2.201	1.455	0.283	3.656	2.20	2.77	336.00	5.510	2.25	0.62	565.40	C2-S1
A26	Well "Kozara"	Skopje	25.50	79.20	28.80	1.109	3.952	2.367	0.624	6.319	2.20	2.48	317.20	5.202	2.28	1.52	535.50	C2-S1
A27	Radial wells Veles	Veles	13.67	88.10	12.40	0.595	4.396	1.019	0.361	5.415	2.20	2.56	311.00	5.100	2.29	0.85	643.50	C2-S1
A28	Well in the factory "Porcelanka" Veles	Veles	59.70	42.50	5.52	2.597	2.121	0.454	2.289	2.574	2.20	2.88	134.20	2.201	2.66	3.80	275.40	C2-S1
A29	Drillhole Negorci health spa	Gevgelija	14.72	27.30	1.32	0.640	1.362	0.109	0.747	1.471	2.10	3.10	488.00	8.003	2.1	1.57	773.80	C3-S1
A30	Well Gevgelija	Gevgelija	41.80	57.50	33.40	1.818	2.869	2.745	1.085	5.615	2.20	2.54	292.80	4.802	2.32	2.54	513.50	C2-S1
A31	Well Toplec Nov Dojran	Gevgelija	39.60	91.70	18.40	1.723	4.576	1.512	0.987	6.088	2.20	2.50	281.00	4.608	2.34	2.33	669.00	C2-S1
A32	Well Chelopek village	Pcinja	1.80	55.80	34.50	0.078	2.784	2.836	0.047	5.620	2.20	2.54	232.00	3.805	2.42	0.10	380.00	C2-S1
A33	Well Ginovci village	Pcinja	39.00	55.80	25.50	1.697	2.784	2.096	1.086	4.881	2.20	2.60	189.10	3.101	2.49	2.29	412.50	C2-S1

Table B.13 Classification of Irrigation Water Based on SAR and Conductivity (Groundwater Quality Survey(1)) (2/3)

N°	Sampling well	River basin/Valley	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	SAR = Na/SQRT((Ca+Mg)/2)	(Ca+Mg)	$(pK_2'-pKc')$	p(Ca+Mg)	(CO_3+HCO_3)	(CO_3+HCO_3)	p(Alk)	Adjusted SAR	Electrical Conductivity	Classification of irrigation water
			(mg/l)	(mg/l)	(mg/l)	(epm)	(epm)	(epm)		(epm)			(mg/l)	(epm)			(μS/cm)	
A34	Well Dragomance village	Pcinja	6.42	92.40	40.90	0.279	4.611	3.362	0.140	7.973	2.30	2.40	268.40	4.402	2.36	0.33	754.10	C3-S1
A35	Well Pcinja village	Pcinja	6.68	154.10	2.00	0.291	7.690	0.164	0.147	7.854	2.30	2.41	366.00	6.002	2.2	0.37	995.80	C3-S1
A36	Well Sredno Konjare village	Pcinja	9.38	264.10	8.50	0.408	13.179	0.699	0.155	13.877	2.30	2.14	390.00	6.396	2.18	0.43	1396.00	C3-S1
A37	Well Katlanovo village	Pcinja	25.80	191.10	35.90	1.122	9.536	2.951	0.449	12.487	2.30	2.20	610.00	10.004	2	1.30	1043.60	C3-S1
A38	Well Trboteviste village	Bregalnica	6.34	85.40	30.20	0.276	4.261	2.482	0.150	6.744	2.24	2.46	335.50	5.502	2.25	0.37	600.50	C2-S1
A40	Spring Kundino village	Pcinja	10.40	120.90	23.50	0.452	6.033	1.932	0.227	7.965	2.30	2.40	213.50	3.501	2.45	0.51	902.40	C3-S1
A41	Well Star Bunar, Berovo	Bregalnica	7.33	141.00	26.20	0.319	7.036	2.154	0.149	9.190	2.30	2.35	427.00	7.003	2.15	0.39	120.40	C1-S1
A42	Well Osojnica village, Vinica	Bregalnica	27.90	28.90	9.70	1.214	1.442	0.797	1.147	2.239	2.20	2.95	103.70	1.701	2.75	1.72	232.50	C1-S1
A43	Well Burilcevo village	Bregalnica	102.20	269.90	3.90	4.446	13.468	0.321	1.693	13.789	2.30	2.14	567.30	9.304	2.03	4.96	1533.00	C3-S1
A44	Well Ratavica village	Bregalnica	27.20	51.90	10.10	1.183	2.590	0.830	0.905	3.420	2.20	2.76	109.80	1.801	2.74	1.54	374.90	C2-S1
A45	Well meat industry Sveti Nikole	Bregalnica	106.30	62.80	66.50	4.624	3.134	5.466	2.230	8.600	2.30	2.37	397.00	6.511	2.17	5.71	973.90	C3-S1
A46	Well Lakavica village	Bregalnica	75.70	140.80	5.60	3.293	7.026	0.460	1.702	7.486	2.27	2.43	348.00	5.707	2.23	4.20	1089.30	C3-S1
A47	Well plumbing Radovis	Strumica	63.00	103.10	2.80	2.741	5.145	0.230	1.672	5.375	2.20	2.56	117.20	1.922	2.72	3.21	632.10	C2-S1
A48	Well Edrenikovo village	Strumica	82.70	159.10	1.38	3.597	7.939	0.113	1.793	8.053	2.30	2.40	543.00	8.905	2.05	4.75	1182.00	C3-S1
A49	Well Susica village	Strumica	77.00	23.10	0.50	3.350	1.153	0.041	4.335	1.194	2.10	3.22	128.10	2.101	2.68	6.07	294.50	C2-S1
A50	Drillhole Monospitovo village	Strumica	4.83	22.60	6.20	0.210	1.128	0.510	0.232	1.637	2.12	3.08	152.50	2.501	2.6	0.37	236.50	C1-S1
