URBAN GROUNDWATER QUESTIONAIRE

Guidance Notes

This Questionnaire seeks to collect data on a core set of urban groundwater data which can be used in:

a) The formulation of a comprehensive groundwater status profile of city; and

b) The development of a database useful for developing groundwater management strategies and policies and, to this end, running the Decision Support System Tool.

The Questionnaire is split into six sections (Table 1). The first section (A) deals with baseline information considered important in any urban environment data gathering/profiling exercise, including urban demographics and economic activities. The remaining five sections (B-F) deal with groundwater conditions, use, contaminant loads, management/institutional arrangements and degradation impacts, respectively. Each section contains a help sheet with guidance on completing the forms. Guidance is provided on items such as potential data sources, computations and units.

Table 1 Structure of the Urban Groundwater Questionnaire

Section	Subject
A	Socio-economic context
B	Hydrogeological setting
C	Groundwater development and use
D	Contaminant loads
E	Groundwater management
F	Degradation impacts

The Questionnaire is intended to be filled out by a study team, or mailed out in sections for completion by appropriate personnel. It is important that the team completing the Questionnaire, or person coordinating the exercise, has:

a) a professional background in urban environmental issues, and preferably water resource management;

b) an understanding of the range of information sources; and

c) access to those sources.

It is anticipated that since the required information is cross-sectoral that an individual will find that questionnaire hard to complete since the results need to be interpreted to the right level of detail and the relevant statistics may be difficult to find.

Mailing or distributing all or parts of the Questionnaire to officials to fill in is usually less productive and more time-consuming than directly requesting, compiling, and summarising the data.

The information gathered is likely to come from a number of different sources. These may include published material (e.g. technical reports; census summaries statistical yearbooks; articles); unpublished material (e.g. consultancy and other internal reports); and anecdotal information and observation (e.g. personal knowledge and experience; interviews). Ideally, the source, date and jurisdiction of information used should be stated. The jurisdiction definitions shown in Table 2 may be useful:

Table 2 Jurisdictional definitions

Jurisdiction	Definition
City Proper	The principal political jurisdiction containing the historical city centre
Metropolitan Area	A politically defined urban area set up for planning or administrative purposes which may combine several jurisdictions (municipalities or cities)
Urban Agglomeration	Total contiguous built up area which may spill over defined political boundaries

The information given should be based on standard units of measurement, as indicated, with all prices quoted in US$ equivalents. For current prices, the current exchange rate should be used. For past prices, exchange rates corresponding to the same period should be used, if possible.

The checklist in Table 3 summarises that tasks to be undertaken to complete the Questionnaire. It refers to the process, not the content, of the Questionnaire. A simple base map of the city should be provided, showing the political/geographic boundaries of the city proper, the metropolitan area, and the urban agglomeration. Further requests are indicated in the Questionnaire help sheets, and summarised in the checklist in Table 4.

Table 3 Data collection checklist

	Activity	Completed?
1.	Obtain appropriate version of Questionnaire (paper copy vs electronic)	
2.	Modify and translate Questionnaire, or sections of it, if necessary	
3.	Identify key sources of information for each section of the Questionnaire (local, regional and national; government and other agencies)	
4.	Identify, assess and select the person or team that will research and complete the Questionnaire	
5.	Contact key information sources and inform them of the purpose of the data collection exercise	
6.	Monitor work of data collection team to identify and solve problems	
7.	Review first draft of completed Questionnaire to locate missing information, errors and inconsistencies	
8.	Collect missing information (if possible), and correct errors and inconsistencies	
9.	Print Questionnaire results and make available all, or part, to interested parties (those who are affected by, interested in, or who influence urban groundwater management, including those who participated in/sanctioned the data gathering exercise)	
10.	Begin work on Groundwater Profile	

Table 4 Supporting material checklist

The following items should be included with the completed Questionnaire:

Section	Item	Description	Provided?
A	Map	Population density	
	Diagram	Physical Location of city and bondaries	
	Map		
B	Diagram	Cross-section of aquifer system	
	Map	Hydrogeology	
	Map	Topography and surface water features	
C	Map	Groundwater abstraction points	
	Map	Areas covered by piped supplies	
D	Map	Land use	
	Map	Location of main treatment plants and sewers/canals, and main solid waste disposable sites by types	
E	Organogram	Administrative structure for groundwater resources management	

The following paragraphs address some of the questions users are likely to raise about the Questionnaire, and about the procedure for filling it in.

Can the Questionnaire be modified?

Yes. The questions and categories can be revised or added to according to the nature of the city and the groundwater context, and the availability of data, for example a section on district heating would be appropriate for many cities in Eastern Europe and the former Soviet Union.

In its present form, and in the interests of producing a relatively compact document, there is little space for writing answers. You may therefore want to redraft sections, or attach supplementary sheets. A computer database (Access) version of the Questionnaire can be obtained from BGS.

How comprehensive should the data collection effort be?

For most cities, data will not be available for all parts of the Questionnaire. However, blank spaces are still useful as guides to where important information is lacking, and may need to be collected in future. This will indicate where supplementary surveys would be useful.

Where does one get access to the data?

Gathering information for the Questionnaire will require access to a range of governmental and other organisations at local, regional and possibly national levels. This requires knowledge of information sources, appropriate contacts within agencies where the information is located, and patience. In particular, the following aspects need to be considered (FAO, 1995):

- Access: how is access to the required information to be obtained? Who are the 'owners' of data, and are they obliged to divulge them? If not, how can they be persuaded to cooperate? If information has to be bought, what is its cost?
- Requirements: what are the minimum information requirements for the purpose intended? For example, if the assessment will underpin the development of a groundwater management strategy, as illustrated in Figure 2.1, then requirements in terms of both the quality and quantity of data will be high. If, however, the assessment will only inform a groundwater monitoring programme, requirements will be much less stringent.
- Quality: related to the above, what standards of information quality are required, and how are they to be achieved? It should be borne in mind that data are often inaccurate and

potentially misleading, and that the motives of those giving information need to be considered.