B1G	Dug well, Zelenikovo	Skopje	6.51	23.10	37.70	0.283	1.153	3.099	0.194	4.252	2.20	2.68	365.94	6.001	2.2	0.45	-	-
B2G	Drilled well, Makedonijapat		95.10	274.60	1.40	4.137	13.703	0.115	1.574	13.818	2.30	2.14	561.11	9.202	2.04	4.60	-	-
B3G	HIV-Veles spring	Veles	5.78	6.44	18.20	0.251	0.321	1.496	0.264	1.817	2.16	3.04	262.30	4.302	2.37	0.48	483.00	C2-S1
B4G	Well - Gradsko	Veles	12.31	10.42	65.10	0.535	0.520	5.351	0.313	5.871	2.20	2.51	579.50	9.504	2.03	0.83	1196.00	C3-S1
B5G	Well Grdovski Orman, Kocani	Bregalnica	52.20	68.30	25.80	2.271	3.408	2.121	1.366	5.529	2.20	2.55	262.30	4.302	2.37	3.11	533.30	C2-S1
B6G	Well, Shtip	Bregalnica	5.65	55.40	32.50	0.246	2.764	2.672	0.149	5.436	2.20	2.56	195.20	3.201	2.48	0.32	480.90	C2-S1
A51	Spring Vrutok village	Polog	5.80	35.10	3.45	0.252	1.751	0.284	0.250	2.035	2.20	3.00	134.20	2.201	2.66	0.39	202.70	C1-S1
A52	Spring Cegrane village	Polog	2.10	43.70	7.60	0.091	2.181	0.625	0.077	2.805	2.20	2.84	219.60	3.601	2.44	0.15	312.60	C2-S1
A53	Spring Proshevacka Jurija	Polog	78.10	18.70	11.50	3.397	0.933	0.945	3.506	1.878	2.17	3.03	73.20	1.200	2.92	4.49	136.70	C1-S1
A54	Spring St. Jovan Bigorski	Debar	6.80	59.30	6.40	0.296	2.959	0.526	0.224	3.485	2.20	2.75	244.00	4.002	2.4	0.46	336.60	C2-S1
A55	Spring Gorna Belica village	Treska	19.30	60.50	8.10	0.840	3.019	0.666	0.619	3.685	2.20	2.73	225.70	3.701	2.43	1.26	237.90	C1-S1
A56	Spring Studencica	Treska	2.70	19.20	12.00	0.117	0.958	0.986	0.119	1.944	2.20	3.00	134.20	2.201	2.66	0.18	190.30	C1-S1
A57	Spring at Treska river	Treska	11.20	17.50	5.80	0.487	0.873	0.477	0.593	1.350	2.10	3.16	237.90	3.902	2.41	1.03	350.00	C2-S1
A58	Spring Crn Drim river St. Naum	Ohrid	4.60	56.20	5.29	0.200	2.804	0.435	0.157	3.239	2.20	2.78	176.90	2.901	2.52	0.30	270.40	C2-S1
A59	Spring Sum Vevcani village	Ohrid	3.37	19.60	3.90	0.147	0.978	0.321	0.182	1.299	2.10	3.18	378.20	6.202	2.19	0.35	201.80	C1-S1
A60	Spring at Brajcinska river	Prespa	5.92	8.20	7.80	0.258	0.409	0.641	0.355	1.050	2.00	3.75	42.70	0.700	3.12	0.19	88.45	C1-S1

Table B.13 Classification of Irrigation Water Based on Sar and Conductivity (Groundwater Quality Survey(1)) (3/3)

N°	Sampling well	River basin/Valley	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	SAR = Na/SQRT((Ca+Mg)/2)	(Ca+Mg)	(pK$_2$'-pKc')	p(Ca+Mg)	(CO$_3$+HCO$_3$)	(CO$_3$+HCO$_3$)	p(Alk)	Adjusted SAR	Electrical Conductivity	Classification of irrigation water
			(mg/l)	(mg/l)	(mg/l)	(epm)	(epm)	(epm)		(epm)			(mg/l)	(epm)			(μS/cm)	
A61	Spring Krusje village	Prespa	56.80	21.70	22.80	2.471	1.083	1.874	2.032	2.957	2.20	2.80	256.20	4.202	2.38	4.10	390.40	C2-S1
A62	Spring Zrze village	Crna	56.80	21.70	22.80	2.471	1.083	1.874	2.032	2.957	2.20	2.80	256.20	4.202	2.38	4.10	390.40	C2-S1
A63	Spring Nebregovo village	Crna	6.00	23.40	17.10	0.261	1.168	1.406	0.230	2.573	2.20	2.90	97.60	1.601	2.78	0.35	179.40	C1-S1
A64	Spring at Crna river Zeleznec village	Crna	16.70	67.50	11.50	0.726	3.368	0.945	0.495	4.314	2.20	2.67	244.00	4.002	2.4	1.05	364.10	C2-S1
A65	Spring Drenovo village	Crna	79.80	71.00	12.80	3.471	3.543	1.052	2.290	4.595	2.20	2.64	323.30	5.302	2.27	5.24	498.00	C2-S1
A66	Spring St. Petka Crnice village	Skopje	5.81	75.30	40.60	0.253	3.757	3.337	0.134	7.095	2.25	2.45	433.10	7.103	2.15	0.34	690.40	C2-S1
A67	Spring Rasce	Skopje	9.95	108.80	9.80	0.433	5.429	0.806	0.245	6.235	2.21	2.49	372.10	6.102	2.19	0.62	533.30	C2-S1
A68	Spring Brodec village	Skopje	16.10	33.90	4.83	0.700	1.692	0.397	0.685	2.089	2.20	2.98	110.00	1.804	2.74	1.01	176.60	C1-S1
A69	Spring at Lisice village	Veles	23.70	21.80	2.53	1.031	1.088	0.208	1.281	1.296	2.10	3.18	67.10	1.100	2.98	1.46	146.10	C1-S1