- Additional data needs: if more data are required, for example to complete key sections of the Questionnaire, how is additional information gathering to be financed and implemented?
- Helpful information may be found in material prepared primarily for commercial marketing or economic statistics purposes.

URBAN GROUNDWATER QUESTIONNAIRE

COVER SHEET

Name of City	
Country	
Currency	
Exchange Rate (and date)	
Inflation rate (and date)	

Contact Person	
Position/Title	
Organisation	
Address	
Telephone and Fax	Tel: Fax:
E-mail (if available)	
Date:	
Who was Questionnaire completed by? (state name and position)	

A. SOCIO-ECONOMIC CONTEXT

A1	DEMOGRAPHIC CHARACTERISTICS			
1.1	**Population figures and estimates**			
		City proper	Metropolitan areas	Urban agglomeration
	Population			
	Year…			
	Year…			
	Year…			
	Year…			
	Year…			
	Year…			
	Year…			
1.2	**Population density and growth rate**			
	Land areas (km^2) and population density (1998)			
	Annual growth rate (%/year)			
	Additional comments/description:			

A2	INCOME AND ECONOMIC STRUCTURE		
2.1	**Income**		
	Regional domestic product per capita per year	$/cap/year	
	Urban poverty line, or World Bank estimate?	$/cap/year	
	Population below poverty line	%	
2.2	**Economic activities**		
	• Agro-industry/processing • Transport hub/port • Manufacturing (inc. light and heavy engineering; petrochemical and refining) • Mining • Finance/insurance • Commerce/retailing • Tourism	Please tick (√) most important economic activities in your city, then rank in order of importance:	
	Additional comments/description:		

A3	MUNICIPAL SERVICES			
3.1	**Services provided by municipal government**			
		Yes - all (√)	Yes - some (√)	None (√)
	Water supply			
	Sewerage			
	Wastewater treatment			
	Drainage			
	Solid waste collection and disposal			
	Additional comments/description:			

HELP NOTES - SECTION A

A1.1 Please provide population estimates over at least a 15 year period. Demographic data can be obtained from census returns, often quoted in government and donor reports on urban issues

A1.2 The annual growth rate can be calculated as the average annual rate of population growth in the preceding five year period.

A2.1 Provide city-level data if available. If unavailable, please provide state or national statistic

Urban poverty line: “those having less income than that needed to buy the minimum requirement of calories and protein, shelter, clothing and other necessities”. This information may only be available in research studies on income inequalities undertaken by the national or city economic planning agency, or academic institutions engaged in economic research.

A2.2 This is intended to provide a ‘rough and ready’ (and subjective) economic profile of the city. More detailed information on urban employment and economic activities is requested in Section D.

A3.1 In some cities, municipal government may provide most of the services listed. In others, the private sector may be important. More detailed information on groundwater supply and waste disposal arrangements is requested in Sections C and D.

Additional material Obtain a map showing the physical location of the city and its boundaries.

B. HYDROGEOLOGICAL SETTING

B1	AQUIFER SYSTEM

- Using the following symbols and shading, could you produce a simplified cross-section that best represents the aquifer system beneath your city.
- Could you give the average thicknesses of the aquifers, aquitards and aquicludes included in the cross-section.
- Could you indicate if the aquifers are unconfined (U), partially confined (P) or confined (C)
- Could you also number the aquifers and the aquitards/aquicludes - this numbering will be used subsequently in the Questionnaire.

aquifer

aquitard

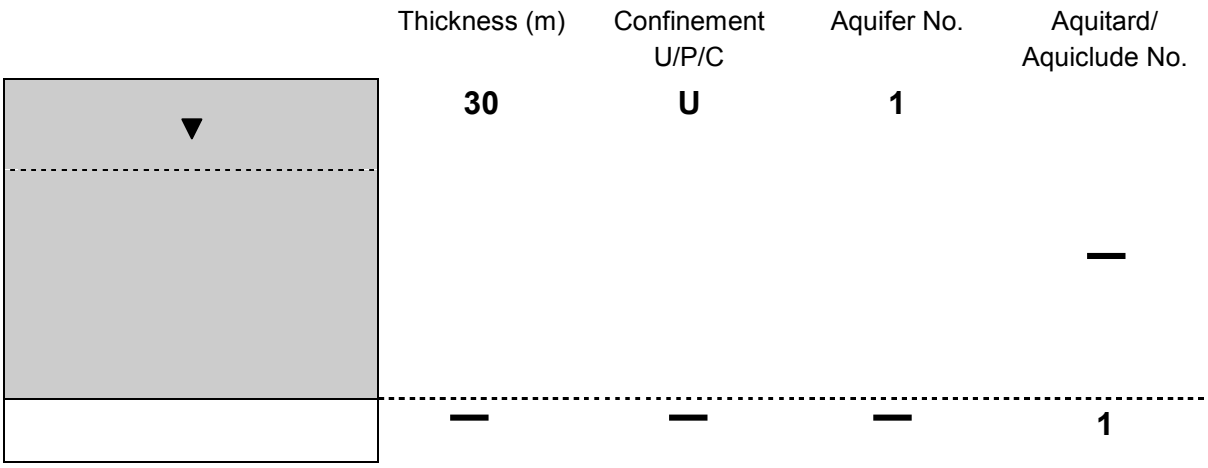
aquiclude

Bedrock

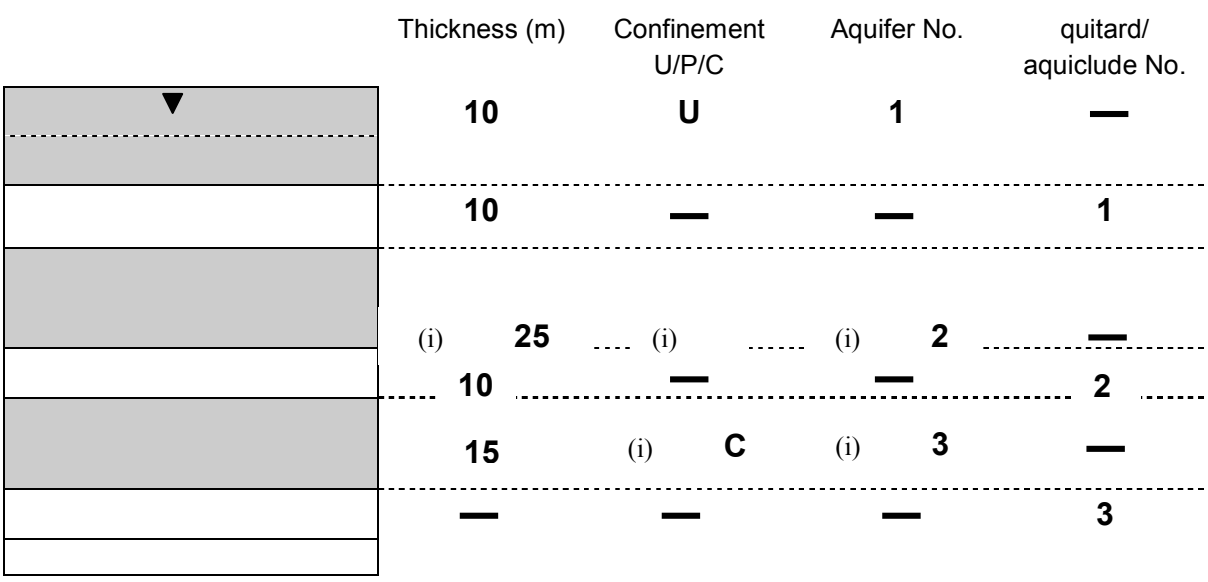
Water-table ▼

Two examples are given below to show how this can be done:

Example 1 **An unconfined aquifer overlying bedrock** e.g. Perth, Australia & Dessau, Germany



Example 2 **A multi-layered aquifer system** e.g. Bangkok, Thailand & Hanoi, Vietnam



If you think that, due to the complexities of the aquifer system beneath your city, the simplified cross-section does not provide sufficient information, please provide your own cross-section in the space below.

B2	GEOLOGY

Describe as best you can the geology of the aquifer system by filling-in Tables B2.1 and B2.2 below. Please only use the terms listed below. Also indicate the type of groundwater flow in each aquifer by ticking the appropriate column in Table B2.1. Where there is more than one type of flow mechanism, indicate which is dominant by putting two ticks (v√) in the appropriate column.

GRAVEL	LIMESTONE/DOLOMITE	BASALT
SAND	CHALK	TUFF
SILT	SANDSTONE	OTHER VOLCANIC ROCK
CLAY	SHALE	CRYSTALLINE BASEMENT

2.1 Aquifer geology and flow type

	Geology	Flow type		
		matrix	Fracture	karstic
Aquifer 1				
Aquifer 2				
Aquifer 3				
Aquifer 4				

2.2 Aquitard/aquiclude geology

	Geology
Aquitard/aquiclude 1	
Aquitard/aquiclude 2	
Aquitard/aquiclude 3	
Aquitard/aquiclude 4	

B3	SHALLOW UNCONFINED AQUIFER

If your city is underlain by a shallow unconfined aquifer please answer the following questions otherwise tick the box below

NA - questions not applicable

3.1 Is there significant leakage from the unconfined aquifer to deeper confined aquifer(s) below?

	Yes (√)	No (√)	Don't know (√)
Natural conditions?			.
Pumping induced conditions?			

3.2 What is the regional groundwater gradient in the unconfined aquifer?

3.3 What is the depth to the water-table from the ground surface in metres?

	(metres)
Maximum	
Minimum	
Average	

B4	AQUIFER PARAMETERS					
4.1	Estimate the average transmissivity for each aquifer unit and tick the range within which the value falls.					
		Transmissivity (m^2/d)				
		<10	10-100	100-500	500-1000	>1000
	Aquifer 1					
	Aquifer 2					
	Aquifer 3					
	Aquifer 4					
	Give details of the source of the information on which you based the estimate of aquifer parameters given above:					
4.2	Estimate the average storativity and porosity for each aquifer unit and tick the range within which the values fall					
		Storativity (-)				Porosity (%)
		$<10^{-4}$	10^{-4}-10^{-3}	10^{-3}-10^{-2}	10^{-2}-10^{-1}	$>10^{-1}$	<1	1-10	>10
	Aquifer 1								
	Aquifer 2								
	Aquifer 3								
	Aquifer 4								
	Give details of the source of the information on which you based the estimate of aquifer parameters given above:								

B5	AQUIFER RECHARGE				
5.1	What is the mean annual rainfall for your city in mm?				
5.2	Tick the appropriate range for mean annual natural aquifer recharge to the aquifer system beneath your city.				
		<50	50-100	100-200	>200
	Aquifer recharge (mm/year)				
	Give details of the source of the information on which you based the estimate of aquifer recharge given above:				

B6	MAPS

Please provide copies of any maps or figures that add detail to the information provided in this section. Please send any other maps that you think are relevant in describing the physical setting of your city:
Tick boxes for maps included.