A70	Spring at Sermeninska river	Gevgelija	2.60	25.40	30.00	0.113	1.267	2.466	0.083	3.733	2.20	2.73	237.90	3.902	2.41	0.17	463.10	C2-S1
A71	Spring Nikuljane village	Pcinja	9.80	66.30	19.60	0.426	3.308	1.611	0.272	4.919	2.20	2.60	244.00	4.002	2.4	0.60	396.60	C2-S1
A72	Spring Zidilovo village	Pcinja	57.80	51.50	29.90	2.514	2.570	2.458	1.586	5.028	2.20	2.60	275.00	4.510	2.35	3.57	361.90	C2-S1
A73	Well Alkaloid Berovo	Bregalnica	63.50	55.80	1.98	2.762	2.784	0.163	2.275	2.947	2.20	2.80	231.80	3.802	2.42	4.51	509.50	C2-S1
A75	Spring Suslevica, Berovo	Bregalnica	13.70	35.10	1.64	0.596	1.751	0.135	0.614	1.886	2.18	3.02	164.70	2.701	2.56	1.01	309.40	C2-S1
A76	Spring Studenko, Istevnik village	Bregalnica	8.00	36.70	25.70	0.348	1.831	2.113	0.248	3.944	2.20	2.70	122.00	2.001	2.7	0.45	308.20	C2-S1
A77	Spring Suvi Laki	Strumica	18.90	11.70	6.40	0.822	0.584	0.526	1.104	1.110	2.10	3.28	42.70	0.700	3.12	0.99	102.69	C1-S1
A78	Spring Studenec Dvoriste village	Strumica	17.30	19.10	5.10	0.753	0.953	0.419	0.908	1.372	2.10	3.17	42.70	0.700	3.12	0.92	120.40	C1-S1

* No analyses of A39 & A74

Table B.14 Geo-Chemical Characteristics (Groundwater Quality Survey(2))(1/2)

No	Sampling well	River basin	Geologic time	Geology of aquifer	Geo-chemical type
A1	Well Gas station - Tetovo	Polog	Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A2	Well Miletino		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A3	Well Fershped - Tetovo		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A4	Drillhole Raotince		Neogene	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A5	Drillhole Jegunovce		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A6	Drillhole OHIS - Gostivar		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A7	Well Piskupshtina	Debar	Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A8	Well Kichevo - Ohrid	Treska	Pliocene	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
A9	Well Sveti Naum	Ohrid	Triassic	Limestone	Calcium-Bicarbonate ($Ca-HCO_3$)
A10	Well Bratstvo - Ohrid	- Struga	Quaternary	Sand	Calcium-Bicarbonate ($Ca-HCO_3$)
A11	Artesian drillhole Struga		Quaternary	Sand	Calcium-Bicarbonate ($Ca-HCO_3$)
A12	Well Asamati	Prespa	Pliocene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A13	Well Carev Dvor		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A14	Well Krushje		Triassic	Limestone	Calcium-Bicarbonate ($Ca-HCO_3$)
A15	Well Sopotnica	Pelagonija	Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A16	Well Buchin		Pliocene	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
A17	Drillhole Krusheani		Pliocene	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A18	Well Pivara Prilep		Pliocene	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A19	Well Aglarci		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A20	Well Kvasara Bitola		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A21	Artesian drillhole Egri		Pliocene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A22	Drillhole Bardovci	Skopje	Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A23	Drillhole Volkovo		Pleistocene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A24	Drillhole Saraj		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A25	Well Pobozje		Proluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A26	Well Kozara		Alluvial	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
B1G	Well Zelenikovo		Alluvial	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
B2G	Well Makedonija Pat Petrovec		Neogene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A27	Radial wells Veles	Veles	Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A28	Well Porcelanka - Veles		Alluvial	Sands & gravels	Sodium-Bicarbonate ($Na-HCO_3$)