Map of city showing topography and surface water features	Transmissivity
Geology	Storativity
Depth to water-table	Porosity
Height of the water-table	Aquifer recharge
Other	
……..	……..
……..	……..

HELP NOTES - SECTION B

B1 An aquiclude is a formation that does not allow water to move through under typical hydraulic gradients. An aquitard allows water to move through but at a much lower rate than through adjacent aquifers.

By confined we mean overlain by and aquitard or aquiclude. Partially confined means an aquifer which is both confined and unconfined within the city boundary.

B2 You may use a combination of the geological terms provided if necessary, e.g. SAND + GRAVEL or SANDY CLAY

Matrix flow is flow through the pores in the rock; fracture flow is flow through fractures and fissures; karstic flow if flow through cave systems produced as a result of dissolution.

B3.1 Contamination of deep aquifers may occur due to leakage of poor quality water from a shallow unconfined aquifer. This leakage may occur naturally due to a positive vertical gradient from the shallow to the deeper aquifer. This positive gradient may be increased or created by the abstraction of groundwater through boreholes pumping from the lower aquifer.

B3.2 The regional groundwater gradient gives an indication of the potential for movement of pollutants laterally through the shallow unconfined aquifer. The groundwater gradient between two points is the difference in the height of the water-table divided by the distance between the two points. There may be localised drawdown in the water-table associated with groundwater abstraction, however, the gradient we require ignores these fluctuations. We want the regional gradient, a mean gradient for the whole city.

B4.1 **Transmissivity** is the multiple of the hydraulic conductivity (the permeability) and the thickness of an aquifer.

B4.2 **Storativity** for confined aquifers is the volume of water that an aquifer releases from storage per square metre as the result of a decline in head of one metre. For unconfined aquifers it is the volume of water released from storage per square metre as the result of a one metre decline in the water table.

Porosity is the percentage of a representative volume of rock that is void. Voids may be the pores in a rock or fractures and fissures.

B5 In the context of aquifer contamination, a knowledge of aquifer recharge that occurs naturally through rainfall or subsequently from rivers or lakes, helps judge the potential for dilution of any pollutants.

C. GROUNDWATER DEVELOPMENT AND USE

Complete this section by providing the most up to date and verifiable information you can obtain. If you cannot provide quantitative data, please provide a qualitative response, referring to the Help Sheet for guidance. Provide all volumes in Megalitres/day (= 000 m^3d).

C1	URBAN WATER RESOURCES		
	Source	**Abstraction (Ml/d)**	**%**
1.1	Surface water		
	River Lake Reservoir Inter-basin transfer Other Total		
1.2	Groundwater		
	City centre City Metropolitan area Total		
1.3	Other		
			100%
	TOTAL		
	Additional comments/description:		

C2	GROUNDWATER SUPPLY AND USE											
2.1	**Supply sources, uses and volumes (D = Domestic; I = Industrial; M = Municipal; O = Other)**											
		Piped supply (state agency; utility) (Gross Ml/d, before distribution losses)				Licensed, legally sanctioned private supply (Ml/d)				Unlicensed, unregulated private supply (Ml/d)			
	Aquifer Unit	D	I	M	O	D	I	M	O	D	I	M	O
	1												
	2												
	3												
	4												
	All Units												
	TOTAL ABST.												
2.2	Groundwater use, net of distribution (unaccounted for) losses												
	TOTAL USE												
	Additional comments/description:												

C3	GROUNDWATER DELIVERY									
3.1	**Technology type (BH = Borehole; SW = Shallow well; S = Spring)**									
		Piped supply (public; utility company) (Gross Ml/d)			Licensed, legally sanctioned private supply (Ml/d)			Unlicensed, unregulated private supply(Ml/d)		
	Aquifer Unit	BH	SW	S	BH	SW	S	BH	SW	S
	A1									
	A2									
	A3									
	A4									
	All Units									
3.2	**Typical yield range (m^3/d)**									
	A1									
	A2									
	A3									
	A4									
	All Units									
	Additional comments/description:									

C4	TRENDS IN GROUNDWATER USE							
4.1	**Total abstraction from aquifer for any purpose (Ml/d) and % of total urban supply**							
		Past trend					**Future projection**	
	Aquifer Unit	Year……	Year……	Year……	Year……	Year……	Year……	Year……
	A1							
	A2							
	A3							
	A4							
	TOTAL							
	Additional comments/description							

C5	WATER QUALITY CONSTRAINTS						
5.1	**Groundwater contamination and treatment**						
	Aquifer Unit	Within WHO drinking water norms? (Y/N)	Problem parameters*	Water treated before use? (Y/N)			Widespread/ local problem? (W/L)
				Piped supply	Licensed supply	Unlicensed supply	
	A1						
	A2						
	A3						
	A4						
	Note *water quality problems: F = faecal pathogens; S = salinity; H = heavy metals; N = nutrient compounds (principally nitrogen); T = taste/odour/stain (manganese, iron); O = micro-organics inc. petroleum products (LNAPLs), solvents (DNAPLs) and/organic load (dissolved organic carbon, BOD)						
	Additional comments/information:						

HELP NOTES - SECTION C

C1 Data often listed in city master/strategic plans, and in water utility/company annual reports. If precise figures are not available (e.g. for alternative groundwater abstraction locations), please provide 'best guess', or enter H (high), M (medium) or L (low).

C2.1 Please provide abstraction data, before distribution (unaccounted) losses. If abstraction estimates are not available, please provide approximate % estimates. If abstraction data are not available for individual aquifers, complete the 'All Units' total only.

For public and licensed private supply, see C1 above.

The volume of unlicensed, private supply may have to be crudely estimated as a residual. For example, if only 60% of households have access to piped supplies and licensed wells (for this data, see C1 above), the remaining 40% may be using unlicensed boreholes or shallow wells. Where one groundwater source serves one household, abstraction can be estimated by multiplying the number of households by a typical household water consumption figure. Household data (numbers; average household size) can be obtained from census returns, and may be quoted in city plans and reports. In industrialised countries, per capita domestic water use is 200-300 l/cap/day. Minimum, basic needs use, is around 25 l/cap/day.

Aquifers referred to should be consistent with those identified in Section B of this Questionnaire.

- Domestic use: household use for drinking, cooking, washing etc.
- Industrial use: to avoid confusion with recycling and reuse, please provide groundwater abstraction data only
- Metropolitan use: government buildings, park and road verge irrigation etc

Other: this could include agricultural/horticultural abstraction within the city boundaries. If relevant, please provide details.

C2.2 Net water use: total abstraction minus unaccounted for losses (leakage; unauthorised connections; flushing water mains and sewers; water drawn for fire fighting etc).

C3 Data may be anecdotal and unreliable. Check with operational division of water utility/company, national water resource institute (geological survey/department of water affairs) or regulator. If detailed figures are not available, please provide approximate estimates or percentages.

C4 Data for public supply and licensed withdrawals may be obtained from metropolitan water authority, water utility/company, a national water resource institute (e.g. geological survey/department of

	water affairs) or a regulator (e.g. licensing authority; environment agency). Data for unlicensed, private abstractions may have to be estimated approximately (see C1 above).
C5	Likely data sources include: water authority/utility/company published/unpublished reports, public health/health ministry surveys, national water resource institute (e.g. geological survey/department of water affairs) and research papers.
Additional Material	For all of the above, collect copies of maps (e.g. coverage of piped water supply), diagrams and tables to help provide orientation. If data are not available, a water supply budget and a groundwater usage survey are required.

D. CONTAMINANT LOAD

D1	PRINCIPAL ECONOMIC ACTIVITIES				
1.1	**Urban industries, employment and output**				
	ISIC Code	Description	Number of industries	Total employment	Output ($/yr)
	31	Food industry			
	32	Textiles/Clothing and leather			
	34	Wood and wood products			
	35	Paper and paper products			
	36	Chemical/Coal/Petro/Plasti c products			
	37	Basic metal industry			
	38	Fabrication of machinery and equipment			
	39	Other manufacturing industry			
	62	Retail trade			
	94	Recreational and cultural services			
	95	Personal and household services			
1.2	**Concentration of industry**				
	Is manufacturing industry located mainly in industrial parks/zones, or is it dispersed across the city?				
	Additional comments/information:				

D2	LAND USE, OWNERSHIP, AND CONTROL		
2.1	**Land use**		
	Code	**Category**	**Area (km^2)**
	1	Residential	
	2	Commercial	
	3	Industrial	
	4	Public (government; schools; hospitals; churches; etc)	
	5	Mixed use	
	6	Transport and communications	
	7	Technical infrastructure	
	8	Recreational and other open land	
2.2	**Land ownership and control**		
	Area of city under land use regulation?		
	Additional comments/description:		

D3	WASTEWATER DISPOSAL ARRANGEMENTS		
3.1	**Disposal methods**		
		Domestic and commercial (Ml/d and % total)	Industrial (Ml/d and % total)
	Sewered or lined collector drain		
	On-site: septic tank		
	On-site: latrine, soakaway, unlined collector drain/lagoon		
	TOTALS		
3.2	**Wastewater treatment**		
		Sewered domestic and commercial - disposal to land and water within urban area (Ml/d and % total)	Industrial (Ml/d and % total)
	No treatment		
	Primary treatment (mechanical)		
	Secondary treatment (biological)		
	Tertiary treatment (advanced)		
3.3	**Wastewater reuse**		
	Is wastewater reuse/spreading practised in periurban areas? (Y/N)		
	Does reuse/spreading overlie the recharge areas on an aquifer used for urban groundwater supply? (Y/N)		
	Additional comments/description:		

D4	SOLID WASTE DISPOSAL ARRANGEMENTS		
4.1	**Disposal of municipal and other solid waste within the urban area**		
		Open dump	**Landfill**
	Total quantity disposed within urban area (tons/day)		
	Quantity disposed within urban area AND overlying aquifer recharge zones (tons/day and %)		
	Quantity disposed to sites with no leachate containment/control (tons/day and % total)		
	Quantity disposed to sites with no leachate containment/control, AND to sites overlying aquifer recharge zones (tons/day and % total)		
	Is leachate pollution monitored for?		
	Has leachate pollution been detected? If so, please describe:		
	Additional comments/description:		

HELP NOTES - SECTION D

D1.1 This section is designed to measure a consistent set of economic data that can be used for cross-city comparisons. The data generated will help provide an *indication* of potential pollutant loads. This data can then be compared with aquifer vulnerability information generated in Section B to help determine the risk to groundwater resources from contamination.

If your country does not use ISIC Codes, please provide national industrial categories and corresponding information. Also, if there are more specific industrial categories in the urban area that are major sources of pollution, identify them and provide appropriate data.