B3G	Well HIV Veles		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
B4G	Well Gradsko		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A29	Well Negorci	Gevgelija	Proluvial	Gravels & sands	Sodium-Sulphate ($NaSO_4$)
A30	Well Moin - Gevgelija		Alluvial	Gravels & sands	Sodium-Bicarbonate ($Na-HCO_3$)
A31	Well Toplec - Dojran		Neogene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A32	Well Chelopek	Pcinja	Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A33	Well Ginovci		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A34	Well Dragomanci		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A35	Well Pcinja		Diluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A36	Well Sredno Konjare		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A37	Well Katlanovo		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A38	Well Trbotevishte	Bregalnica	Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A39	Well Delchevo		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A40	Well Alkaloid - Berovo		Pliocene	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A41	Well Star Bunar - Berovo		Alluvial	Sands & gravels	Sodium-Bicarbonate ($Na-HCO_3$)
A42	Well Osojnica		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A43	Well Burilchevo		Proluvial	Sands & gravels	Magnesium-Bicarbonate ($Mg-HCO_3$)
A44	Well Ratavica		Alluvial	Sands & gravels	Calcium-Bicarbonate ($Ca-HCO_3$)
A45	Well Amzebegovo		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A46	Well Lakavica		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
B5G	Well Grdovski Orman		Alluvial	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
B6G	Well Shtip		Alluvial	Gravels & sands	Magnesium-Bicarbonate ($Mg-HCO_3$)
A47	Well Radovish	Strumica	Neogene	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A48	Well Edrenikovo		Neogene	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A49	Well Sushica		Neogene	Gravels & sands	Calcium-Bicarbonate ($Ca-HCO_3$)
A50	Drillhole Monospitovo		Neogene	Gravels & sands	Sodium-Bicarbonate (Na-HCO3)

Table B.15 Summary of Data Analysed (Groundwater Quality Survey(2)) (2/2)

No	River basin	Sampling well	Geologic time	Geology of aquifer	Water temperature	Electrical Conductivity	pH	Turbidity(mg/l silica ground)	Bicarbonate(HCO3)	Carbonate (CO3)	Sulphate (SO4)	Chloride (Cl)	Ammonium as N (N-NH4)	Nitrate as N (N-NO3)	Nitrite as N (N-NO2)	Sodium (Na)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Iron (Fe)	Manganese (Mn)	Chromium (Cr)	Arsenic (As)	Lead (Pb)	Mercury (Hg)	Copper (Cu)	Cadmium (Cd)	Selenium (Se)	Fluoride (F)	Silica (SiO2)	Phenols (C6H5OH)	Tri-chlorophenols	Chloroform (CHCl3)	Tri-chloroethylene	Tetra-chloroethylene	DDT	Aldrin & Dieldrin	Lindane	2,4D	Chlordane	Gross alpha radioactivity	Gross beta radioactivity	Total coliform bacteria MPN	Total hardness
					(oC)	(μS/cm)			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	Bq/m³	Bq/m³		
A1	Polog	Well Gas station - Tetovo	Alluvial	Gravels & sands	12.0	374.1	6.95	5.0	213.5	9.0	14.10	7.0	0.00	1.36	0.000	8.90	2.40	48.80	17.80	0.119	0.002	0.008	0.001	0.039	0.000	0.020	0.000	0.001	0.1	120.40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00105	0.01132	16.0	11.20
A2		Well Miletino	Alluvial	Gravels & sands	12.0	781.2	6.48	0.0	390.4	0.0	20.50	26.0	0.00	13.60	0.000	34.10	62.70	11.50	14.30	0.006	0.004	0.009	0.000	0.073	0.000	0.014	0.000	0.000	0.1	209.62	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05020	0.49947	16.0	19.50
A3		Well Fershped - Tetovo	Alluvial	Gravels & sands	15.0	457.9	6.82	0.0	115.9	43.0	18.60	14.0	0.00	4.07	0.000	11.80	3.70	69.90	16.30	0.047	0.003	0.014	0.000	0.049	0.000	0.014	0.000	0.000	0.1	147.30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02110	0.20781	6.0	13.70