Data sources: national/regional planning offices; statistical offices; government industrial department

Note: if you can obtain more detailed information on industrial outputs under each ISIC Code, these can be used to generate contaminant load estimates and control costs using the World Bank's Industrial Pollution Projection System (IPPS). This can be downloaded from the New Ideas in Pollution Regulation website (http://www.worldbank.org/nipr).

D1.2 See D2.1 below.

D2.1 Information on urban land use can also provide useful context for an assessment of pollution risk (see D1.1 above). It can also be used to build up a picture on aquifer recharge.

Data sources: as for D1.1, plus government mapping office

D2.2 This information is important for groundwater protection policy.

Data sources: government planning office

D3.1 If detailed estimates are unavailable, provide a 'best guess' %, or enter H (High), M (Medium), or L (Low).

Data sources: city master/strategic plans; water utility/company reports; environment agency/institution. Alternatively, research/water sector reports (universities; ESAs, NGOs) - published and unpublished.

D3.2 As for D3.1

D3.3 Reuse here refers to use of wastewater on land surface for garden/agricultural use within the city.

D4.1 If detailed estimates are unavailable, provide a 'best guess' %, or enter H (High), M (Medium), or L (Low).

Data sources: as for D3.1

Additional material

For D2.1, provide a land use map of the city and show clearly where categories are aggregated when detailed breakdowns are inadequate.

For Sections D3 and D4, provide a map showing location of main treatment plants and sewers/canals, and main solid waste disposal sites and type.

E. GROUNDWATER MANAGEMENT

Tick (√) the box that best describes water resources policy

E1	POLICY FRAMEWORK				
1.1	**National water policy**				
	Sustainable management and conservation of water resources (including groundwater) is an integral part of national development policy	Fully	Partially	A little	Not at all
1.2	**Urban groundwater policy**				
	An urban groundwater management and development policy exists and is effectively implemented	Yes - policy exists and is implemented	Exists, but not effectively implemented	Exists, but ineffective	No policy; no implementation
	Goals for urban groundwater management and development are clearly defined, responsibilities allocated, and resources committed	Yes - goals exist, with full provision to implement	Goals exist, but only partial provision to implement	Goals exist, but no provision to implement	No goals or provision to implement
1.3	**Strategies and action plans**				
	A specific strategy and action plan (S&AP) for urban groundwater development and management is laid out, responsibilities allocated, and resources committed	S&AP exists; full provision to implement	S&AP exists; partial provision to implement	S&AP exists; no provision to implement	No S&AP or provision to implement
	Additional comments/description:				

Tick (√) the box that best describes the institutional framework for groundwater management

E2	INSTITUTIONAL FRAMEWORK/ARRANGEMENTS				
2.1	**Coordination**				
	Formal arrangements exist to ensure cooperation between water-related agencies, and are implemented on an ongoing basis	Formal arrangements are fully effective	Formal arrangements are partially effective	There is informal coordination	There is active competition between agencies
	Formal arrangements enable participation of groundwater users, NGOs and other non-government stakeholders in groundwater planning and management	Yes			No
2.2	**Regulation**				
	Legally binding procedures exist, with machinery to implement them, to allocate groundwater and resolve conflicts between competing users and uses	Procedures exist; full provision to implement	Procedures exist; partial provision to implement	Procedures exist; no provision to implement	There are no procedures
	There is a functional separation, but legal link between, groundwater regulation and groundwater development.	Yes			No
2.3	**Capacity**				
	Institutions dealing with groundwater management have the technical, financial and management skills and resources to fulfil designated tasks and functions	Fully	Partially	A little	Not at all
	Regulatory body has the capacity and authority to monitor compliance with groundwater-related legislation, and to enforce controls	Regulations strictly monitored and enforced	Partial monitoring and enforcement	Some monitoring but little enforcement	Inadequate monitoring and enforcement of controls
	Additional comments/description:				

Please tick (√) the appropriate box

E3	POLICY INSTRUMENTS FOR GROUNDWATER MANAGEMENT				
		Measure exists and is fully implemented	Measure exists but is only partially implemented	Measure exists but is not implemented	Measure does not exist
3.1	**Pollution control - regulation**				
	Ambient groundwater quality standards (listing permissible concentrations)				
	Effluent standards (quality; quantity) -for specific industries -for specific pollutants -in vulnerable recharge areas				
	Industrial process standards				
	Mandatory pretreatment/treatment				
	Discharge permit system -for specific industries -for specific pollutants -for specific areas				
	Technical standards				
	Land use and building controls				
3.2	**Pollution control - economic incentives**				
	Effluent charges/taxes				
	Marketable discharge permits				
	Subsidies for clean technologies				
3.3	**Pollution control - other**				
	Self monitoring and reporting				
3.4	**Abstraction controls - regulations**				
	Abstraction licenses/permits				
	Abstraction quotas				
	Technical standards/controls				
	Process standards				
	Land use and building controls - zoning				
3.5	**Abstraction controls - economic incentives**				
	Groundwater tariffs -mains piped -private industrial/household				
	Enforcement incentives				
	Administration charges				
	Marketable quotas/licenses				
	Subsidies for water efficient technologies				
3.6	**Abstraction controls - other**				
	Metering				
	Additional comments/description:				

E4	INSTITUTIONAL INVENTORY			
4.1	**Classification** Status: G = Government; SG = Semi -government agency; P = Private; NGO = Non-government Organisation; A = Academic; O = Other (please specify) Jurisdiction: C = City/municipality; R = Region; B = Basin; N = National			
	Function	**Name of institution(s)**	**Status**	**Jurisdiction**
	Groundwater resource assessment and research			
	Groundwater resource policy formulation			
	Coordination of water-related activities			
	Groundwater resource planning			
	Regulation and enforcement of controls and standards			
	Operations management			
	Additional comments/description:			

Please tick (√) the appropriate box

E5	INFORMATION, PLANNING AND PUBLIC AWARENESS				
5.1	**Information availability**				
	Information on groundwater conditions and rates of change is sufficient for planning, development and management of the resource	Fully sufficient	Adequate	Insufficient	No information available
5.2	**Information use**				
	Information on groundwater conditions and rates of change is routinely used in urban planning and groundwater management	Yes - full use	Partial use	Little use	Not use at all
5.3	**Administration and support**				
	Information collection, processing and dissemination is handled by a specialist support unit, independent of other line agencies, and serves all government agencies and the private sector	Yes - specialist unit provides comprehensive, prompt service	Specialist unit provides limited support	No specialist unit; data holdings fragmented	No specialist unit or data holdings
5.4	**Public knowledge**				
	Information about water resources are available to the public to aid their participation in planning and decision-making	Extensive information readily available	Limited official information supplements news media	Limited information is available by via news media	No information is available through any medium
5.5	**Consensus**				
	There is broad consensus on the causes and consequences of degradation among groundwater users/polluters, city residents generally, and professional planning/regulatory agencies	Yes	Problem/facts not disputed; action is	Facts, interpretation, and action disputed	No debate therefore nothing to dispute
	Additional comments/description:				

HELP NOTES - SECTION E

The questions in Sections E and F are more subjective and judgmental than those in other sections. It is therefore important to seek a range of views on the question, and state clearly (the basis on which) how a team decision was reached.

E1.1 Answer either 'fully' or 'partially' if (a) a national water policy exists, and makes explicit reference to the need for sustainable development (including conservation and protection); and/or (b) the government is committed to policy, legal and institutional changes in the water sector as a result of election pledges, conditions set by external donors etc. Use your judgement to decide which statement best describes your national policy.

Data sources: national (government) policy documents; water sector/environment reports/reviews by external support agencies (e.g. World Bank; UN agencies)

E1.2 Does a specific urban groundwater management policy exist? If it does exist, to what extent is it operational, e.g. in terms of economic incentives and regulations governing abstraction and protection? Use your judgement to decide which statement best describes urban water policy.

Data sources: regional/municipal government policy documents; operations reports from government departments/agencies dealing with groundwater management (e.g. annual reports published by regulatory authority/agency).

E1.3 In addition to policies (1.1 and 1.2 above), does an action plan for urban groundwater development and management also exist? An action plan deals with the development and conservation of groundwater resources, with reference to (a) the availability of water (quantity and quality); (b) existing utilisations; and (c) future needs on the basis of projected demands. It will set time-bound targets, and be costed, perhaps as a series of projects. It may be part-funded by an external support agency such the World Bank.

Data sources: as above.

E2.1 Are the various organisations (public and private) concerned with groundwater, either directly or indirectly, obliged to coordinate activities and share information? For example in some countries, water councils have been formed to ensure coordinated planning, with representation from different government departments, and sometimes NGOs, professional/academic associations and community leaders.

Data sources: as above.

E2.2 Procedures for allocating groundwater include use of licenses and quotas to control who uses groundwater, what it is used for, and how much is used. Therefore, managed allocation can only occur where (a) individual use rights are limited in some way, connected to the rights of others and overall use; and where (b) urban groundwater policies and action plans (see E1) are in place and operational.

Answer 'yes' to next question if (a) the regulatory institution avoids performing developmental functions such as construction, and operation and maintenance; and (b) developmental functions are controlled by separate regulators, with clear legal links between the two.

Data sources: as above

See also Section E3

E2.3 This question may be easier to answer after completing Section E3. Answer 'fully' or 'partially' if groundwater planning, development and management is controlled, consistent, and continuous.

Data sources: as above

E3 These questions deal with the economic incentives, and regulatory controls, used to manage groundwater abstraction and pollution.

Firstly, you need to find out whether a particular measure exists. Then, you need to decide whether the measure is implemented, which will depend on the institutional capacity, and will, to monitor and enforce measures. For example, are industrial effluents routinely monitored, and is compliance enforced? Do abstraction controls exist, and are they observed? What proportion of groundwater users pay a tariff for their water?

In the 'Additional comments' section, it would be helpful to describe the basis on which some of your 'implementation/no implementation' decisions are made.

Data sources: water company/utility reports and records; regulatory agency reports and records; NGO/ESA urban reports/articles.

E4 There may be several institutions involved in the areas listed, and their status may vary. For example, assessment and research functions may be carried out by a government agency, semi-government body (e.g. geological survey), private company (e.g. water company) and academic institution (e.g. university hydrogeology department)

Additional material:

For Sections E and F, it would be useful to collect as much background material as possible on water policies and planning, the legal and institutional framework, regulations and economic incentives and quality, mobilisation and use of groundwater resources data.

Essential material is likely to include: government policy and legal documents (especially in relation to groundwater rights and regulations); water sector/city reports/reviews by external support agencies (e.g. World Bank; UN agencies), which may be available from country offices; and reports/reviews from water utilities/companies and different government agencies/departments (e.g. regulatory agency) on the implementation of policy, particularly in relation to the monitoring and enforcement of abstraction and pollution controls.

Note: not all information needed will be documented. For example in many countries, groundwater rights have originated in historical use and have been sustained over time by custom, and only sometimes confirmed by specific legislation or constitutional decree. Hence in many cases, the nature of groundwater rights is vague, and use may be determined by long established, customary practices which ignore formal laws and regulations. A groundwater user survey may therefore be necessary to determine what these customary practices and views are.