A4		Drillhole Raotince	Neogene	Gravels & sands	12.0	965.8	5.70	0.0	585.6	0.0	49.30	16.0	0.00	1.36	0.000	18.00	8.00	55.00	23.00	0.090	0.003	0.008	0.000	0.047	0.000	0.012	0.000	0.000	0.1	430.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02535	0.26806	0.0	40.00
A5		Drillhole Jegunovce	Alluvial	Gravels & sands	11.0	320.2	6.07	0.0	176.9	0.0	28.20	7.0	0.00	0.00	0.000	26.60	3.10	32.20	12.10	0.044	0.003	0.007	0.000	0.041	0.000	0.013	0.000	0.000	0.1	100.83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00382	0.03628	0.0	9.38
A6		Drillhole OHIS - Gostivar	Alluvial	Gravels & sands	9.0	357.6	6.25	0.0	79.3	24.0	40.30	13.0	0.00	1.36	0.000	20.30	4.70	52.90	9.70	0.089	0.003	0.007	0.000	0.048	0.000	0.014	0.001	0.000	0.1	189.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00322	0.03386	0.0	9.80
A7	Debar	Well Piskupshtina	Alluvial	Gravels & sands	6.5	437.0	7.18	10.0	146.4	36.0	4.50	7.0	0.03	0.00	0.000	11.80	0.20	65.10	13.20	0.530	0.075	0.003	0.000	0.021	0.000	0.011	0.000	0.000	0.1	133.30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00310	0.02990	16.0	12.40
A8	Treska	Well Kichevo - Ohrid	Pliocene	Gravels & sands	11.7	189.4	6.70	0.0	73.2	0.0	0.66	12.0	0.00	9.04	0.003	29.10	3.10	17.02	4.84	0.039	0.001	0.004	0.000	0.035	0.000	0.089	0.000	0.000	0.1	38.05	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00510	0.04706	16.0	3.54
A9	Ohrid	Well Sveti Naum	Triassic	Limestone	12.2	311.1	7.16	0.0	48.8	42.0	11.50	8.0	0.00	0.00	0.000	9.80	5.00	42.60	13.10	0.024	0.000	0.003	0.000	0.010	0.000	0.012	0.000	0.000	0.1	97.28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00150	0.01050	16.0	9.05
A10	- Struga	Well Bratstvo - Ohrid	Quaternary	Sand	14.2	573.4	6.82	0.0	146.4	48.0	34.60	13.0	0.00	4.07	0.000	18.00	0.90	96.20	7.92	0.033	0.001	0.003	0.000	0.032	0.000	0.013	0.000	0.000	0.1	165.55	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00160	0.01584	16.0	15.40
A11		Artesian drillhole Struga	Quaternary	Sand	13.3	324.9	7.25	10.0	67.1	48.0	3.20	7.0	0.05	0.00	0.000	24.90	3.10	45.90	16.70	0.714	0.099	0.004	0.000	0.019	0.000	0.011	0.000	0.000	0.1	111.80	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00110	0.01020	0.0	10.40
A12	Prespa	Well Asamati	Pliocene	Sands & gravels	10.0	301.2	5.78	5.0	103.7	0.0	18.60	15.0	0.00	6.78	0.000	31.00	74.70	32.60	9.90	0.178	0.018	0.010	0.000	0.025	0.000	0.014	0.000	0.000	0.2	76.32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00731	0.06125	16.0	7.10
A13		Well Carev Dvor	Alluvial	Sands & gravels	12.0	329.4	6.52	5.0	158.6	0.0	25.00	7.0	0.00	1.36	0.000	26.80	2.50	38.90	13.60	0.274	0.200	0.006	0.000	0.025	0.000	0.012	0.000	0.000	0.2	93.52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01208	0.13341	0.0	8.70
A14		Well Krushje	Triassic	Limestone	11.0	286.7	6.42	0.0	140.3	0.0	15.30	10.0	0.00	1.36	0.000	26.70	8.40	35.20	6.60	1.467	0.062	0.012	0.000	0.025	0.000	0.012	0.000	0.000	0.1	69.87	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01482	0.13388	16.0	6.50
A15	Pelagonija	Well Sopotnica	Alluvial	Gravels & sands	12.0	469.3	6.56	5.0	152.5	36.0	23.10	10.0	0.00	2.26	0.000	24.90	11.50	43.70	26.80	0.265	0.000	0.012	0.000	0.031	0.000	0.012	0.000	0.000	0.1	134.37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01030	0.09162	16.0	12.50
A16		Well Buchin	Pliocene	Gravels & sands	12.5	476.6	5.89	10.0	48.8	0.0	20.50	8.0	0.00	1.36	0.000	25.80	10.02	17.80	2.64	0.712	0.367	0.012	0.000	0.055	0.000	0.014	0.000	0.000	0.2	33.54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.01823	0.17819	16.0	3.12
A17		Drillhole Krusheani	Pliocene	Gravels & sands	15.0	620.0	6.42	0.0	329.4	102.0	10.90	45.0	0.00	0.00	0.000	64.60	22.90	38.50	41.58	1.430	0.056	0.010	0.000	0.028	0.000	0.012	0.000	0.000	0.2	163.40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02485	0.23234	0.0	15.20
A18		Well Pivara Prilep	Pliocene	Gravels & sands	13.5	907.1	6.37	0.0	341.6	0.0	66.70	60.0	0.00	13.56	0.000	58.20	48.50	77.10	33.90	0.061	0.014	0.004	0.000	0.037	0.000	0.015	0.000	0.000	0.3	202.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.04083	0.41565	0.0	18.80
A19		Well Aglarci	Alluvial	Gravels & sands	15.0	627.7	6.46	5.0	305.0	0.0	0.66	35.0	0.00	13.50	0.000	52.90	6.20	42.60	41.80	0.275	0.023	0.012	0.000	0.042	0.000	0.013	0.000	0.000	0.5	170.92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02932	0.30536	0.0	15.90
A20		Well Kvasara Bitola	Alluvial	Gravels & sands	16.0	476.6	6.15	0.0	231.8	0.0	60.00	14.0	0.00	1.36	0.000	37.70	5.40	45.90	21.30	0.008	0.400	0.005	0.000	0.037	0.000	0.013	0.001	0.000	0.4	123.62	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00131	0.01288	16.0	11.50
A21		Artesian drillhole Egri	Pliocene	Sands & gravels	13.5	2229.0	5.34	30.0	1342.0	0.0	188.20	20.0	0.00	0.00	0.000	73.30	92.60	70.00	4.40	9.600	0.172	0.011	0.000	0.095	0.000	0.014	0.001	0.000	0.1	569.75	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00120	0.01010	0.0	53.00
A22	Skopje	Drillhole Bardovci	Alluvial	Gravels & sands	13.8	656.8	6.43	0.0	244.0	36.0	38.42	16.0	0.00	3.10	0.000	64.00	18.30	88.16	15.18	0.172	0.007	0.002	0.000	0.031	0.000	0.019	0.000	0.000	0.1	169.74	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00131	0.01112	2.0	15.79
A23		Drillhole Volkovo	Pleistocene	Sands & gravels	10.6	520.3	6.65	0.0	152.5	42.0	16.02	10.0	0.00	1.36	0.000	12.60	2.20	59.66	13.34	0.047	0.006	0.002	0.000	0.023	0.000	0.016	0.001	0.000	0.1	122.44	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00530	0.04906	0.0	11.39
A24		Drillhole Saraj	Alluvial	Gravels & sands	13.4	1381.0	6.49	5.0	329.4	84.0	101.10	70.0	0.00	13.56	0.000	55.20	35.90	79.20	62.92	0.179	0.184	0.010	0.000	0.047	0.000	0.016	0.000	0.000	0.1	279.50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00520	0.04626	0.0	26.00
A25		Well Pobozje	Proluvial	Gravels & sands	14.5	810.1	6.50	15.0	451.4	18.0	23.70	8.0	0.00	1.36	0.000	43.10	14.70	68.40	17.25	0.970	0.225	0.007	0.000	0.096	0.000	0.024	0.000	0.000	0.1	145.23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01128	0.10243	16.0	13.51
A26		Well Kozara	Alluvial	Gravels & sands	13.5	702.2	6.35	0.0	317.2	12.0	46.74	27.0	0.00	4.97	0.000	84.30	10.60	44.84	33.30	0.042	0.006	0.003	0.000	0.021	0.000	0.018	0.000	0.000	0.1	214.24	0.000	0.037	0.012	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.01673	0.17758	0.0	19.93
B1G		Well Zelenikovo	Alluvial	Gravels & sands	12.5	679.4	6.68	0.0	231.8	48.0	24.98	35.0	0.00	1.36	0.000	77.70	9.50	45.60	49.50	0.074	0.005	0.000	0.000	0.036	0.000	0.020	0.000	0.000	0.2	139.53	0.000	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02537	0.24760	0.0	17.90
B2G		Well Makedonija Pat Petrovec	Neogene	Sands & gravels	14.0	1714.0	6.68	0.0	420.9	36.0	136.34	182.0	0.00	13.60	0.000	45.00	23.80	64.65	43.56	1.252	0.010	0.020	0.000	0.150	0.000	0.023	0.000	0.000	0.8	366.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.04532	0.46287	16.0	34.07
A27	Veles	Radial wells Veles	Alluvial	Sands & gravels	15.5	762.7	7.02	0.0	164.7	54.0	35.86	56.0	0.00	4.97	0.000	52.40	11.50	69.56	9.24	0.873	0.025	0.014	0.001	0.014	0.000	0.011	0.000	0.001	0.2	131.00	0.000	0.018	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.02989	0.31713	2.0	12.19
A28		Well Porcelanka - Veles	Alluvial	Sands & gravels	12.5	243.9	6.59	0.0	79.3	18.0	28.20	12.0	0.08	0.00	0.000	56.00	34.20	38.11	7.26	0.135	0.117	0.000	0.000	0.007	0.000	0.033	0.000	0.000	0.3	77.40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01122	0.10876	16.0	7.20