F. DEGRADATION IMPACTS

F1	THE IMPORTANCE OF GROUNDWATER			
1.1	**Groundwater dependency**	Please tick (√) the appropriate box		
	Proportion of total urban water budget provided by groundwater	High (>50%)	Moderate (20-50%)	Low (<20%)
	Future trend	Increasing Dependency	As now	Decreasing dependency
	Dependence of different uses (total water use): -domestic - industrial - irrigated agriculture -other	High (>50%)	Moderate (20-50%)	Low (<20%)
1.2	**Importance of groundwater-intensive sectors to local economy**			
	The 3 most groundwater intensive economic activities are: 1. 2. 3.	Contribution to municipal output (%)	Groundwater abstraction (m3/year and % total)	Output value $/m3/year
1.3	**Supply-demand balance**	**Please tick (√) the appropriate box**		
	Current abstraction/renewable supply ratio	>1.0	1.0	<1.0
	Projected abstraction/renewable supply ratio	Increasing	Steady	Decreasing
	Additional comments/description:			

F2	COMPETING GROUNDWATER USES: INTERACTION				
	0: no competition; 1: minor competition; 2: moderate competition; 3: severe competition				
		Salinity control	Domestic water supply	Industrial water supply	Wastewater disposal
	Salinity control				
	Domestic water supply				
	Industrial water supply				
	Wastewater disposal				
	Comments:				

F3	STANDARDS OF SERVICE AND EFFICIENCY			
3.1	**Water supply and use**	**Please tick (√) the appropriate box**		
	Per capita domestic water use (l/c/d)	High (>200l/c/d)	Moderate (100-200 l/c/d)	Low (<100 l/c/d)
	Per capita urban water use (l/c/d)			
	Proportion of population with access to utility/company piped supply	High (>70%)	Moderate (50-70%	Low (<50%)
	Unaccounted for water (%)	High (>50%)	Moderate (30-50%)	Low (<30%)
	Use of private water vendors? (if 'yes', state proportion of urban population buying water this way)	Yes	No	
3.2	**Current efficiency**			
	Scope for conservation/pollution control (H, M or L): • leakage control • recycling/reuse • more water-efficient processes • more water-efficient devices • use of low quality water for non-sensitive uses	DOMESTIC SUPPLY	INDUSTRIAL SUPPLY	MUNICIPAL SUPPLY
3.3	**Symptoms of scarcity and pollution**			
	* = no data; 0 = rare/no impact; 1 = infrequent/minor impact; 2 = frequent/moderate impact; 3 = very common/severe impact			
	• Rationing of public supplies (e.g. to 3 days/week) • Queuing at public taps • Purchase of water from private vendors • Breakdown in public supply • Breakdown in treatment • Water-related illness • Rising costs of supply and treatment • Abandonment/relocation of private boreholes/wells due to declining yields and/or declining quality • Relocation of business and industry to more water abundant areas and cities	Frequency/impact	Comments	
	Additional comments/description:			

F4	COSTS AND AFFORDABILITY			
4.1	**Current status**			
√	Average cost of piped water supply production and distribution (US$/m3)	High (>$0.70)	Moderate ($0.30-0.70)	Low (<$0.30)
√	Average recovered cost (from tariffs)	High (80-100%)	Moderate (50-80%)	Low (<50%)
	Price of water in free market conditions, if applicable (US$/m3)			
√	Proportion of average household disposable income spent on water (%/month)	High (>5%)	Moderate (1-5%)	Low (<1%)
	Proportion of municipal budget earmarked for water projects			
	Proportion of municipal public investment programme accounted for by water projects			
	Proportion of foreign aid accounted for by water projects			
4.2	**Alternative supplies**			
	Distance to next major source (km)			
	Incremental cost of next major source (US$/m3)			
	Size of alternative source (m3/year)			
	Additional comments/description:			

HELP NOTES - SECTION F

F1.1 Refer back to Section C. Include both public piped supply and private abstractions

F1.2 This information is needed to find out how important groundwater-intensive activities are to the urban economy, using an objective measure such as output value per unit of water used.

This can be estimated in the following way:

a) Disaggregate industrial groundwater use to particular industrial activities, based on the ISIC coding system (Section D),

b) Identify the three highest groundwater-using sectors and their economic output values, preferably in value added terms,

c) divide output values by water abstraction figures to give a crude indication of the importance of groundwater to the local economy.

Data sources: refer back to Section D for industrial classification based on ISIC codes and industrial water use figures. Groundwater abstraction figures for industrial sectors may be recorded by a regulatory agency, or public utility.

F1.3 Refer back to Sections B and C.

F2 To what extent, if any, do the activities listed in the table conflict with each other? For example, do industrial and domestic users compete for the same groundwater, or do they use different aquifers?

F3.1 Ideally, domestic (household) per capita water use estimates should be provided for different segments of the population (e.g. income groups), as average figures may conceal wide disparities in water use. In the industrialised countries, domestic water use generally exceeds 150-200 l/c/d. In addition, it is useful to calculate total per capita water use (including domestic, industrial and other uses) to give a crude indication of overall levels of water use within the urban area.

F3.2 It is important to find out how efficiently water is currently used by different sectors, and what the potential might be for conservation and pollution control. For example, is recycling/reuse of water (reducing use and effluent discharge) widespread (see also Section D)? Are water-efficient consumer appliances widely used?

If you consider measures to improve the efficiency of water use could be taken relatively easily and at low cost, answer ‘High’ (H) where appropriate.

F4.1-4.2 It is important to know whether future supply options are significantly more difficult and costly than current water supply projects. It is also important to know how affordable any cost increases may be.

Additional material