B3G		Well HIV Veles	Alluvial	Sands & gravels	15.0	533.2	6.80	0.0	237.9	18.0	25.62	16.0	0.00	1.00	0.000	44.50	8.30	55.50	21.34	0.050	0.013	0.007	0.000	0.051	0.000	0.016	0.000	0.000	0.1	140.71	0.000	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.04963	0.52898	2.0	13.09
B4G		Well Gradsko	Alluvial	Gravels & sands	14.0	1273.4	6.68	0.0	567.3	18.0	125.46	56.0	0.00	13.60	0.900	36.90	5.60	07.94	7.92	0.051	0.147	0.009	0.000	0.014	0.000	0.022	0.000	0.000	0.5	340.60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02232	0.21847	2.0	31.69
A29	Gevgelija	Well Negorci	Proluvial	Gravels & sands	42.0	783.6	7.81	0.0	0.0	0.0	142.74	57.0	0.00	0.00	0.000	35.90	1.70	27.75	1.54	0.046	0.008	0.007	0.000	0.006	0.000	0.017	0.000	0.000	1.2	46.65	0.000	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02533	0.26079	2.0	4.34
A30		Well Moin - Gevgelija	Alluvial	Gravels & sands	12.0	507.6	7.03	0.0	140.3	48.0	74.26	8.0	0.00	1.00	0.000	81.80	19.60	65.86	26.84	0.063	0.005	0.003	0.000	0.012	0.000	0.019	0.000	0.000	0.2	170.92	0.000	0.000	0.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00956	0.08924	2.0	15.90
A31		Well Toplec - Dojran	Neogene	Sands & gravels	16.0	640.0	6.60	0.0	274.5	6.0	27.54	20.0	0.00	11.34	0.000	67.30	24.70	94.35	12.32	0.068	0.006	0.012	0.000	0.029	0.000	0.024	0.000	0.000	0.1	177.16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00784	0.08049	2.0	16.48
A32	Pcinja	Well Chelopek	Alluvial	Sands & gravels	7.9	631.0	6.58	0.0	219.6	36.0	42.30	18.0	0.00	2.26	0.000	32.10	21.50	79.55	28.82	0.068	0.003	0.013	0.000	0.006	0.000	0.000	0.000	0.000	0.2	193.39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01012	0.09768	16.0	17.99
A33		Well Ginovci	Alluvial	Sands & gravels	9.8	437.6	6.34	0.0	91.5	36.0	42.90	17.0	0.00	2.26	0.000	40.60	7.60	58.46	16.94	0.064	0.003	0.009	0.000	0.018	0.000	0.010	0.000	0.000	0.2	131.36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00123	0.01112	16.0	12.22
A34		Well Dragomanci	Alluvial	Sands & gravels	10.5	759.4	6.81	0.0	152.5	42.0	122.90	32.0	0.00	13.56	0.000	52.80	44.40	91.02	22.88	0.058	0.006	0.010	0.000	0.008	0.000	0.011	0.000	0.000	0.3	195.65	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.04002	0.38448	16.0	18.20
A35		Well Pcinja	Diluvial	Sands & gravels	11.5	939.6	6.60	0.0	237.9	42.0	98.00	50.0	0.00	6.78	0.000	57.60	82.80	01.38	31.90	0.039	0.001	0.010	0.000	0.016	0.000	0.012	0.000	0.000	0.2	234.13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05636	0.55163	16.0	21.78
A36		Well Sredno Konjare	Alluvial	Sands & gravels	13.0	1529.0	6.30	0.0	707.6	30.0	81.94	64.0	0.00	13.60	0.000	34.00	15.70	43.20	28.29	0.121	0.010	0.003	0.000	0.037	0.000	0.018	0.000	0.000	0.2	434.60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.07032	0.67667	0.0	40.43
A37		Well Katlanovo	Alluvial	Gravels & sands	11.0	1065.3	6.63	0.0	536.8	24.0	71.06	30.0	0.00	1.36	0.000	61.80	17.20	42.55	97.90	0.067	0.016	0.002	0.000	0.057	0.000	0.027	0.000	0.000	0.3	319.06	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01502	0.13134	1.0	29.68
A38	Bregalnica	Well Trbotevishte	Alluvial	Gravels & sands	14.1	602.7	6.23	0.0	244.0	24.0	66.70	12.0	0.00	1.36	0.000	38.80	8.40	74.74	27.94	0.066	0.004	0.019	0.000	0.011	0.000	0.002	0.000	0.000	0.2	183.82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00511	0.05295	0.0	17.10
A39		Well Delchevo	Alluvial	Gravels & sands	7.2	495.6	6.78	0.0	201.3	24.0	46.70	13.0	0.00	0.00	0.000	32.90	10.50	26.64	42.02	0.095	0.008	0.015	0.000	0.021	0.000	0.010	0.000	0.000	0.2	146.95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00598	0.06268	0.0	13.67
A40		Well Alkaloid - Berovo	Pliocene	Sands & gravels	13.5	436.3	5.95	0.0	85.4	24.0	31.00	26.0	0.00	0.00	0.000	45.90	11.50	43.66	13.20	0.052	0.003	0.016	0.000	0.007	0.000	0.001	0.000	0.000	0.2	99.43	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01782	0.16835	16.0	9.25
A41		Well Star Bunar - Berovo	Alluvial	Sands & gravels	8.2	809.2	6.67	0.0	256.2	42.0	106.90	23.0	0.00	4.50	0.000	71.40	16.40	52.54	34.76	0.058	0.004	0.019	0.000	0.025	0.000	0.010	0.000	0.000	0.2	167.70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00613	0.05752	0.0	15.60
A42		Well Osojnica	Alluvial	Sands & gravels	7.8	259.7	6.37	0.0	128.1	0.0	15.40	10.0	0.00	0.00	0.005	32.20	17.50	29.60	11.22	0.057	0.006	0.013	0.000	0.022	0.000	0.009	0.000	0.000	0.1	73.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01632	0.15958	16.0	6.81
A43		Well Burilchevo	Proluvial	Sands & gravels	13.2	1201.4	7.08	0.0	305.0	72.0	170.90	45.0	0.00	13.56	0.000	31.90	136.70	64.01	69.30	0.052	0.003	0.018	0.000	0.017	0.000	0.000	0.000	0.000	1.2	272.72	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.12001	1.19981	16.0	25.37
A44		Well Ratavica	Alluvial	Sands & gravels	9.5	367.1	6.59	5.0	122.0	0.0	62.10	9.0	0.00	1.36	0.000	34.20	14.70	43.66	14.30	0.152	0.006	0.018	0.000	0.014	0.000	0.003	0.000	0.000	0.2	102.23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00692	0.07304	16.0	9.51
A45		Well Amzebegovo	Alluvial	Gravels & sands	17.0	1203.0	6.77	0.0	372.1	48.0	131.90	43.0	0.00	13.56	0.000	68.60	137.90	54.39	56.10	0.060	0.003	0.022	0.000	0.007	0.000	0.002	0.000	0.000	1.2	320.24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.01486	0.15374	0.0	19.80
A46		Well Lakavica	Alluvial	Gravels & sands	8.5	1334.0	6.71	0.0	140.3	54.0	36.50	47.0	0.00	1.36	0.000	65.60	30.60	19.80	34.98	0.087	0.011	0.025	0.000	0.035	0.000	0.004	0.001	0.000	0.4	387.86	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.03313	0.32761	16.0	36.08
B5G		Well Grdovski Orman	Alluvial	Gravels & sands	13.0	561.1	6.71	0.0	183.0	30.0	46.10	16.0	0.00	1.36	0.000	34.10	13.30	64.52	24.20	0.042	0.006	0.016	0.000	0.009	0.000	0.000	0.000	0.000	0.1	158.67	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00896	0.09130	16.0	14.76
B6G		Well Shtip	Alluvial	Gravels & sands	12.5	533.9	7.02	5.0	134.2	30.0	84.50	18.0	0.00	1.36	0.002	38.40	24.70	36.26	35.86	0.176	0.009	0.020	0.000	0.016	0.000	0.004	0.000	0.000	0.2	145.87	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02838	0.29079	16.0	13.57
A47	Strumica	Well Radovish	Neogene	Gravels & sands	13.5	725.6	6.53	0.0	262.3	36.0	48.02	33.0	0.00	6.78	0.000	51.50	21.60	01.75	2.20	0.050	0.009	0.000	0.000	0.040	0.000	0.022	0.000	0.000	0.2	162.30	0.000	0.015	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.01311	0.12062	0.0	15.10
A48		Well Edrenikovo	Neogene	Gravels & sands	14.0	1924.0	6.02	0.0	427.0	0.0	80.66	160.0	0.00	13.56	0.005	81.80	25.90	78.60	13.00	0.070	0.010	0.024	0.000	0.019	0.000	0.020	0.000	0.000	0.2	188.66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01877	0.19243	16.0	27.55
A49		Well Sushica	Neogene	Gravels & sands	16.0	302.9	6.50	0.0	109.8	0.0	23.06	11.0	0.00	4.50	0.000	2.64	7.60	22.94	7.26	0.025	0.004	0.002	0.000	0.006	0.000	0.017	0.000	0.000	0.3	54.07	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00992	0.09571	1.0	5.03
A50		Drillhole Monospitovo	Neogene	Gravels & sands	7.2	258.6	6.60	0.0	152.5	0.0	0.02	5.0	0.90	0.00	0.000	70.40	17.60	29.60	20.24	0.847	0.084	0.004	0.000	0.017	0.000	0.015	0.017	0.000	1.0	97.82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00693	0.07025	0.0	9.10
STANDARD						600	5-9.5	10					0.1	10	0.005	150	12	200	50	0.3	0.05	0.15	0.05	0.05	0.01	0.1	0.005	0.01	1.5		1	1	30	30	100	1	0.03	3	40	0.03	0.1	1	10	20